CHAPTER 4

The Role of Knowledge in the Development of Strategies

David F. Bjorklund
Jacqueline E. Muir-Broaddus
Florida Atlantic University

Wolfgang Schneider
Max-Planck-Institute

Cognition always occurs in some context. When children (or adults) have performed in a particular setting before or have dealt previously with the materials or information pertinent to the task at hand, levels of performance are typically higher than when the context is less familiar. Fischer (1980), in his theory of cognitive development, made much of this fact, postulating that children function at their optimal level (which is set by maturation) only when the environment is maximally supportive.

This dependency upon context is central to issues in the development of children's strategies. Children display high levels of performance and apparently use sophisticated strategies, but only under specific conditions. The environment must be supportive to the extent that it provides prompts or cues for children to use a particular strategy or to the extent that task-relevant information is well known to the children, presumably permitting them to process that information efficiently. When children are presented with similar tasks without prompts or involving less familiar information, task performance and strategy use decline (see Bjorklund & Muir, 1988).

One of the major factors in the development of strategies, we believe, is children's acquisition of knowledge. Children are universal novices (Brown & DeLoache, 1978), knowing relatively little about most of the things they encounter. With age and experience they develop expertise in certain areas; but development of knowledge is rarely uniform across domains, and children find themselves with more pockets of ignorance than of expertise. As a result, when strategies are used effectively, they are typically limited to specific knowledge-defined contexts, rarely generalizing to other situations in which they could be useful.

Although knowledge can be defined very broadly, in this chapter unless otherwise stated, we define content knowledge in terms of information in a modified network model of semantic memory (see Bjorklund, 1987). Each item in semantic memory is defined by a node that is connected to other nodes in semantic memory. In addition to connections with other items, each node also has associated with it features that characterize it. In development, the number of nodes changes, as do the number and strength of connections among items. Also, the number of features associated with an item changes developmentally, as does the feature hierarchy (i.e., the priority given to various features associated with an item, cf., Gibson, 1971). When referring to a "domain" of knowledge, we refer to semantic knowledge that is highly interrelated, such as a knowledge of the game of chess, the rules of soccer, or the composition of one's school class. Strategies and their development can best be understood when one considers the domain of knowledge to which a strategy is applied.

Of course, we do not mean to imply that all there is to development is the acquisition of knowledge. Rather, knowledge represents a center stage around which both more elementary and specific and more complex and global processes revolve. Factors that influence the encoding of stimuli, the selective attention to relevant features of events, and the ease with which information can be represented in memory all affect the state of a person's knowledge. Similarly, one's knowledge base will influence (and will be influenced by) effortful strategies and metastrategies for operating on information. The effects on performance of developmental differences in the knowledge base cannot in and of themselves adequately explain age differences in thinking; however, we believe that an understanding of developmental differences in the knowledge base and their effects on cognition are central to understanding strategy development, and cognitive development generally.

DEVELOPMENTAL DIFFERENCES IN KNOWLEDGE, MENTAL EFFORT, AND STRATEGY USE

The Relation Between Knowledge and Mental Effort

There is little controversy in the statement that a child's knowledge of the world increases over the course of development. What is more controversial is the assumption that these quantitative differences in content knowledge determine developmental differences in cognition (e.g., Carey, 1985). We do not make this strong claim here. We believe that many aspects of cognitive development are qualitative in nature (although the mechanisms underlying these qualitative changes may be quantitative). However, we also contend that quantitative changes in knowledge play a critical role in shaping children's cognitions, and many of the differences found on a wide range of cognitive tasks between children of different ages can be attributed to differences in their knowledge bases (see Bjorklund, 1989; Carey, 1985; Chi, 1985).

With respect to the development of strategies, having detailed knowledge for a particular domain permits a person to process information from that domain more efficiently, with knowledge (and processing efficiency) increasing developmentally (e.g., Bjorklund, 1985, 1987; Bjorklund & Harnishfeger, 1989, 1990; Muir-Broaddus & Bjorklund, in press). Basically, similar to Case (1985), we propose that cognitive resources are limited, with children becoming more effective in allocating their limited pool of resources for the execution of cognitive operations with age.

One aspect of information processing that involves a portion of these shared, mental resources is the activation (or identification) of the information. When children are highly familiar with the items on a cognitive task or the relations among items, less in the way of mental resources is required to activate those items. By expending less of one's limited cognitive capacity for the activation of relevant task information, more resources can be allocated to the short-term storage of information or to the execution of resource-expensive *strategies*. Thus, as children's knowledge becomes more detailed and better integrated, individual items and sets of related items can be accessed with reduced amounts of mental effort, affording more resources for the execution of effortful strategies.

Figure 4.1 presents a schematic representation of how having substantial knowledge for a particular domain may result in increased strategy use, and in turn, increased task performance. The primary effect that an elaborated knowledge base has on cognitive processing is to increase speed of processing for domain-specific information. Individual items can be accessed more quickly from the long-term store, as can relations among related items in the knowledge base. In the current model, faster processing is equated with more efficient processing, which results in greater availability of mental resources. These mental resources can then be applied to retrieving specific items (item-specific effects, Bjorklund, 1987; Muir-Broaddus & Bjorklund, in press), to domain-specific strategies, or to metacognitive processes. Domain-specific strategies can directly facilitate task

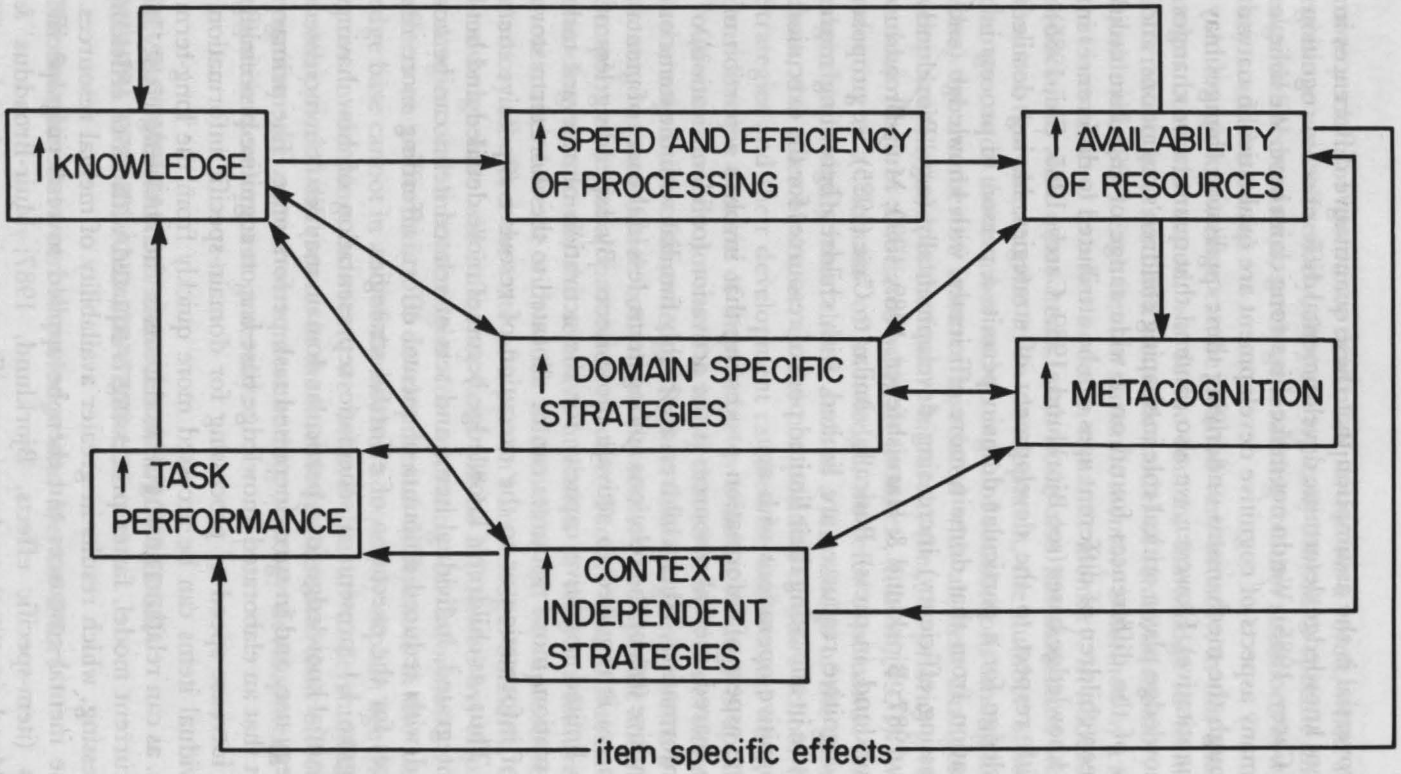

FIG 4.1. Model of the effects of knowledge on information processing and acquisition of subsequent knowledge.

performance, as can context-independent strategies, both of which can in turn affect subsequent metacognitive processes. This feedback loop between metacognitive processes and strategy use can take many forms. For example, in a free-recall task, children may begin to recall items according to categorical relations, with such clustering being guided primarily by strong interitem associations. In monitoring their recall, they may note some of these relations and more systematically guide their subsequent retrieval by this categorical scheme (see Bjorklund & Zeman, 1982).

This, of course, represents merely a brief sketch of the relation between knowledge, mental effort, and strategy use. Having detailed knowledge can facilitate task performance in ways other than via strategies, but strategies are the emphasis of this chapter. Our point in the review that follows is to illustrate how developmental differences in knowledge play an important role in the development of strategies.

Strategies as Effortful Processes

In this chapter, strategies are defined as being effort consuming. They are goal directed in that they are not ends in themselves but deliberate means to an end, the end being enhanced task performance. Strategies achieve cognitive purpose and are potentially conscious and controllable activities (cf. Flavell, 1985). When tasks can be successfully completed without the use of strategies, there is no reason to expect effortful operations to be used. Thus, when children can use relatively automatic and thus effortless processes to solve a problem, there is no need for the use of strategies. And when a process has been exercised so thoroughly that it is executed without conscious awareness, bringing the specific procedures involved in that operation to consciousness can actually impede cognition. Whether these formerly conscious and effortful but now unconscious and effortless procedures should be called strategies is certainly arguable (see Paris, Lipson, & Wixson, 1983; Schneider & Pressley, 1989). However, in the present context, we use the term *strategy* to refer to cognitive operations that are effortful and subject to consciousness.

Strategies then, as defined here, are not necessary for all forms of complex cognition and may not always facilitate task performance, although this is the intent of using them. In fact, based on the assumption that the use of strategies requires large amounts of a child's limited mental resources, there should be situations where task performance will actually be hindered (or at least not greatly facilitated) by the use of a strategy. This occurs when the execution of the strategy depletes so much of a child's information-processing capacity that too little remains for allocation to other aspects of the task. Older children and adults, by comparison, are able to take advantage of the greater efficiency that a strategy affords because they have sufficient mental resources available (e.g., Bjorklund & Harnishfeger, 1987; DeMarie-Dreblow & Miller, 1988; Guttentag, 1984; Kee & Howell, 1988).

Evidence of developmental changes in efficiency of strategy execution has been obtained in dual-task experiments, in which performance on a secondary task (finger tapping, for example) is evaluated as a function of performance on a primary task (free recall, for example). Using dual-task paradigms, there is evidence that when performance is equivalent across different age groups there may nevertheless be age-related differences in the mental resources consumed by strategy implementation (e.g., Bjorklund & Harnishfeger, 1987; Guttentag, 1984; Kee & Davies, 1988; Kee & Howell, 1988; for a review of this work see Guttentag, 1989). Although we are confident that one of the reasons for these increases in efficiency with age is related to maturationally based changes in the speed with which information can be processed (e.g., Dempster, 1985; Kail, 1986, 1988), we are equally confident that age-related differences in knowledge also contribute significantly to this developmental change (e.g., Roth, 1983).

The greater efficiency afforded by a strategy must be weighed against the depletion of limited resources required for the execution of that strategy. This trade-off has consequences that will vary with the age (and thus processing efficiency) of the child. In general, children can execute a strategy more efficiently with age (i.e., using less in the way of mental resources), making that strategy more likely to be beneficial to task performance.

KNOWLEDGE AND THE DEVELOPMENT OF STRATEGIES

Evidence from Nonmemory Research

A developmental relationship between knowledge, mental effort, and strategy use has been demonstrated for a broad range of tasks, including mathematics, reading, and problem solving.

Mathematics

In the domain of mathematics, increases in strategy sophistication and factual and procedural knowledge act to increase processing efficiency, and thereby decrease the mental effort requirements of mathematical operations. Although children as young as 5 and 6 years demonstrate some fact retrieval, as shown by their fast performance of simple operations with small whole numbers (e.g., Hamann & Ashcraft, 1985), they quickly revert to overt strategies such as finger counting as problem difficulty increases (Siegler & Shrager, 1984). For the most part, then, young children rely on simple but relatively effortful strategies, such as counting each element separately in order to determine the total (Siegler, 1987). Another early strategy is the *min* procedure, which entails setting one's "mental counter" at the larger of two numbers to be added, and then counting by increments of one until the second smaller number has been added to the first (Ashcraft & Fierman, 1982; Siegler, 1987). As predicted by the min model, reaction times are proportional to the size of the numbers being added (Groen & Parkman, 1972; Groen & Resnick, 1977), attesting to the laborious nature of this early counting procedure.

Although Ashcraft and Fierman (1982) found that the transitional stage between the min strategy and fact retrieval occurs around the third grade level, Siegler (1987) has provided evidence that as early as first and second grade, children performed more fact retrieval and decomposition (transforming a problem into two or more simpler ones) than their kindergarten counterparts. Though decomposition is an effortful strategy, it has the effect of reducing the mental effort requirements of the necessary computations. Thus, with age, there is a gradual transition from the use of "labor-intensive" to "labor-efficient" techniques, and from effortful (strategies) to automatic (fact retrieval) processes in the domain of arithmetic. As these processes become more efficient, moreover, their mental effort requirements are further lessened.

Reading

The significance of mental effort has also been emphasized in the domain of reading. Following a model of mental resources similar to what we have ascribed (Case, 1985), Daneman and her colleagues have examined the interplay between the processing and storage functions of working memory in an attempt to understand developmental and individual differences in reading comprehension (e.g., Daneman & Blennerhassett, 1984; Daneman & Carpenter, 1980; Daneman & Green, 1986). Basically, they proposed that it is necessary for information to be retained in working memory for as long as possible so that each newly read word in a passage can be integrated with the words and concepts that preceded it. Younger or less proficient readers have less available capacity to store and maintain information in working memory because it is necessary for them to devote considerable capacity to the processes involved in comprehension (Daneman & Blennerhassett, 1984). These include anything from letter decoding to concept integration. Alternately, young children also have fewer resources to devote to comprehension processes because more capacity is consumed by storage and maintenance functions.

This trade-off between processing, storage, and comprehension was examined across a variety of age groups. For example, in a study of prereaders, Daneman and Blennerhassett (1984) provided convincing evidence that listening span, defined as the number of successive short sentences that could be recalled verbatim, correlated significantly with comprehension. The second experiment of this two-part study was especially convincing because of the systematic variations made in the level of integration required for comprehension. They reasoned that the greater the required level of integration, the greater the processing demands on working memory and thus the less capacity remaining for storage. As expected, the greater the required level of integration, the greater was the performance advantage of large-span over small-span listeners in terms of comprehension. Daneman and her colleagues have arrived at similar interpretations in experiments with older children and adults (e.g., Daneman & Carpenter, 1980; Daneman & Green, 1986).

One factor believed to influence the efficiency of text processing is knowledge. Anderson and his colleagues (Anderson, Hiebert, Scott, & Wilkinson, 1984) defined reading as "a process in which information from the text and the knowledge possessed by the readers act together to produce meaning" (p. 8). In other words, "reading is a constructive process" (p. 9), in which the background knowledge that one brings to a text interacts with its literal content to produce inferences and interpretations of varying degrees of concordance with the author's intended purpose. Anderson et al. cited considerable evidence from the research literature to support these claims. In a study by Pearson, Hansen, and Gordon (1979), for example, second graders who were equated in reading skill were tested for their knowledge of spiders and then given a passage about spiders to read. The children who knew more about spiders at the outset were better at answering subsequent questions about the passage, especially those questions that involved reasoning. Instructional efforts aimed at increasing background knowledge have also been found to enhance reading comprehension (e.g., Hansen, 1981; Hansen & Pearson, 1983; Omanson, Beck, Voss, & McKeown, 1984). In more recent research, Schneider, Körkel, and Weinert (in press) compared the text comprehension of soccer expert with soccer novice third-, fifth-, and seventh-grade children on stories related to soccer. The soccer experts showed significantly greater comprehension, with performance being unrelated to individual differences in intelligence. In other words, domain-specific knowledge was more important for comprehension than intelligence (see also Recht & Leslie, 1988; Walker, 1987). Knowledge, then, clearly makes reading more accurate and meaningful. It also makes reading less effortful, in that knowledge provides "ready made" inferences and interpretations to the reader.

Problem Solving

The relationship between knowledge, mental effort, and strategy use is also evident in the study of problem solving. Considerable research has explored the role of knowledge by comparing the problem-solving characteristics of experts and novices. One robust finding has been that the two groups categorize problems differently (e.g., Chi, Feltovich, & Glaser, 1981; Chi, Glaser, & Rees, 1982), with novices tending to categorize problems by their surface features and experts tending to categorize them by their underlying principles. A study comparing novices and experts in the domain of physics, for example, found that novices grouped the problems according to characteristics of the problem statement, such as all those problems involving a certain object (such as a rotating disk), or containing certain physics-related keywords (such as "friction"). Experts, on the other hand, categorized problems according to their "deep structure," such as the relevance of Newton's second law (Chi et al., 1981). These differences between novices and experts have been interpreted as reflecting characteristics of the "problem schema" by which problems are encoded and represented (Chi & Greeno, 1987). For the expert, schemas include secondary procedural knowledge about the applicability of existing strategies to the specific demands of the problem, thereby enabling inferences about the problem (i.e., the relations among problem components) and its solution to be drawn. In this way, strategies can be viewed as simply one component of a rich knowledge base. With experience, problem and solution become increasingly intertwined in a single problem schema, so that the activation of appropriate problem-solving strategies becomes increasingly automatic.

Knowledge, then, plays a considerable role in determining the mental effort requirements of a problem-solving task. Unlike experts, who can attack a problem armed with a well developed schema and pre-existing problem representation, the problem solving of novices is carried out on line (Chi & Greeno, 1987). That is, solutions must be derived from the problem itself instead of being selected from an available schema, and resources are consumed in the ongoing process of developing a schema where none or next-to-none existed before.

There is considerable evidence from research in nonmemory domains of the interrelationships between knowledge, mental effort, and strategy use. Common themes that emerge from the domains of arithmetic, reading, and problem solving are that knowledge provides the necessary background information and context to appropriately and efficiently guide the comprehension of a passage or problem. It also frees mental effort for the implementation of strategies appropriate for carrying out the task at hand. As these strategies become more efficient, more of one's mental capacity remains for higher level comprehension, increasingly complex strategies, and the acquisition of more detailed and integrated knowledge.

Evidence from Memory Research

Knowledge and the Development of Rehearsal Strategies

Recent work by Ornstein, Naus, and their colleagues suggests that the much cited change in rehearsal style over childhood (from passive to active, or cumulative, e.g., Ornstein, Naus, & Liberty, 1975) is attributed, in part, to changes in children's knowledge base. For example, Tarkin, Myers, and Ornstein (cited in Ornstein & Naus, 1985), compared third graders' overt rehearsal for two word lists that differed in meaningfulness, with *meaningfulness* defined in terms of the extent to which the words elicited associations. Large differences in spontaneous rehearsal were observed, in that fewer than two words were typically rehearsed together when the list was low in meaningfulness, whereas more than three words tended to be grouped together during rehearsal of the highly meaningful list.

In related research, Zembar and Naus (1985) reported more sophisticated rehearsal for sixth versus third grade children when a standard set of words served as the stimulus list. However, differences in rehearsal style and recall were eliminated when the third graders were given a list of highly familiar words (e.g., *shoe, doll*) and the sixth graders were given a list of difficult, unfamiliar words (e.g., *limpet, galleon*). In other research, soccer expert and novice college students were given lists of categorized words to rehearse and recall (cited in Ornstein & Naus, 1985). One list consisted of soccer-related words, whereas a control list consisted of nonsoccer words. No group differences emerged for the control list; on the soccer list, however, experts grouped together more items from each category during rehearsal than the novices, and subsequently showed superior recall.

Findings such as these indicate a potent relationship between knowledge and strategy use. When subjects are familiar with the to-be-processed items, they are apt to use a more sophisticated rehearsal strategy that results in enhanced levels of performance. The experiments by Ornstein and Naus clearly indicate that patterns of strategy use can be manipulated by varying the materials with which subjects are presented. They also indicate that the age-related changes typically observed in children's rehearsal activities are influenced by similar developmental changes in knowledge.

Knowledge and the Development of Organizational Strategies

Perhaps the area of memory research that has contributed most to our understanding of the developmental relationship between knowledge and strategy use concerns organization. There have been a number of studies in which children's familiarity for sets of related items has been manipulated, with investigators assessing levels of recall and strategy use (usually categorical clustering). Although several studies have examined children's tendencies to use taxonomic/conceptual versus complementary schemes in memory tasks (e.g., Bjorklund & Zaken-Greenberg, 1981; Lange & Jackson, 1974; Worden, 1976), more recent studies have manipulated children's knowledge of categorical relations in terms of *category typicality* (e.g., Ackerman, 1986; Bjorklund, 1988; Bjorklund & Bernholtz, 1986; Corsale & Ornstein, 1980; Rabinowitz, 1984, 1988). In general, the results of these studies indicate that children are more apt to use a strategy effectively when the stimulus items are highly representative (i.e., typical) of their categories.

Category Typicality and Children's Strategy Use. Research by Rabinowitz (1984, 1988) provides a good example of the relationship between category typicality and strategy use. In one experiment, second and fifth grade children were presented with sets of highly typical (e.g., *cat, horse*) or moderately typical (e.g., *fox, goat*) category exemplars for free recall (Rabinowitz, 1984). Subjects in the category condition were told of the categorical nature of the list and instructed to remember the items by categories. Subjects in the standard condition were given conventional free-recall instructions. Rabinowitz reported that differences in recall between the category and standard conditions were greater (in favor of the category condition) for the highly typical than the moderately typical list items. In other words, subjects were better able to take advantage of the categorical instructions to benefit recall for the highly typical items. These findings were supported in a later experiment with adults (Rabinowitz, 1988), in which greater awareness of an instructed organizational strategy and greater transfer of that strategy was demonstrated for items rated as high as opposed to medium or low in category typicality. In both of Rabinowitz's experiments, overall recall was greater for the high than for the less typical items, as were the benefits of strategy use and transfer, clearly illustrating an interaction between knowledge base and strategy use.

In related research, Bjorklund and his colleagues (Bjorklund, 1988; Bjorklund & Buchanan, 1989) assessed children's acquisition and generalization of an organizational strategy for sets of typical and atypical items over repeated trials. As in previous research, levels of recall and clustering were greater for the sets of typical than atypical items, with age differences being most apparent for the atypical items. Children were also classified as using an organizational strategy on each trial, separately for the typical and atypical items, using a procedure developed by Bjorklund and Bernholtz (1986). Children were classified as strategic if they had at least one long intracategory cluster (three words or more) and fast within-category interitem latencies (i.e., their mean within-category interitem latencies were faster than their mean between-category interitem latencies).

The number of fourth and seventh grade children classified as strategic using this dual criterion is shown for the typical and atypical items over trials in Table 4.1. As shown in the table, seventh graders were more apt to be classified as strategic than the fourth graders,

TABLE 4.1 Number and Percentage of Subjects Classified as Strategic by Grade, Typicality, and Trial

	Trial			
	1	*2*	*3*	*4*
Fourth Grade				
Typical	11 (32%)	10 (29%)	17 (50%)	22 (65%)
Atypical	2 (6%)	10 (29%)	11 (32%)	18 (53%)
Seventh Grade				
Typical	16 (50%)	25 (78%)	24 (75%)	29 (91%)
Atypical	7 (21%)	18 (56%)	20 (63%)	24 (75%)

Note. From "Acquiring a Mnemonic: Age and Category Knowledge Effects" by D. F. Bjorklund, 1988, *Journal of Experimental Child Psychology, 45*, p. 80. Copyright 1988 by Academic Press.

children were more apt to be classified as strategic for the typical than for the atypical items, and there was a dramatic increase in strategic classification over trials. As can be seen from the table, most children were not classified as strategic on the initial trial. This is especially apparent for the atypical items. However, the situation was substantially different by the fourth trial. Most seventh grade children were classified as strategic for both the typical and atypical items. In fact, *every* seventh grade child was classified as strategic on Trial 4 for either the typical or atypical items. The pattern was similar although less pronounced for the fourth graders, with 74% of these children being classified as strategic for at least one set of items on the final trial.

The findings of the Bjorklund (1988) study were bolstered by a training experiment by Bjorklund and Buchanan (1989), in which third, fifth, and seventh grade children were trained to use an organizational strategy on sets of either typical or atypical items (Experiment 2). Following training, children were given a second list of items on a generalization task, with half of the children receiving category-typical items and half receiving category-atypical items. The training lists (typical or atypical) were orthogonal to the generalization lists (typical or atypical). As in the Bjorklund (1988) investigation, children were classified as strategic using the dual criterion of at least one long intracategory cluster and fast within-category latencies.

The results of training were impressive in that there were no grade differences in the percentage of children classified as strategic for the typical items by the final (third) training trial (88%, 94%, and 94% for the third, fifth, and seventh graders, respectively). Grade differences were apparent, however, for the atypical items (56%, 63%, and 91% classified as strategic for each grade, respectively), although more than half of the third grade children tested were classified as strategic for these items. In assessing generalization, it was found that children at each grade level showed higher levels of recall and clustering when they had been trained on the category-typical items (cf. Rabinowitz, 1988). Patterns of results were similar for the strategy-classification measure. Moreover, grade differences in strategy classification on the generalization trials were limited to the atypical items.

Bjorklund and Buchanan (1989) proposed that the greater saliency of the typical categories, and the increased ease of accessing one category member given another, resulted in higher levels of recall relative to children who received training with sets of atypical items. This heightened performance may have provided children with the opportunity to assess more intently the organizational mnemonic they were being taught, resulting in greater inculcation of the strategy than found for children who were given the atypical lists. This, in turn, led to greater generalization. Bjorklund and Buchanan (1989) concluded that using highly typical items makes the training of a strategy easier and the generalization of that strategy more likely. "Children's earliest successful memory strategies begin with highly familiar information and so do successful training efforts" (p. 469). They also commented that, although children of all ages display greater levels of performance and strategy use with sets of typical as opposed to atypical items, younger children's strategy use is especially affected by the use of atypical items. "The less sophisticated children are with respect to strategy use, the more important knowledge base factors are to their performance" (p. 470).

Associative Versus Categorical Relations. Other research has examined developmental differences in strategy use when list items can be related on the basis of both associative *and* categorical relations (e.g., Bjorklund & de Marchena, 1984; Bjorklund & Jacobs, 1985; Frankel & Rollins, 1982, 1985; Lange, 1973; Schneider, 1986). Associative relations are believed to be formed prior in development to categorical relations (Bjorklund & Jacobs, 1984), with the activation of one item eliciting its associate in an automatic (i.e., effortless) fashion.

In one experiment by Schneider (1986), second and fourth grade children were given a sort/recall task, with categorizable pictures serving as stimuli. Four different types of lists were used that varied in degree of category and interitem relatedness (cf. Frankel & Rollins, 1985). One list contained items that were highly related to the category with high interitem associations among some of the items on the list (high related–high associated). A second list was composed of items highly related to the category but with low interitem associations (high related–low associated). A third list was composed of items that were weakly related to the category, although some were highly associated (low related–high associated), and a fourth list consisted of words low in both category relatedness and interitem associativity (low related–low associated). Examples from the category "animals" for each list type are shown in Table 4.2.

In general, more clustering was found for the highly associated lists, and the fourth graders had higher levels of recall and clustering and sorted items according to categorical membership to a greater degree than the second graders. Most importantly, there was a striking age-by-list associativity interaction in the clustering data, such that low associativity especially penalized the younger children. There were also significant correlations between sorting at study, clustering, and recall, with particularly high correlations (all *r*s > .5) for the older

TABLE 4.2 Examples of Items by List-Type

High related-high associated list:	dog, cat, pig, horse, cow, mouse
High related-low associated list:	tiger, elephant, cow, pig, bear, dog
Low related-high associated list:	goat, deer, buffalo, hippopotamus, monkey, lamb
Low related-low associated list:	beaver, rat, alligator, camel, squirrel, giraffe

Note. From "The Role of Conceptual Knowledge and Metamemory in the Development of Organizational Processes in Memory" by W. Schneider, 1986, *Journal of Experimental Child Psychology, 42,* p. 222. Copyright 1986 by Academic Press.

children. Overall, what emerges from this study is a portrait of second graders who use organizational strategies much less than fourth graders. This is a qualified conclusion, however, in that younger children's use of the clustering strategy can be evoked when the categories contain highly associated items.

In a related experiment by Bjorklund and Jacobs (1985), children from Grades 3, 5, 7, and 9 were given categorized lists of words to recall that varied in the associative strength among items within a category. Within each five-item category, two pairs of items were high associates of each other (e.g., *cat, dog* and *lion, tiger*). A fifth item (e.g., *cow*) was not strongly associated with any of the other list items. Thus, in remembering category items together, a subject could recall items contiguously that are high associates of one another (e.g., *dog, cat*), or could recall items that are related to one another strictly on the basis of category relationship (i.e., not high associates, e.g., *dog, lion; cow, tiger*). Lists of items were presented to subjects in one of three ways: randomly, blocked by categories with highly associated items separated within the list (blocked), and blocked by categories with highly associated items presented contiguously (blocked associate).

Patterns of recall and clustering varied with grade and presentation condition, with performance being greatest in the blocked-associate condition and least in the random condition for all grades. More interesting than levels of recall, however, was the pattern of correlations between recall and clustering. Bjorklund and Jacobs argued, as have others (e.g., Frankel & Rollins, 1985; Jablonski, 1974), that high, positive correlations between recall and clustering are indicative of strategic functioning. These correlations, presented in Table 4.3, were significant for all grade levels for subjects in the blocked condition, indicating that the blocking manipulation resulted in the identification and use of an organizational strategy even by the youngest subjects tested here (8- to 9-year-olds). However, these correlations were nonsignificant for the third, fifth, and seventh graders

TABLE 4.3 Correlations Between Recall and Clustering by Grade and Condition: Experiment 1

	Condition		
Grade	*Random*	*Blocked*	*Blocked Associate*
Third	.16	.45*	.08
Fifth	.13	.56*	–.04
Seventh	.32	.69*	.28
Ninth	.59*	.66*	.51*

* $p < .05$.
Note 1. All $df = 18$.
Note 2. From "Associative and Categorical Processes in Children's Memory: The Role of Automaticity in the Development of Organization in Free Recall by D. F. Bjorklund and J. W. Jacobs, *Journal of Experimental Child Psychology,* 1985, *39,* p. 605. Copyright 1985 by Academic Press. Reprinted by permission.

in both the random and blocked-associate conditions. Only for the ninth graders were the correlations between recall and clustering significant for these two conditions. Thus, despite the high levels of recall and clustering observed in the blocked-associate condition, the organization observed here for the third, fifth, and seventh graders was apparently mediated by the relatively effortless activation of associative relations, and not by strategic (i.e., deliberate) processes.

A similar pattern of correlational results has been reported in a recent study by Hasselhorn (1989). Second and fourth grade children were presented with lists varying in categorical relatedness (high versus low) and associativity (high versus low) (cf. Schneider, 1986). In a free-recall condition, Hasselhorn reported nonsignificant correlations between recall and clustering for both the high and low associated lists, and for the low categorical lists for both the second and fourth grade subjects. For the high categorical lists, the correlation between recall and clustering was again low for the second graders ($r = .08$) but higher and approaching significance for the fourth graders ($r = .30$). Thus, using the relationship between clustering and recall as an indication of strategic processing, only the oldest children could be considered to be strategic, and this only for the high categorical lists.

Knowledge and Organization at Output

With respect to the development of organizational strategies, Bjorklund and his colleagues have proposed that the organization that is initially seen in the recall of most young children is mediated not by a deliberately imposed strategy, but rather by the relatively automatic activation of well established semantic memory relations. In the process of this associatively mediated retrieval, children may notice categorical relations in their recall, and may then proceed to use this fortuitously discovered organizational strategy to guide the remainder of their recall (Bjorklund, 1985, 1987; Bjorklund & Jacobs, 1985; Bjorklund & Zeman, 1982, 1983).

Such a process was inferred in experiments by Bjorklund and Zeman (1982, 1983), who asked children to recall the members of their current school class. Although levels of recall and clustering were high for children of all grades (first, third, and fifth) when asked to retrieve the well known names of their classmates, metamemory interviews indicated that few children at any grade were aware of using an organizational strategy. Moreover, examination of children's clustering for each *half* of recall indicated that many children apparently switched organizational schemes in the course of recall. Bjorklund and Zeman concluded that few children began the class-recall task in a strategic (i.e., deliberate) way. However, because of the associative nature of their recall, organizational schemes (e.g., recalling children by seating arrangements, sex) were discovered by some children and used to direct the remainder of their recall. Children who, during the metamemory interview, were able to profess accurately a strategy they had used in recalling their classmates' names (as reflected by their clustering scores) had higher overall levels of recall and clustering than children who were unable to accurately profess a strategy. These data suggest that the use of a strategy does facilitate performance (although even the performance of the nonstrategic children was high in an absolute sense), with the strategy being "discovered" because of the familiar (and highly associative) nature of the to-be-remembered material.

More direct evidence for this position comes from an experiment by Bjorklund and Jacobs (1985), outlined briefly above. To reiterate the design, third, fifth, seventh, and ninth grade children were given categorized lists to recall consisting of items related on the basis of both categorical and associative relations (e.g., *dog, cat, cow, lion, tiger*). Children's intracategory clusters of three words or more were examined as a function of whether these clusters were led by an associative pair (e.g., *dog, cat, cow*) or not (e.g., *dog, cow, cat*). In the random condition, where subjects were not biased by order of item presentation to recall words either by categories or by associates, a nonmonotonic developmental relationship was observed. As shown in Fig. 4.2, the proportion of category clusters led by a high associate peaked for the seventh and ninth grade children. These values were significantly lower for the younger children and for a group of adults (who were run in the random condition only).

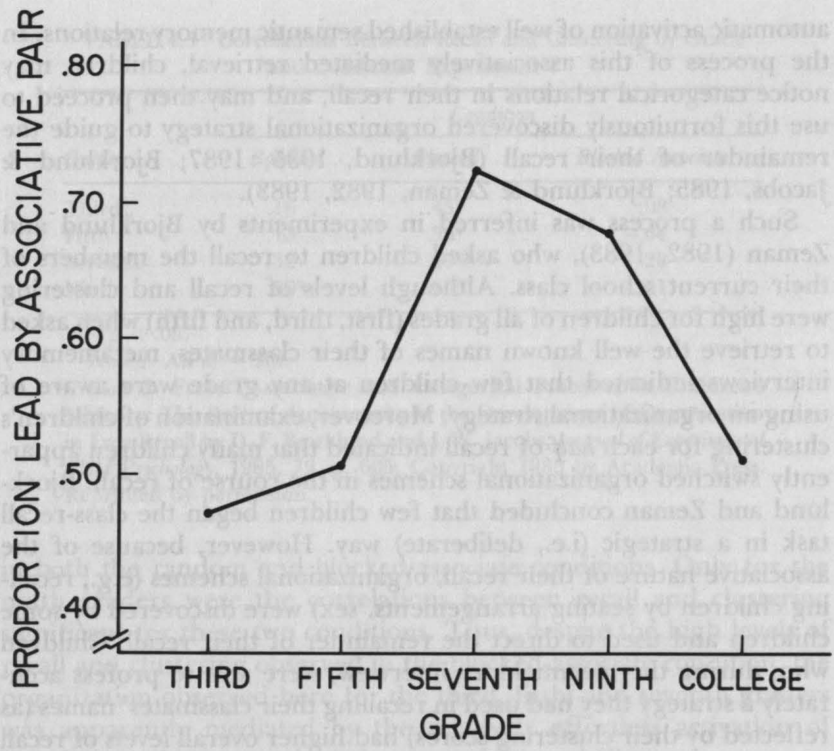

FIG 4.2. Proportion of total number of intracategory word strings of length three, four, and five to those leading with a high-associative word pair by grade. Data from "Associative and Categorical Processes in Children's Memory: The Role of Automaticity in the Development of Organization in Free Recall" by D. F. Bjorklund and J. W. Jacobs, *Journal of Experimental Child Psychology*, 1985, *39*, p. 613. Copyright 1985 by Academic Press. Reprinted by permission.

Bjorklund and Jacobs (1985) interpreted these results as reflecting the fact that the seventh and ninth grade children were making use of the high associative relations to instigate categorical recall. As a result of the relatively automatic activation of associative relations, pairs of categorically related items were retrieved contiguously. These older children then used these associatively retrieved pairs as prompts for other categorically related items. The proportion of category clusters led by associative pairs was less for the adults, presumably, because they were sufficiently strategic so that they did not require high associativity to prompt categorical recall. In contrast, nonassociated category relations were not easily activated by the third and fifth graders, making the associative prompts relatively ineffective in eliciting subsequent clustering.

What may cause children, who apparently begin the task in a nondeliberate manner, to begin to use an organizational strategy in the course of recall? Bjorklund and his colleagues suggested a process akin to Piaget's (1971) idea of *reflective abstraction* (Bjorklund, 1980, 1985, 1987; Bjorklund & Jacobs, 1985; Bjorklund & Zeman, 1982). Preadolescent children have the ability to reflect upon the outcomes of their own cognitions. In the present context, children are able to examine the products of their recall efforts and, in the process, may recognize previously unnoticed relations among the recalled items. Reflective abstraction is a conscious and effortful process, although it is likely not planful, in that children do not enter a task with the idea of evaluating the products of their recent cognitions. However, because it is resource consuming, children are not likely to engage in reflective abstraction until other aspects of task processing can be executed efficiently. Accordingly, children's "discovery" of an organizational strategy should be most apt to occur for sets of items that are well represented in their semantic memories, such as the names of their classmates and highly associated words. It is primarily in this way, we believe, that deliberate and effective strategies are typically mediated in development.

We must emphasize here that this picture of the acquisition of an organizational strategy is meant to describe the developmental progression for tasks where children are not biased to organize information at time of presentation. For example, in sort/recall paradigms, where children are allowed (and sometimes required) to group items according to meaning prior to recall, there is clear evidence of spontaneous strategy use in preadolescent, and even preschool, children (e.g., Bjorklund & de Marchena, 1984; Bjorklund & Zaken-Greenberg, 1981; Kee & Bell, 1981; Schneider, 1986; Schneider, Borkowski, Kurtz, & Kerwin, 1986; Sodian, Schneider, & Perlmutter, 1986). The discrepancy between these results and those reported when sorting prior to testing is not possible, can be attributed to differences in task difficulty. Sort/recall tasks are easier to handle for young children because children usually have sufficient time to encode the stimulus items, and the instructions often bias children to form meaningful groupings of items, which is not the case in most free-recall (nonsorting) experiments. In general, adequate encoding strategies (i.e., sorting according to categories) greatly facilitates subsequent retrieval.

Success in nonsorting free-recall tasks, on the other hand, heavily depends on the efficiency of the retrieval strategies. There is evidence that young elementary school children's problems with semantic categorization tasks are due more to deficiencies in retrieval strategies than to deficiencies in encoding relevant information (cf. Ackerman, 1985, 1987; Brainerd, 1985). It is not surprising, then, that elementary school children seem able to spontaneously use organizational strategies during encoding in sort/recall tasks, but fail to employ organizational strategies at retrieval in free-recall tasks where sorting is not permitted. It is only for the latter type of task that spontaneous use of organizational strategies is rarely observed in preadolescent children. However, we should note that differences in the familiarity of the task materials also influences children's tendencies to organize information at input in sort/recall tasks. Younger children require more obvious and strongly associated relations among items (e.g., Corsale & Ornstein, 1980; Schneider, 1986) or more explicit prompts from the experimenter (e.g., Bjorklund, Ornstein, & Haig, 1977) before displaying strategic organization.

STRATEGIES, THE KNOWLEDGE BASE, AND METAMEMORY

So far, we have restricted our review to studies that examined the role of semantic knowledge on children's strategies. There are other aspects of knowledge that can affect strategies as well. Since the early seventies, research on metamemory has explored the relevance of knowledge about memory for strategy use and performance in various tasks (see Cavanaugh & Perlmutter, 1982; Flavell, 1985; Schneider, 1985; Wellman, 1983, for reviews of the literature).

In most taxonomies of metamemory, a distinction is made between *declarative* and *procedural* knowledge components. The declarative component taps factual knowledge about memory by using metamemory questionnaires or interview procedures. More specifically, declarative metamemory includes knowledge about mnemonic persons, tasks, and strategies. The person category addresses the child's mnemonic self-concept, including ideas about his or her own memory strengths and weaknesses. Task variables include factors that make a memory task easier (e.g., familiarity with learning materials, high interitem associations). Finally, the strategies variable refers to verbalizable knowledge about encoding and retrieval strategies.

Although measures of declarative metamemory are taken without concurrent memory assessment (independent measures), measures of procedural knowledge are collected simultaneously with the measurement of memory activity (concurrent measures). They tap awareness of ongoing processes (memory monitoring) and mostly consist of judgments or feelings about the ease or difficulty of remembering something. Examples of memory monitoring measures include performance predictions and recall-readiness assessments.

It has been shown in numerous studies that both declarative and procedural metamemory components are developing rapidly during the elementary school years (see Schneider & Pressley, 1989). Although this seems to be an interesting finding in its own right, the question crucial for most researchers in the field has been how and to what degree increases in metamemory influence children's strategy use and performance in memory tasks.

Interrelations Among Organizational Strategies, Semantic Knowledge, and Metamemory

We have stated earlier in this chapter that most young children do not use organizational strategies spontaneously. Given that strategy use, as defined in this chapter, is principally conscious and intentional, the expectation is that strategy usage should covary with the ability to verbally describe and explain strategic behavior (i.e., declarative metamemory). Theoretically, all children applying an organizational strategy should also possess the relevant declarative strategy knowledge, but not necessarily vice versa (cf. Wimmer & Tornquist, 1980). In the aforementioned study by Schneider (1986), this assumption was tested by assessing different aspects of children's declarative metamemory. Metamemory measures included an interview tapping general metamemory, an interview dealing with knowledge about organizational strategies, and a paired-comparison judgment task developed by Justice (1986) to assess children's judgments of strategy effectiveness.

The data showed that the different components of metamemory were related to memory performance in fourth graders but not in second graders. Moreover, individual differences in task-related metamemory (i.e., knowledge about organizational strategies) were important predictors of strategy use and recall for the fourth-grade children. In contrast, second graders' task-related metamemory was not related to sorting at study or clustering during recall. These findings demonstrate that second graders are relatively unaware of the importance of organizational strategies for facilitating recall on sort/recall tasks, indicating that output organization (i.e., clustering during recall) is involuntarily guided by associations between items rather than by category grouping principles (cf. Bjorklund & Jacobs, 1985; Bjorklund & Zeman, 1982). Deliberate use of organizational strategies is typically not found in this age group.

On the other hand, fourth graders seem to be in a transitional state concerning the flexible use of organizational strategies. About half of the sample of fourth graders in Schneider's (1986) study showed strategic behavior, and those children were also able to verbalize their knowledge about organizational strategies. The remaining subjects seemed to be unaware of task requirements. It is important to note that the degree of interitem associativity in the sort/recall lists also affected strategy use and recall of those children with high metamemory scores. Apparently, these children are "transitional" concerning deliberate strategy use because they required salient learning materials to capitalize on their declarative knowledge. It appears, then, that the knowledge base and metamemory jointly contribute to the acquisition of organizational strategies.

Significant correlations between the use of organizational strategies and declarative metamemory are occasionally found for children even younger than those recruited by Schneider (1986). In our view, this may be due to the interplay between the knowledge base and declarative metamemory. That is, only rudimentary knowledge about the advantage of organizational strategies may be sufficient to elicit sorting in a sort/recall task, provided that the children are highly familiar with stimulus materials. Given these preconditions, even young children (i.e., preschoolers and kindergarteners) can behave strategically in tasks of this nature (cf. Fabricius & Hagen, 1984; Paris, Newman, & McVey, 1982; Sodian et al., 1986).

However, in concluding that there can be correlational relationships between knowledge about the efficacy of organizational strategies and memory behaviors in young children, it must also be pointed out that samples of young children typically include very few subjects who know a lot about organizational strategies and their advantages. For example, a closer inspection of the Wimmer and Tornquist (1980) data shows that only three out of the 24 first grade children possessed adequate knowledge of organizational strategies and used semantic categorization. Sodian et al. (1986) obtained a statistically significant correlation ($r = .37$) among 6-year-olds between reported preference for sorting strategies and their use in a sort/recall task. However, perceptual sorting strategies were preferred over semantic organizational strategies overall, even though they are less effective in mediating performance for this age group (Schneider, Körkel, & Vogel, 1987). Instead, the positive correlation reflects the fact that the few subjects who reported a preference for semantic sorting in their metamemory interview also used this strategy to a large extent. Taken together, the results of these studies indicate that most children between four and eight years of age do not know about the effectiveness of semantic organizational strategies.

Retrieval Strategies, Knowledge Base, and Metamemory

Although research on organizational strategies reveals that young children do not know much about these strategies and consequently rarely apply them spontaneously, it has been shown in several studies that young children do have a rudimentary knowledge of memory strategies (cf. Baker-Ward, Ornstein, & Holden, 1984; Fabricius & Cavalier, 1989; Fabricius & Hagen, 1984; Sodian et al., 1986).

If young children possess a metacognitive understanding of the behaviors they display on memory tasks, this understanding should be clearer and more articulate the more natural a memory task is for the child. Even very young children (2-year-olds) are familiar with hide-and-seek tasks, and memory-for-location tasks have been successfully used with children of that age (e.g., DeLoache, 1980). Among other purposes, these tasks have been employed to study the development of a particular type of retrieval strategy, namely, cueing strategies. Geis and Lange (1976) found that even 4-year-olds, when hiding pictures of people in houses, made spontaneous use of the fact that the houses were marked with pictures of objects that were semantically related to the people's social roles (e.g., crown–king). Young children's use of cueing strategies seems to be dependent, however, on the strength of the semantic association between cue and target items (cf. Ritter, 1978; Whittaker, McShane, & Dunn, 1985). Thus, it could be that young children's behavior in hide-and-seek tasks, where there are strong semantic relations between cues and hidden objects, reflects an automatic tendency to group pictures with related objects rather than a deliberate, truly strategic attempt at remembering.

One way to find out whether young children employ retrieval cues in a deliberate attempt to aid prospective retrieval is to investigate their metacognitive understanding of retrieval-cue utilization. Studies by Beal (1985) and Whittaker et al. (1985) reveal that 5- and 6-year-olds are aware of some of the basic requirements for retrieval cues, such as that the cue should be associated with the target item, and that an encounter with the cue is necessary for retrieval to occur. However, it is not clear from these studies if this knowledge is closely related to preschoolers' and kindergarteners' use of cueing strategies.

In a more recent study (Schneider & Sodian, 1988), the relationships among planful behaviors, metacognitive awareness of the functions of these behaviors, and memory performance were investigated in 4- and 6-year-old children. Using a memory task similar to that of Geis and Lange (1976), pictures of people were hidden in and retrieved from houses. Half of the houses were marked with a picture of an object that was conceptually related to one of the people's social roles, whereas the other half were marked with pictures that were not related in a conventional way to the people. The question was whether and to what extent preschoolers and kindergarteners would make use of the semantic association between cues and targets, and whether the use of related cues would improve their performance on two memory tasks (relocating the hidden pictures and free recall). A task-related metamemory interview was also given to explore whether the use of retrieval cues was accompanied by an awareness of their function.

Schneider and Sodian (1988) found significant correlations between metamemory and memory behavior (i.e., use of retrieval cues) and memory performance (i.e., relocating hidden objects and free recall). The results thus showed that even very young children's planful behaviors in memory tasks are accompanied by some degree of conscious awareness of the usefulness of these behaviors. Intercorrelations among metamemory, memory behavior, and memory performance were generally substantial, a result rarely found for this age group. In addition to metamemory, semantic knowledge positively affected recall. When children created their own relationships between target items and unrelated cues, they were less successful in relocating the items than when they relied on pre-established semantic relationships. Again, it appears that it is the interaction of the two knowledge components that leads to optimal performance.

Strategies, Knowledge, and Metamemory in Text Processing

From a theoretical perspective, it seems particularly interesting to analyze interactions between the knowledge base and metamemory in complex cognitive activities such as text processing. There is plenty of evidence in the literature that metacognitive knowledge concerning text recall and comprehension develops rather late in childhood (Baker & Brown, 1984; Brown, Bransford, Ferrara, & Campione, 1983; Garner, 1987). The impact of older children's metacognitive knowledge about text processing on text recall and comprehension has also been consistently demonstrated (Forrest-Pressley & Waller, 1984; Jacobs & Paris, 1987; Pressley, Forrest-Pressley, & Elliott-Faust, 1988). Similarly, strong effects of the knowledge base on text processing have been frequently shown, particularly impressively in research using the expert–novice paradigm (cf. Chi & Ceci, 1987; Chiesi, Spilich, & Voss, 1979). However, research on the interaction of the knowledge base and metacognitive knowledge in determining text recall and comprehension is rare.

In a first attempt to address this complicated issue, the research group at the Munich Max-Planck-Institute for Psychological Research conducted a series of developmental studies all dealing with the impact of soccer expertise and metacognitive knowledge on recall and comprehension of a story dealing with a soccer game (Hasselhorn & Körkel, 1986; Körkel, 1987; Schneider, Körkel, & Weinert, in press). Although the story was generally easy to understand even for novices, there were a few exceptions to this rule. That is, occasionally important information was omitted that had to be inferred by the reader. Moreover, several contradictions were built into the text that could only be detected by careful reading. Although knowledge about soccer was important in order to draw correct inferences, it was not always necessary to detect the contradictions in the text. The soccer experts and novices in these studies (mostly third, fifth, and seventh graders) were presented with an extensive battery of memory and metamemory measures.

Interactions between metamemory and the knowledge base were analyzed separately for declarative and procedural metacognitive knowledge. The declarative metamemory questionnaire tapped general metacognitive knowledge not restricted to a specific domain. Thus, the expectation was that the soccer experts and novices would not differ on this measure. However, if individual differences in metacognitive knowledge are indeed important for text recall, this should be evident in within-group comparisons. Accordingly, the assumption was that in both the soccer expert and novice groups, children with high metacognitive knowledge should outperform those with low metacognitive knowledge.

As can be seen from Fig. 4.3, the empirical findings confirmed this prediction. Recall was greater for the experts than the novices overall. In both the expert and novice groups, furthermore, children with high metacognitive knowledge recalled significantly more text units than their metacognitively unknowledgeable counterparts. Again, this result demonstrates that it is the combination of a rich knowledge base and high metacognitive knowledge that leads to optimal performance.

The expectations concerning the relationship between the knowledge base and procedural metacognitive knowledge differed from

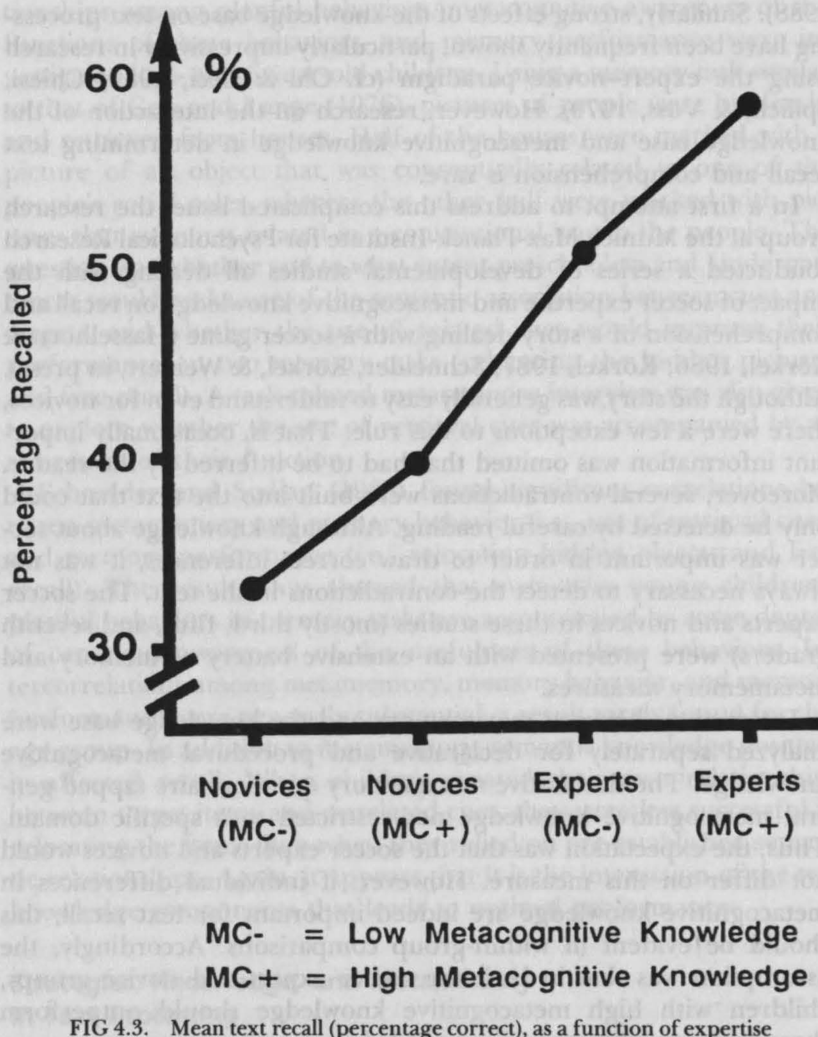

FIG 4.3. Mean text recall (percentage correct), as a function of expertise and metacognitive knowledge. Data from "Die Entwicklung von Gedächtnis-und Metagedächtnisleistungen in Abnägigkeit von Bereich sspezifischen Vorkenntnissen" by J. Körkel, 1987. Copyright 1987 by J. Körkel. Reprinted by permission.

those for the interaction between the knowledge base and declarative metacognitive knowledge. Although the declarative metamemory measure assessed general metacognitive knowledge, the measures tapping procedural metacognitive knowledge were closely linked to the domain of interest. In a performance-prediction task, subjects had to predict how many sentences of the soccer story they could correctly remember. The second measure of procedural knowledge consisted of "feeling-of-knowing" judgments that were given after responding to each item of a cloze test. That is, children had to indicate how certain they were that they filled in the blanks correctly. Results were straightforward in that soccer experts outperformed soccer novices on both tasks, regardless of age.

Taken together, these results indicate that expert knowledge strongly affects the quality of procedural metacognitive knowledge, and that both expert knowledge and declarative metamemory greatly facilitate text recall. One of the most interesting findings from the soccer expertise studies concerns the fact that metamemory significantly contributes to cognitive performance even in those cases where the knowledge base is very rich.

KNOWLEDGE AND THE DEVELOPMENT OF STRATEGIES: SOME CONCLUDING COMMENTS

The research reviewed in this chapter makes clear the developmental relationship between knowledge and strategy use, particularly in memory tasks. Preadolescent children can and do use memory strategies, but only when the task stimuli are highly familiar to them or when biased by the experimental context (e.g., as in sort/recall tasks). Older children are also affected by their knowledge of the to-be-remembered materials, but will behave strategically even with sets of atypical or low-associated items, especially if repeated trials are administered. Children's content knowledge influences the quality of their procedural metacognitive knowledge, with children being more apt to show metacognitive competence for highly familiar sets of items. The benefits of strategy training are greater and generalization is more likely to be found when highly familiar (e.g., category typical) items serve as stimuli.

Despite our firm beliefs about the relationship between knowledge and strategy development, we must temper our conclusions somewhat because of ambiguities in just exactly what we mean by *strategies* and *knowledge*. We briefly discuss some of these definitional problems in the following section.

Defining Strategies

In this chapter we have used a traditional definition of strategy, stating that it is an effortful, deliberately implemented, goal-directed process that is potentially available to consciousness (e.g., Flavell, 1985; Pressley, Forrest-Pressley, Elliot-Faust, & Miller, 1985). From this definition, processes that are activated automatically, that are not planful, and that we are not aware of, are not considered to be strategic, even if they greatly facilitate task performance.

The most notable advantage of this definition is that it limits the range of cognitive operations to which the term can be applied. When *strategy* includes all processes involved in the execution of some task, it becomes a generic term, no different from any one of a number of synonyms for *thought* (e.g., cognitive operation, mental processing). By restricting the definition of strategy as we have, other processes that are not strategic can be studied, unencumbered by the connotations of an overused label.

This does not imply, however, that strategies should be viewed as being independent of nonstrategic processes. Our view of strategies makes it clear that they are intricately related to nonstrategic processes. The selection and execution of a strategy involves many nonstrategic operations, and understanding these nonstrategic components is necessary if we are to understand the nature and development of the strategy itself.

Furthermore, there must be the recognition that strategies exist on a continuum in terms of complexity, effectiveness, and the amount of mental effort required for their execution. When we state that few preadolescent children spontaneously use memory strategies such as organization or rehearsal, it is not tantamount to saying that these children are incapable of strategy use. Rather than simply labeling children as *strategic* or *nonstrategic,* it is instead much more fruitful to determine the type and nature of strategies used by children of a given age and how those strategies develop into more effective operations.

Our definition is not without its own problems, however. The requirement that strategies be potentially available to consciousness biases one to notice them more in older children and adults than in younger children. Consciousness itself is a sticky problem, and insisting that children of any age (but especially young ones) prove that they are aware of what they are doing before declaring them strategic is a serious shortcoming of our definition. Equally problematic is the fact that many adults are rarely at a loss to explain their cognitions, sometimes inventing reasons for unconsciously motivated behavior (e.g., Gazzaniga, 1985), potentially causing us to overestimate their strategicness.

We do not offer a solution for this definitional conundrum here. We do think it is important, however, to maintain a definition of strategy that makes it distinct from other terms describing cognitive activity. Regardless of how one defines strategy, it is imperative that that definition be made explicit, making it clear what the writer considers to be strategic and what he or she does not when making claims or interpreting research findings.

Measuring Knowledge

Knowledge is an equally problematic concept. Knowledge-base theorists usually specify the general type of knowledge they are concerned with (declarative, procedural), but, at least with respect to declarative knowledge, often fail to provide a detailed description of the nature of the knowledge base. There are exceptions to this trend, such as the work by Chi and her colleagues for children's knowledge of dinosaurs (Chi, 1985; Chi & Koeske, 1983; Gobbo & Chi, 1986), research dealing with people's knowledge of the procedures of familiar games such as chess (e.g., Roth, 1983), and studies focusing on children's knowledge of the small and highly familiar set of their classmates (e.g., Bjorklund & Zeman, 1982; Chi, 1985). However, when discussing children's knowledge for broader categories, such as words and real-world events, estimates of what children know is less precise. Moreover, terms such as *semantic knowledge, world knowledge,* and *domain-specific knowledge* often go undefined, permitting readers to provide their own meanings for these terms.

Norms of children's word knowledge do exist and are used in memory and learning experiments. These include norms of category frequency (Posnansky, 1978), word associations (Bjorklund & Jacobs, 1984; Entwistle, 1966), and category typicality (Bjorklund, Thompson, & Ornstein, 1983). However, these norms are based on small samples, both of children and words, and although they are useful, they do not provide the level of detail we need to make more accurate predictions about the developmental relationship between knowledge and cognitive processing.

Despite the recognition of the importance of such descriptive information, we fear that this paucity of normative data will not soon be rectified. Because the main contribution of normative studies is descriptive and not theoretical, they excite few researchers, and, when they are done, they rarely find their way into the most prestigious journals. Yet it is only with more detailed descriptions of children's declarative knowledge that we can develop more sophisticated models, and we encourage researchers to collect and report normative data in their studies examining the role of knowledge on children's cognition.

The need for more precise measures of children's knowledge is not restricted to the important but limited domain of word meanings. If knowledge is as potent a mediator of strategy use as we propose, we must extend our work beyond list-learning experiments and investigate real-world topics, such as children's knowledge of history, literature, and geography. These and related topics have important implications for communication, reading (e.g., Anderson et al., 1984), and, more generally, success in a technological society (see Hirsch's, 1987, discussion of cultural literacy). Recent research investigating reading comprehension as a function of intelligence and knowledge has provided important steps in the right direction (e.g., Recht & Leslie, 1988; Schneider et al., in press; Walker, 1987). However, as topics of research interest become broader and more contextually relevant, the knowledge base with which we are dealing becomes, necessarily, less well defined.

Research and theorizing cannot wait until we can describe precisely the nature of children's knowledge, particularly considering that much of what any particular child knows will be idiosyncratic to that child alone. An alternative is to administer knowledge pretests to subjects, and, although time consuming, to use them to develop test materials individually tailored to each specific child's knowledge base (cf. Bjorklund & Bernholtz, 1986). Even if such an idiographic approach were to prove successful and become widespread, we must also continue with research that outlines what children at any one age tend to "know," and how this knowledge influences other aspects of cognition.

CONCLUDING REMARKS

Despite the definitional problems, the relation between knowledge and strategy use seems unambiguous to us. Age-related changes in children's content knowledge are integrally related to their tendency to use a memory strategy, the quality of their metacognitive knowledge about such strategies, the likelihood that a strategy will enhance performance, the success of strategy training, and the transfer of a strategy once acquired. Much more needs to be done, however, in terms of describing more precisely what children know and extending our theorizing to socially important content. Although much of this work may be tedious, it will be necessary if we are to attain a clearer understanding of the nature of knowledge development and how it interacts with other aspects of cognition.

ACKNOWLEDGMENTS

We would like to thank Brandi L. Green, Katherine Kipp Harnishfeger, Katherine Lyon, and Donna Watson for comments on earlier versions of this manuscript. Portions of this manuscript were done while the first author was a Visiting Professor at the Max-Planck-Institute for Psychological Research in Munich, West Germany, and he thanks Franz Weinert and the Institute's staff for their support during this time.

REFERENCES

Ackerman, B. P. (1985). Children's retrieval deficits. In C. J. Brainerd & M. Pressley (Eds.), *Basic processes in memory development* (pp. 1–46). New York: Springer-Verlag.

Ackerman, B. P. (1986). Retrieval search for category and thematic information in memory by children and adults. *Journal of Experimental Child Psychology, 42*, 355–377.

Ackerman, B. P. (1987). Descriptions: A model of nonstrategic memory development. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 20, pp. 143–183). Orlando, FL: Academic Press.

Anderson, R. C., Hiebert, E. H., Scott, J. A., & Wilkinson, I. A. G. (1984). *Becoming a nation of readers: The report of the commission on reading*. Washington, DC: U.S. Department of Education.

Ashcraft, M. H., & Fierman, B. A. (1982). Mental addition in third, fourth, and sixth graders. *Journal of Experimental Child Psychology, 33*, 216–234.

Baker, L., & Brown, A. L. (1984). Metacognitive skills and reading. In P. D. Pearson, M. Kamil, R. Barr, & P. Mosenthal (Eds.), *Handbook of reading research* (pp. 353–394). New York: Longman.

Baker-Ward, L., Ornstein, P. A., & Holden, D. J. (1984). The expression of memorization in early childhood. *Journal of Experimental Child Psychology, 37*, 555–575.

Beal, C. R. (1985). Development of knowledge about the use of cues to aid prospective retrieval. *Child Development, 56*, 631–642.

Bjorklund, D. F. (1980). Developmental differences in the timing of children's awareness of category relations in free recall. *International Journal of Behavioral Development, 3*, 61–70.

Bjorklund, D. F. (1985). The role of conceptual knowledge in the development of organization in children's memory. In C. J. Brainerd & M. Pressley (Eds.), *Basic processes in memory development: Progress in cognitive development research* (pp. 103–142). New York: Springer.

Bjorklund, D. F. (1987). How age changes in knowledge base contribute to the development of children's memory: An interpretative review. *Developmental Review, 7*, 93–130.

Bjorklund, D. F. (1988). Acquiring a mnemonic: Age and category knowledge effects. *Journal of Experimental Child Psychology, 45*, 71–87.

Bjorklund, D. F. (1989). *Children's thinking: Developmental function and individual differences.* Pacific Grove, CA: Brooks/Cole.

Bjorklund, D. F., & Bernholtz, J. E. (1986). The role of knowledge base in the memory performance of good and poor readers. *Journal of Experimental Child Psychology, 41*, 367–393.

Bjorklund, D. F., & Buchanan, J. J. (1989). Developmental and knowledge base differences in the acquisition and extension of a memory strategy. *Journal of Experimental Child Psychology, 47*, 451–471.

Bjorklund, D. F., & de Marchena, M. R. (1984). Developmental shifts in the basis of organization in memory: The role of associative versus categorical relatedness in children's free-recall. *Child Development, 55,* 952–962.

Bjorklund, D. F., & Harnishfeger, K. K. (1987). Developmental differences in the mental effort requirements for the use of an organizational strategy in free recall. *Journal of Experimental Child Psychology, 44,* 109–125.

Bjorklund, D. F., & Harnishfeger, K. K. (1989). In defense of resources. *Journal of Experimental Child Psychology, 47,* 19–25.

Bjorklund, D. F., & Harnishfeger, K. K. (1990). The resources construct in cognitive development: Diverse sources of evidence and a theory of inefficient inhibition. *Developmental Review, 10.*

Bjorklund, D. F., & Jacobs, J. W. (1984). A developmental examination of ratings of associative strength. *Behavior Research Methods, Instruments & Computers, 16,* 568–569.

Bjorklund, D. F., & Jacobs, J. W. (1985). Associative and categorial processes in children's memory: The role of automaticity in the development of organization in free recall. *Journal of Experimental Child Psychology, 39,* 599–617.

Bjorklund, D. F., & Muir, J. E. (1988). Children's development of free recall memory: Remembering on their own. In R. Vasta (Ed.), *Annals of Child Development* (Vol. 5, pp. 79–123). Greenwich, CN: JAI.

Bjorklund, D. F., & Ornstein, P. A., & Haig, J. R. (1977). Development of organization and recall: Training in the use of organizational techniques. *Developmental Psychology, 13,* 175–183.

Bjorklund, D. F., Thompson, B. E., & Ornstein, P. A. (1983). Developmental trends in children's typicality judgments. *Behavior Research Methods & Instrumentation, 15,* 350–356.

Bjorklund, D. F., & Zaken-Greenberg, F. (1981). The effects of differences in classification style on preschool children's memory. *Child Development, 52,* 888–894.

Bjorklund, D. F., & Zeman, B. R. (1982). Children's organization and metamemory awareness in their recall of familiar information. *Child Development, 53,* 799–810.

Bjorklund, D. F., & Zeman, B. R. (1983). The development of organizational strategies in children's recall of familiar information: Using social organization to recall the names of classmates. *International Journal of Behavioral Development, 6,* 341–353.

Brainerd, C. J. (1985). Model-based approaches to storage and retrieval development. In C. J. Brainerd & M. Pressley (Eds.), *Basic processes in memory development: Progress in cognitive development research* (pp. 143–207). New York: Springer-Verlag.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering, and understanding. In J. H. Flavell & E. M. Markman (Eds.), *Cognitive development: Vol. 3. Handbook of child psychology* (4th ed., pp. 77–166). New York, NY: Wiley.

Brown, A. L., & DeLoache, J. S. (1978). Skills, plans, and self-regulation. In R. S. Siegler (Ed.), *Children's thinking: What develops?* (pp. 3–35). Hillsdale, NJ: Lawrence Erlbaum Associates.

Carey, S. (1985). *Conceptual changes in childhood.* Cambridge, MA: MIT Press.

Case, R. (1985). *Intellectual development: Birth to adulthood.* New York: Academic Press.

Cavanaugh, J. C., & Perlmutter, M. (1982). Metamemory: A critical examination. *Child Development, 53,* 11–28.

Chi, M. T. H. (1985). Interactive roles of knowledge and strategies in the development of organized sorting and recall. In S. F. Chipman, J. W. Segal, & R. Glaser (Eds.), *Thinking and learning skills: Vol. 2. Research and open questions* (pp. 457–483). Hillsdale, NJ: Lawrence Erlbaum Associates.

Chi, M. T. H., & Ceci, S. J. (1987). Content knowledge: Its role, representation, and restructuring in memory development. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 20, pp. 91–142). Orlando, FL: Academic Press.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 15,* 121–152.

Chi, M. T. H., Glaser, R., & Rees, E. (1982). Expertise in problem solving. In R. J. Sternberg (Ed.), *Advances in the psychology of human intelligence,* (Vol. 1, pp. 7–75). Hillsdale, NJ: Lawrence Erlbaum Associates.

Chi, M. T. H., & Greeno, J. G. (1987). Cognitive research relevant to education. *Annals of the New York Academy of Sciences, 517,* 39–57.

Chi, M. T. H., & Koeske, R. D. (1983). Network representation of a child's dinosaur knowledge. *Developmental Psychology, 19,* 29–39.

Chiesi, H. L., Spilich, G. J., & Voss, J. F. (1979). Acquisition of domain-related information in relation to high and low domain knowledge. *Journal of Verbal Learning and Verbal Behavior, 18,* 257–274.

Corsale, K., & Ornstein, P. A. (1980). Developmental changes in children's use of semantic information in recall. *Journal of Experimental Child Psychology, 30,* 231–245.

Daneman, M., & Blennerhassett, A. (1984). How to assess the listening comprehension skills of prereaders. *Journal of Educational Psychology, 76,* 1372–1381.

Daneman, M., & Carpenter, P. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior, 19,* 450–466.

Daneman, M., & Green, I. (1986). Individual differences in comprehending and producing words in context. *Journal of Memory and Language, 25,* 1–18.

DeLoache, J. S. (1980). Naturalistic studies of memory for object location in very young children. In M. Perlmutter (Ed.), *New directions for child development: Children's memory* (pp. 17–32). San Francisco: Jossey–Bass.

DeMarie-Dreblow, D., & Miller, P. H. (1988). The development of children's strategies for selective attention: Evidence for a transitional period. *Child Development, 59,* 1504–1513.

Dempster, F. N. (1985). Short-term memory development in childhood and adolescence. In C. J. Brainerd & M. Pressley (Eds.), *Basic processes in memory development: Progress in cognitive development research* (pp. 209–248). New York: Springer.

Entwisle, D. R. (1966). *Word associations of young children.* Baltimore: Johns Hopkins Press.

Fabricius, W. V., & Cavalier, L. (1989). The role of causal theories about memory in young children's memory strategy choice. *Child Development, 60,* 298–308.

Fabricius, W. V., & Hagen, J. W. (1984). Use of causal attributions about recall performance to assess metamemory and predict strategic memory behavior in young children. *Developmental Psychology, 20,* 975–987.

Fischer, K. W. (1980). A theory of cognitive development: The control and construction of hierarchies of skills. *Psychological Review, 87,* 477–531.

Flavell, J. H. (1985). *Cognitive development* (2nd ed.). Englewood Cliffs, NJ: Prentice–Hall.

Forrest-Pressley, D. L., & Waller, T. (1984). *Cognition, metacognition, and reading.* New York: Springer-Verlag.

Frankel, M. T., & Rollins, H. A. (1982). Age-related differences in clustering: A new approach. *Journal of Experimental Child Psychology, 34,* 113–122.

Frankel, M. T., & Rollins, H. A. (1985). Associative and categorical hypotheses of organization in the free recall of adults and children. *Journal of Experimental Child Psychology, 40,* 304–318.

Garner, R. (1987). *Metacognition and reading comprehension.* Norwood, NJ: Ablex.

Gazzaniga, M. S. (1985). *The social brain: Discovering the networks of the mind.* New York: Basic Books.
Geis, M. F., & Lange, G. (1976). Children's cue utilization in memory-for-location task. *Child Development, 47,* 759–766.
Gibson, E. J. (1971). Perceptual learning and the theory of word perception. *Cognitive Psychology, 2,* 351–368.
Gobbo, C., & Chi, M. T. H. (1986). How knowledge is structured and used by expert and novice children. *Cognitive Development, 1,* 221–237.
Groen, G. J., & Parkman, J. M. (1972). A chronometric analysis of simple addition. *Psychological Review, 79,* 329–343.
Groen, G. J., & Resnick, L. B. (1977). Can preschool children invent addition algorithms? *Journal of Educational Psychology, 69,* 645–652.
Guttentag, R. E. (1984). The mental effort requirement of cumulative rehearsal: A developmental study. *Journal of Experimental Child Psychology, 37,* 92–106.
Guttentag, R. (1989). Age differences in dual-task performance: procedures, assumptions, and results. *Developmental Review, 9,* 146–170.
Hamann, M. S., & Ashcraft, M. H. (1985). Simple and complex mental addition across development. *Journal of Experimental Child Psychology, 40,* 49–72.
Hansen, J. (1981). The effects of inference training and practice on young children's reading comprehension. *Reading Research Quarterly, 16,* 391–417.
Hansen, J., & Pearson, P. D. (1983). An instructional study: Improving the inferential comprehension of good and poor readers. *Journal of Educational Psychology, 75,* 821–829.
Hasselhorn, M. (1989). *The emergence of strategic knowledge activation in categorical clustering during retrieval.* Manuscript submitted for publication.
Hasselhorn, M., & Körkel, J. (1986). Metacognitive vs. traditional reading instructions: The mediating role of domain-specific knowledge on children's text-processing. *Human Learning, 5,* 75–90.
Hirsch, E. D. (1987). *Cultural literacy: What every American needs to know.* Boston: Houghton Mifflin.
Jablonski, E. M. (1974). Free recall in children. *Psychological Bulletin, 81,* 522–539.
Jacobs, J. E., & Paris, S. G. (1987). Children's metacognition about reading: Issues in definition, measurement, and instruction. *Educational Psychologist, 22,* 255–278.
Justice, E. M. (1986). Developmental changes in judgements of relative strategy effectiveness. *British Journal of Developmental Psychology, 4,* 75–81.
Kail, R. (1986). The impact of extended practice on rate of mental rotation. *Journal of Experimental Child Psychology, 42,* 378–391.
Kail, R. (1988). Developmental functions for speeds of cognitive processes. *Journal of Experimental Child Psychology, 45,* 339–364.
Kee, D. W., & Bell, T. S. (1981). The development of organizational strategies in the storage and retrieval of categorical items in free-recall learning. *Child Development, 52,* 1163–1171.
Kee, D. W., & Davies, L. (1988). Mental effort and elaboration: A developmental analysis. *Contemporary Educational Psychology, 13,* 221–228.
Kee, D. W., & Howell, S. (1988, April). *Mental effort and memory development.* Paper presented at the meeting of the American Educational Research Association, New Orleans, LA.
Körkel, J. (1987). *Die Entwicklung von Gedächtnis-und Metagedächtnisleistungen in Abhnägigkeit von bereichsspezifischen Vorkenntnissen.* Frankfurt/Main: Lang.
Lange, G. W. (1973). The development of conceptual and rote recall skills among school age children. *Journal of Experimental Child Psychology, 15,* 394–407.

Lange, G. W., & Jackson, P. (1974). Personal organization in children's free recall. *Child Development, 45,* 1060–1067.

Muir-Broaddus, J. E., & Bjorklund, D. F. (in press). Developmental and individual differences in children's memory strategies: The role of knowledge. In W. Schneider & F. E. Weinert (Eds.), *Interactions among strategies, knowledge, and aptitudes in cognitive performance.* New York: Springer–Verlag.

Omanson, R. C., Beck, I. L., Voss, J. F., & McKeown, M. G. (1984). The effects of reading lessons on comprehension: A processing description. *Cognition & Instruction, 1,* 45–67.

Ornstein, P. A., & Naus, M. J. (1985). Effects of the knowledge base on children's memory strategies. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 19, pp. 113–148). New York: Academic Press.

Ornstein, P. A., Naus, M. J., & Liberty, C. (1975). Rehearsal and organizational processes in children's memory. *Child Development, 46,* 818–830.

Paris, S. G., Lipson, M. Y., & Wixson, K. K. (1983). Becoming a strategic reader. *Contemporary Educational Psychology, 8,* 293–316.

Paris, S. G., Newman, R. S., & McVey, K. A. (1982). Learning the functional significance of mnemonic actions: A microgenetic study of strategy acquisition. *Journal of Experimental Child Psychology, 34,* 490–509.

Pearson, P. D., Hansen, J., & Gordon, C. (1979). The effect of background knowledge on young children's comprehension of explicit and implicit information. *Journal of Reading Behavior,* 201–209.

Piaget, J. (1971). *Biology and knowledge.* Chicago: University of Chicago Press.

Posnansky, C. J. (1978). Category norms for verbal items in 25 categories for children in grades 2–6. *Behavior Research Methods & Instrumentation, 10,* 819–832.

Pressley, M., Forrest–Pressley, D. L., & Elliott–Faust, D. J. (1988). What is strategy instructional enrichment and how to study it: Illustrations from research on children's prose memory and comprehension. In F. E. Weinert & M. Perlmutter (Eds.), *Memory development: Universal changes and individual differences* (pp. 101–130). Hillsdale, NJ: Lawrence Erlbaum Associates.

Pressley, M., Forrest–Pressley, D. L., Elliot–Faust, D., & Miller, G. (1985). Children's use of cognitive strategies: How to teach strategies, and what to do if they can't be taught. In M. Pressley & C. J. Brainerd (Eds.), *Cognitive learning and memory in children* (pp. 1–47). New York: Springer-Verlag.

Rabinowitz, M. (1984). The use of categorical organization: Not an all-or-none situation. *Journal of Experimental Child Psychology, 38,* 338–351.

Rabinowitz, M. (1988). On teaching cognitive strategies: The influence of accessability of conceptual knowledge. *Contemporary Educational Psychology, 13,* 229–235.

Recht, D. R., & Leslie, L. (1988). Effect of prior knowledge on good and poor reader's memory for text. *Journal of Educational Psychology, 80,* 16–20.

Ritter, K. (1978). The development of knowledge of an external retrieval cue strategy. *Child Development, 49,* 1227–1230.

Roth, C. (1983). Factors affecting developmental changes in the speed of processing. *Journal of Experimental Child Psychology, 35,* 509–528.

Schneider, W. (1985). Developmental trends in the metamemory-memory behavior relationship: An integrative review. In D. L. Forrest–Pressley, G. E. MacKinnon, & T. G. Waller (Eds.), *Metacognition, cognition, and human performance* (Vol. 1, pp. 57–109). Orlando, FL: Academic Press.

Schneider, W. (1986). The role of conceptual knowledge and metamemory in the development of organizational processes in memory. *Journal of Experimental Child Psychology, 42,* 218–236.

Schneider, W., Borkowski, J. G., Kurtz, B. E., & Kerwin, K. (1986). Metamemory and motivation: A comparison of strategy use and performance in German and American children. *Journal of Cross-Cultural Psychology, 17*, 315–336.

Schneider, W., Körkel, J., & Vogel, K. (1987). Zusammenhänge zwischen Metagedächtnis, strategischem Verhalten und Gedächtnisleistungen im Grundschulalter: Eine entwicklungspsychologische Studie. *Zeitschrift fur Entwicklungspsychologie und Pädagogische Psychologie, 19*, 99–115.

Schneider, W., Körkel, J., & Weinert, F. E. (in press). Expert knowledge, general abilities, and text processing. In W. Schneider & F. E. Weinert (Eds.), *Interactions among aptitude, strategies, and knowledge in cognitive performance*. New York: Springer-Verlag.

Schneider, W., & Pressley, M. (1989). *Memory development between 2 and 20*. New York: Springer–Verlag.

Schneider, W., & Sodian, B. (1988). Metamemory-memory relationships in preschool children: Evidence from a memory-for-location task. *Journal of Experimental Child Psychology, 45*, 209–233.

Siegler, R. S. (1987). The perils of averaging data over strategies: An example from children's addition. *Journal of Experimental Psychology: General, 116*, 250–264.

Siegler, R. S., & Shrager, J. (1984). Strategy choices in addition and subtraction: How do children know what to do? In C. Sophian (Ed.), *Origins of cognitive skills* (pp. 229–293). Hillsdale, NJ: Lawrence Erlbaum Associates.

Sodian, B., Schneider, W., & Perlmutter, M. (1986). Recall, clustering, and metamemory in young children. *Journal of Experimental Child Psychology, 41*, 395–410.

Walker, C. H. (1987). Relative importance of domain knowledge and overall aptitude on acquisition of domain-related information. *Cognition and Instruction, 4*, 25–42.

Wellman, H. M. (1983). Metamemory revisited. In M. T. H. Chi (Ed.), *Trends in memory development research* (pp. 31–51). Basel: Karger.

Whittaker, S., McShane, J., & Dunn, D. (1985). The development of cueing strategies in young children. *British Journal of Developmental Psychology, 3*, 153–161.

Wimmer, H., & Tornquist, K. (1980). The role of metamemory and metamemory activation in the development of mnemonic performance. *International Journal of Behavioral Development, 3*, 71–81.

Worden, P. E. (1976). The effects of classification structure on organized free recall in children. *Journal of Experimental Child Psychology, 22*, 519–529.

Zembar, M. J., & Naus, M. J. (1985, April). *The combined effects of knowledge base and mnemonic strategies on children's memory*. Paper presented at meeting of the Society for Research in Child Development, Toronto.