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A Developmental Study of Changes in Strategy Selection

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ABSTRACT

The present study focused on the relationship between children's knowledge of appropriate task strategies and actual strategy use on two recall memory tasks and two tasks less demanding of memory--coding and alphabetizing. On the recall memory tasks, attention was specifically directed to the modifications of children's strategies as a function of changing task demands. The subjects consisted of 80 seven-, nine-, 11-, and 15-year-olds. The children were shown sets of pictures on cards, representing three categories, which were later to be recalled. The children were free to manipulate the pictures during all the study periods. Task demand changes included either the study time allowed (30 seconds or 2 minutes) or the number of items to be remembered (12 or 24 pictures). The coding task required that the children copy symbols that corresponded to numbers in the coding key. For the alphabetizing task, children were to put words on cards in alphabetical order within a given amount of time. The data analyses showed that children's knowledge of task relevant strategies closely paralleled their task behavior. Overall, picture recall increased with age and with the type of strategy used. Rehearsal was used most often when study time varied, whereas a combination of rehearsal, categorization, and self-testing was used more often when list length varied. Generally, more 11- and 15-year-olds categorized the pictures under all treatment conditions. However, changes in the strategy used

did not occur within a task demand manipulation (e.g., short versus long study times or short versus long list lengths). These findings have been interpreted to show that the "executive function" includes the continued use of a particular strategy when appropriate for different task demands (Barclay, 1979). On the coding tasks, 15-year-olds coded all the same numbers first, whereas seven-year-olds coded in a random order. While the type of strategy did not influence performance, there was a positive trend in the number of boxes coded across age groups. Strategy differences were also apparent on the alphabetizing task. Fifteen-year-olds alphabetized the words beginning with the top card most often, whereas younger children displayed the cards before alphabetizing them. Performance scores not only increased significantly with age, but also with the type of strategy used. These results suggest that a "general strategic factor" (Kail, 1979) may underlie these age differences, and that around the ages of eight to 11 years, children become more proficient in their strategic behaviors for a variety of tasks.

Chapter I

Introduction

Statement of the Problem

The literature in the area of memory in children has focused on several memory related phenomena. Two specific types of phenomena examined have been labeled as "knowing how to know" and "knowing about knowing" (i.e., metamemory) (Brown, 1975; Flavell, 1970). "Knowing how to know" refers to knowledge of how different variables affect performance. Such variables may include a person's characteristics and abilities, task characteristics, and strategies. In developmental studies of memory, these variables have been examined as independent units. One problem, however, is that few investigators have examined the possible interactions of these variables. Further, those studies that have focused on children's knowledge of these memorial factors in an interaction paradigm have done so by presenting hypothetical situations and recording children's verbal responses. In most cases, these studies have not examined what children do in a given situation when variables, such as task demands, are manipulated. What is known is that even young children (e.g., five years of age) may be aware of the presence of these different variables and that age differences are apparent in strategy selection. It has not been determined, however, whether strategy selection is modified as a function of changing variable manipulations or whether age differences continue to be present. Secondly, while age differences in strategic behaviors have been observed for memory tasks, the extent to which children are planful and strategic in other task situations less demanding of memory needs further investigation.

The purpose of this study is to examine age differences in performance and strategy choice for specific tasks which were either greatly dependent on memory, such as recall, or where memory demands were lower, such as in coding and alphabetizing.

Review of Relevant Literature

Three categories of memory-related phenomena have been identified in the study of memory development by Brown (1975) and Flavell and Wellman (1977). Brown (1975) labeled these categories "knowing," "knowing how to know," and "knowing about knowing." "Knowing" refers to an involuntary storage, retention, and retrieval of information, due to the general developmental advances in one's cognitive abilities, which causes the stimuli to be more meaningful, familiar, and interrelated. The second category is distinguished by its voluntary and strategic quality. "Knowing how to know" involves a variety of potential conscious behaviors or strategies an individual may intentionally choose to employ for the purpose of achieving any mnemonic end. Mentally rehearsing a friend's telephone number prior to making a call is a familiar example. Flavell (1970) coined the term "metamemory" for "knowing about knowing" to refer to knowledge of and awareness of one's memory processes or of any specific techniques germane to the storage and retrieval of information. One aspect of metamemory is an individual's awareness of memory goals. That is, what tasks or situations require storing and retrieving information and how are those processes best accomplished. This review focuses on different mnemonic knowledge and skills children acquire in relation to various demands and goals of a task. This information closely associates with the category of "knowing how to know."

Part of mnemonic knowledge consists of a sensitivity to the present situation (Flavell & Wellman, 1977; Wellman, 1978). An individual's ability to perform a certain cognitive activity, such as memorizing, depends on an awareness of the need to use planful, memory-facilitating strategies, while realizing that other situations do not call for or require different deliberate strategic efforts to store and retrieve information. For example, adults are usually aware that a recognition task is easier than a recall task, given equivalent information. They are sensitive to the fact that recall requires the use of intentional mnemonic strategies to a greater extent than recognition. Levin, Yussen, DeRose and Pressley (1977) had first- and fifth-grade children and college students predict the number of nouns they could either recall or recognize. Fifth-graders and college students were more accurate in their predictions for recall than recognition, while first-graders' predictions did not vary for either task. Speer and Flavell (1979) replicated the Levin et al. (1977) study with one change. They assessed young children's (kindergarten and first grade) judgments of the difficulty of each task when the two mnemonic tasks were directly compared (i.e., within-subject design). The findings were contrary to those reported by

Levin et al. (1977) in that children believed that the recognition tasks were easier than recall tasks.

Although these studies do not directly examine a person's awareness of the need to employ mnemonic strategies, they show that young children seem to have some precursory knowledge of the relative difficulty of each task. Knowledge of the need to implement task-appropriate strategies may be acquired later in development as a result of cognitive growth and learning experiences. Secondly, metacognitive knowledge consists of knowledge about what factors or variables act and interact in ways to affect the outcome of a cognitive undertaking. Three major variables likely to affect performance on memory tasks are: (a) memory-relevant characteristics of the person--this encompasses everything one knows about his/her memory capabilities and how these skills compare with those of other people; (b) memory-relevant characteristics of the task--what information is available to perform the task, or what task demands make some tasks more difficult than others; and (c) potential strategies to be utilized (Flavell, 1977, 1979; Flavell & Wellman, 1977; Wellman, 1978).

While each of these variables may be thought of as independent, one who is more advanced in a metacognitive sense probably perceives the variables as interacting. To illustrate what is meant by metacognitive knowledge of combinations involving two or three variables, an individual may know that information is easier to retrieve depending on who is storing it (Person X Task); that the types of mnemonic strategies should be varied with the corresponding characteristics of the task (Strategy X Task); that she/he can use one strategy more successfully than another strategy (Person X Strategy); and that she/he, unlike a friend, believes that one strategy (rather than another) should be used in a certain task (as contrasted with another cognitive task) (Person X Strategy X Task). Metcognitive knowledge of these variables and their interactions can have important effects on the cognitive activities of children and adults. It can direct an individual to ". . . select, revise, and abandon cognitive tasks, goals, and strategies in light of their relationship with one another . . ." (Flavell, 1979, p. 908).

Few metamemory studies have dealt with metacognitive knowledge relating to the interaction of the variables involved. Wellman (1978) was one of the first to investigate children's metamnemonic understanding of interactions. The paradigm consisted of pictorial stimuli depicting memory situations, where five- and 10-year-olds were asked to rate the difficulty of tasks that differed on combinations of variables. Some problems required a judgment of the memory relevance of a single variable (e.g., the pictures depicted a boy with either three, nine, or 18 items to remember), a judgment of the memory irrelevance of a single variable (e.g., a set of three pictures depicted a fat, skinny, or normal sized boy with the same memory task), or a judgment of the interactions of two memory relevant variables (e.g., Task X Strategy, where a boy looked at three items, or 18 items, or looked at three items and then wrote the names down). The results showed that five- and 10-year-olds performed similarly on tasks when variables were in isolation. For hypothetical situations with interacting variables, however, five-year-olds consistently judged memory performance on the basis of only one of the relevant variables. Wellman (1978) notes that this inferior performance was not due to incorrectly identifying the relevant variables because they made correct judgments in the simple-relevant and irrelevant problems, nor was it due to a failure to notice both variables in the complex problems because subjects could point out the variables prior to making a judgment. Rather, five-year-olds lacked the memory knowledge for a complex interaction of variables. Apparently, children's metacognitive knowledge proceeds from a lack of understanding of memory-relevant factors to acquiring insights about the variables as separate facts, and then later they develop knowledge about a complex interaction. This finding may have important implications for the study of strategic memory behavior, where particular strategies are tailored to fit the specific features of different memory tasks. At some point, an individual comes to know when and why she/he should intentionally store and retrieve, and what strategies can be used to most efficiently accomplish the goal. Strategic beahviors differ, in that some may be relevant to a number of situations and task demands, whereas others may be "optimal" and specifically tailored to certain conditions. Therefore, to perform a task (memory or other) most efficiently, a person must be aware of the means, the goal, and the functional relationship between the means and goals.

Strategy use and task goals. The primary purpose of many of the tasks employed in research studies has been remembering or memorizing, which has limited our knowledge of how strategy use relates to tasks demanding less of one's memory. This does not imply that strategy use is unnecessary in achieving goals other than memorizing. Rather, this area has not been sufficiently investigated. It may be that strategy use in "non-memory" tasks is a precursory condition for strategy use in memory tasks which place a greater demand on one's organizational plans. Mnemonic strategies can be either self-generated or externally provided from another source (e.g., instructions to rehearse, categorize, or underline). In a similar manner, task goals can be divided into deliberate or intentional remembering (i.e., the child is aware of the need to remember and she/he tries to behave accordingly to promote that goal) and "non-memory" goals (e.g., solving problems). The kinds of tasks presented when a child is aware of the means and memory goals assess his/her ability to use a particular strategy to enhance memory performance. Conversely, tasks may be structured to elicit a predominant skill (e.g., labeling, clustering, or categorizing) as a means of achieving the designated memory goal. The terms, mediational and production deficiencies, have been assigned to these respective situations when a child fails to show good memory performance (Paris, 1978a). In a similar manner, tasks with "non-memory" goals can be structured in such a way that the means are either externally provided or self-generated. Failure to perform on these types of tasks would be analogous to the mediational and production deficiencies described earlier, except that in this case they apply to "non-memory" goals.

While a child's inability to adopt externally provided means and goals reveals his/her limitations in efficient skill usage, it may not tell us much about how a child selects his/her operations to accomplish the set goal.

> It cannot be assumed that children of different ages have the same . . . comprehension of task demands and appreciation of the utility of mnemonic skills. Developmental memory research should be expanded to investigate age-related changes in perceived means and goals so that children's abilities to coordinate their own means with their goals can be evaluated. (Paris, 1978a, p. 266)

Children often are not aware of the most suitable means for remembering and do not employ these means effectively. Brown (1978) asked children: "If after having been told a friend's phone number, would you prefer to dial the number immediately or get a drink of water first?" and "How would you remember the phone number?" Most third graders (95%) were aware that they should dial right away, whereas first graders and retardates were not aware of the problems and difficulties that could develop by waiting. Writing the number down, if one could remember, was the activity most frequently mentioned. Almost all the third graders showed some planfulness and were aware of an appropriate means, but many of the other children could not think of anything to do to help them remember. A second task was designed to test the children's awareness of strategies for studying a list of categorizable pictures. The chosen means were divided into strategy responses (e.g., categorization, rehearsal, or association) and no strategy responses (e.g., look at, randomly arrange, or do nothing). Again, planful behavior was most characteristic of third graders.

Appel, Cooper, McCarrell, Sim-McKnight, Yussen and Flavell (1972) also examined children's abilities to use memory-facilitating strategies (e.g., verbal rehearsal and conceptual categorization) during study and recall periods. The task instructions, however, were varied in order to discover the differential behaviors in response to explicit instructions to either "remember" or "look" (non-memory). If a child is told that the task requires recall (or intentional learning) will she/he engage in preparatory beahviors that are different from those used in simply looking (or incidental learning) at a set of items? Given an intentional learning task, such as memorizing a list of words, older children (e.g., fifth graders) usually show active attempts to store the material for future retrieval. They may label the items, rehearse them overtly or covertly, or cluster the words into categories or meaningful associations. However this is accomplished, the child's behavior indicates that she/he has more in mind than merely perceptually identifying the items. The younger child (e.g., preschooler), in contrast, does not engage in similar strategic efforts. Appel et al. (1972) base their thinking on a "differentiation hypothesis." Perhaps for the young child perception and memorization have not been differentiated from one another. The child may not understand that a request to memorize items for future retrieval requires the use of goal-directed activities, rather than just perceiving the information in a purposeless fashion. Thus, early in development instructions to remember or look may be treated identically.

To test this assumption, Appel et al. (1972) told four-, seven- and 11-year olds to either look at an array of categorizable pictures very carefully because this would help them later on, or to try to remember the names of the pictures. Each child was presented with two different stimulus lists, one in each condition. During the study period the children could manipulate the pictures in any way to help them look carefully or remember. (During this time, the experimenter recorded the use of specific mnemonic strategies.) Comparisons between children's study behaviors and subsequent recall performance indicated that preschoolers' behavior did not differ between the look and memory conditions. Four-year-olds, however, may have looked because they did not know how to categorize or rehearse, or they could not think of anything else to do with the information. This does not imply that the four-year-olds did not intend to remember the pictures. This interpretation suggests that the tasks may have been too difficult and required actions beyond their abilities. In comparison, 11-year-olds differentiated between the two instructions both conceptually and behaviorally. They realized that the memory task required the use of special strategies and therefore engaged in appropriate behaviors such as clustering, thereby resulting in better recall performance. The seven-year-olds may have differentiated conceptually, but they did not evoke the appropriate strategies to demonstrate this understanding. The authors concluded that memory development seems to proceed from a state of possessing the basic idea of deliberate memorization to acquiring specialized cognitive "subroutines" that are effective in reaching the goal.

Later studies have shown that first graders (seven-year-olds) can process items differently and better under memorization than look instructions, if they can think of something mnemonically efficient to do with the information (Salatas & Flavell, 1976; Wellman, Ritter &

Flavell, 1975). Salatas and Flavell (1976) assigned first graders to either an experimental group (e.g., remember or look) or to a control group. The study time was followed by a free recall task with repeated trials. Subjects instructed to remember exhibited a greater spontaneous use of categories and superior recall across trials, compared to the look group. The amount of time spent looking at the stimuli did not differ significantly between the groups. The use of repeated trials and a retest six weeks later allowed the child to become familiar with the task, which resulted in optimal performance and revealed significant relationships between the variables. The results showed that seven-year-olds do seem to distinguish between instructions to remember and those that do not require cognitive processing.

Research with preschoolers has shown that when given a less structured game-like task these children have some conception of the need to intentionally remember (Acredolo, Pick & Olsen, 1975; Wellman et al., 1975; Yussen, 1974, 1975). Yussen (1974) instructed some 4½-year-olds to try to remember a model's favorite object, while others were just told that later they would play a game like the model. The results showed that when a child was directed to remember what was seen, his/her level of attention to the task was enhanced, and, as a consequence, recall performance improved. Second graders did not necessarily look for longer periods of time; rather, they looked at the moments when looking had informative value, and they were more strategic in their use of attention. These results were replicated by Yussen (1975) who also showed that four-year-olds were less distracted, and they scanned the items for a longer time when told to remember than when told to inspect.

In a series of experiments using a simple memory task that did not require rote memorization skills, Wellman et al. (1975) asked two- to four-year-olds to either "wait here" with a hidden toy or to "remember" where it was placed while the experimenter left the room for 45 seconds. Activities of the subjects were recorded during the delay periods. Observations of the children's behavior indicated that three- and four-year-olds engaged in simple strategies to prepare for future retrieval. More specifically, the children who were asked to remember the location displayed deliberate and strategic behaviors (e.g., looking longer, touching, rehearsing, and making the cup more distinctive by moving it to a prominent position) during the delay period that appeared directly related to the goal of remembering the hiding place. Those children who engaged in these types of mnemonic behaviors had higher levels of recall, whereas the majority of those children who were instructed to wait did not engage in specific memorial activities and therefore remembered less. The conflict between this finding that young children do differentiate between intentional and incidental learning instructions and those of previous studies which indicated they do not differentiate behaviorally can be resolved if one assumes that young children have some understanding of what deliberate memorizing means, but they do not know the types of strategies required for success. That is, young children may lack the ability to spontaneously generate the necessary strategic behavior. The tasks used may also be a factor. Recalling where things are (spatial location) is a more familiar, meaningful, and frequently reinforced activity for a young child than recalling a list of pictures. Thus, the more meaningful task may account for the unexpected memory performance in the Wellman et al. (1975) study.

Strategy use and task demands. Paris (1978b) hypothesized that the reason young children do poorly on memory tasks is because they do not understand the task demands and the appropriate strategies. Using a multiple recall task, second and sixth graders were given a randomized list of 20 words from five categories. The instructions only asked the children to try to remember as many words as possible. They did not specify a particular strategy to be used, that the words could be categorized, or that multiple recall trials would be used. The results indicated that recall among sixth graders increased over trials, while recall performance among second graders remained the same for each trial. Order of recall also differed, with younger children using the same order across trials, while older children categorized more frequently and thus did not recall the words in serial order. Categorization was advantageous for recall performance. Further, young children failed to coordinate various strategies at their disposal with the "true" purpose of the task, which was free recall (that is, recall in any order). In this case, note however, that the children's means of remembering were not necessarily inefficient or incorrect with his/her perception of the goal. Therefore, it may be important to focus on the children's understanding of the task demands and the appropriate means to achieve the goal.

Constructive skills are relative to the child's standards or goal within a given task.

Thus, when faced with a memory task, the child must know about the various task situations and strategies that best fit a particular task. Kreutzer et al. (1975) conducted an extensive investigation on elementary children's knowledge of the effect of different variables (e.g., person, task and strategy) on memory performance. Children from kindergarten, first, third and fifth grades were given hypothetical problems and asked a variety of questions to find out what they knew about mnemonic techniques and the appropriateness of various strategies for different tasks. In some of the interview questions, children were asked to think of the things they could do to help them remember to take their ice skates to school the next morning. Consistent with the recall literature, older children approached the task with more planfulness than younger children, who gave fewer responses about what to do. Older children were aware of the task demands and, in their knowledge base, possessed rules concerning the operation of a number of strategies (Ornstein & Corsale, 1979). The most frequently mentioned strategies involved relying on external retrieval cues (e.g., putting the skates by the door or writing a note as a reminder) instead of their own internal memory process (e.g., going through a mental checklist of things to bring to school). Overall, third- and fifth-graders were more knowledgeable, inventive, and means-end oriented than younger children in generating methods of enhancing remembering.

A different perspective to the lack of awareness and inefficient utilization of strategies was taken by Yussen and Levy (1977) in a series of two experiments. They examined the developmental changes in metaretrieval plans (i.e., knowledge of plans and actions one can use to retrieve stored information) that eight- and 15-year-olds offered to solve different retrieval problems. This study differed from previous metaretrieval research in that it included both internal and external retrieval problems. External problems (e.g., "How could you go about finding your lost jacket?") could be solved easily by using physical aids or cues available in the immediate environment. Internal problems (e.g., "How could you remember the idea you had for a birthday gift?") restricted one to his/her own mental world, where few external aids were available. Yussen and Levy (1977) assumed that older children would perform similarly to younger children on internal problems. That is, they would find the internal problems difficult and express limited ideas about how to solve them. Third, fifth-, seventh-, and ninth-graders were presented with two hypothetical problems and were asked to verbalize all the possible ways they could retrieve the information successfully. Verbal responses were classified into three major categories: search, think and other (taken from the scoring system of Kreutzer et al., 1975). Interview data indicated that with an increase in age, children gave a greater number of different ideas for internal problems. Their finding suggests that children may be beginning to acquire insightful ideas for these problems around middle childhood. For example, to use retracing one's steps was recommended most frequently as a strategy.

The information given during the unstructured interview in the first experiment was highly dependent upon the verbal skills of the subjects. Therefore, Yussen and Levy (1977) conducted a second experiment in which children in the same grades as described in Experiment 1 made forced-choice judgments about retrieval strategies from a list of alternatives. Comparisons were made between those solutions selected most frequently as the "best strategy" in Experiment 2 and the most frequently mentioned strategy in Experiment 1 to determine if the judgments were congruent. When given the opportunity to make a comparison judgment, internal problems were seen by the children as more difficult than external problems. Secondly, forced-choice judgments yielded different results than the solutions offered in the first experiment. Retracing steps was identified as the "best strategy" in both types of problems, but other strategies were more likely to be given in Experiment 1. This difference suggests that various plans have different retrieval value for the child. Further, when faced with an actual retrieval problem, strategy choice may be different than in a hypothetical situation.

In addition to their lack of awareness of the best means for remembering, children may not have an appreciation of strategic intervention, in general. Brown (1975, 1978) assessed children's ability to predict the outcome of using a particular strategy of studying for a longer period of time. The children were shown 20 pictures which supposedly had been seen by two children who were asked to learn them. They were told that one child had five minutes to look and study, while the other child had one minute. The children were then asked to predict which child would remember more and, whether they would want to study for one or five minutes if they had to learn the pictures. Most of the children predicted that studying for five minutes would be better, although the younger children and those who were mentally retarded could not justify their choice. When asked about their own behavior, some of the younger and mentally retarded children indicated that they would study for one minute, although they had previously predicted that a five minute study period would result in better recall. Brown, Campione, Barclay, Lawton and Jones (cited in Brown, 1978) assessed normal and mentally retarded children's knowledge about the effectiveness of a strategy for free recall. Children viewed a video tape of a 12-year-old performing four different activities while trying to learn a list of 12 pictures. The four study behaviors were categorizing, rehearsing, labeling and looking. After seeing the tape, the children were asked to predict which activity would lead to better recall performance. Predictions for normal four-year-olds were evenly divided across all four strategies, whereas many of the mentally retarded children had an awareness that an active strategy, such as categorizing and rehearsing, would enhance performance. The majority of the third graders also indicated that an active strategy was the best activity to use. Interestingly, when compared to actual performance, few retarded and young children adopted the strategy they had originally predicted would be superior. The relationship between prediction and performance was not perfect even for third graders. These findings suggest that children's knowledge about memory is incongruent with their memory behavior.

Butterfield and Belmont (1976) have coined the term "executive function" to refer to a basic metamemorial ability of an intelligent memorizer. According to them, this person:

> must be able to organize his activities in the most efficient manner by selecting a task-appropriate skill and deciding to maintain, modify, or abandon that skill in response to feedback, that is, changing task demands or the success or failure of the strategy. (Brown & Barclay, 1976, p. 72)

Butterfield and Belmont (1977) have been concerned with an individual's ability to change strategies as a function of task difficulty. That is, how much flexibility does an individual have in revising or abandoning a strategy when it is no longer appropriate and in reinstating it when its use again becomes needed? Several different lists of items were presented to 10- and 12-year-olds and adults until a stable rehearsal strategy was established. Then, without notice, one of the lists was presented for a second time, thus lessening the demands to use an active operation. Finally, new lists were introduced without warning, and the individual had to again revise his/her means in order to assimilate the new information. They found that older children (i.e., 12-year-olds) and adults needed less time to select a strategy when compared to the 10-year-olds. Further, the older children and adults abandoned a strategy more quickly when the need diminished, and they required less time to reinstate it when the need arose. It appears from this finding that adults and older children show a greater flexibility in strategy transfer. Further research needs to be concerned with when and under what situations children apply a strategy and the effect of choosing between two or more competing strategies on subsequent behavior.

Using the idea of "executive control," Barclay (1979) investigated an individual's ability to adapt a single mnemonic routine, such as rehearsal, to two slightly different task situations. Barclay assumed that the "executive function" would be present if the subject changed strategies (as shown previously) as well as when she/he recognized and continued to use a strategy on a second task. A recall task, presented in a pause-time paradigm (i.e., self-paced presentation) was given to sixth-, tenth- and twelfth-grade children and adults (27 years of age). In the first phase, labeled assessment, subjects' spontaneous strategy selection was evaluated. Those not adopting a "cumulative rehearsal, fast-finish" routine were trained in its use. Following training, a series of unprompted maintenance (no instructions) trials were given. In the generalization phase, the task demands were changed slightly. Subjects were again required to recall six times, but this time the to-be-remembered (TBR) items were dispersed randomly among six to-be-forgotten (TBF) items. Developmental trends related to the executive control of strategic behavior were found. Adults adopted an "optimal" or most efficient strategy as shown by average pause-times and their accuracy in item recall. The same mnemonic operation was used in the maintenance and generalization tasks. This strategy selection was not used by school-aged subjects, indicating that the executive function develops with age. When instructed, all subjects easily learned and maintained the strategy without prompting. The results for the generalization tasks, however, indicated that the older the subject, the more closely his/her mnemonic behavior approximated that of an adult. Although they have been trained, children were unaware of the ways in which mnemonic efforts facilitated memory, and therefore they abandoned the strategy unless they were prompted to use it. Apparently children do not monitor the effects of these mnemonic operations on their performance, whereas the adult information processor selects, revises, or continues to use an "optimal" means. Or, is it that children do not recognize that a behavior found to be useful and appropriate for one task can be employed successfully in another task? These findings indicate that the development of metacognition, specifically knowledge about memory or metamemory, matures with age. But, regardless of the age, knowledge about one's own memory processes:

> must play a vital role in determining if strategies and plans will be adopted, and if appropriate plans will be used. Without such introspective knowledge, it would be difficult if not impossible to select an appropriate strategy at the onset of a task and to change or modify that strategy . . . . (Brown, 1979, p. 239)

Metamemory and memory behavior. Much theorizing has been done regarding metamemory and its development. An issue of critical concern is how metamemory influences one's ability to apply this knowledge. It has been argued that there is a close connection between memory awareness and how one approaches a memory task (Brown, 1978; Flavell & Wellman, 1976). But, attempts to relate memory knowledge and memory behavior indicate that metamemorial information may not be sufficient to increase memory abilities (Brown & Barclay, 1976; Salatas & Flavell, 1976). In an earlier cited study, Salatas and Flavell (1976) followed their free recall task with metamemory questions focusing on the facilitative effect of categorization on memory. They found that the use of categorization on the successive memory trials was not related to the answers given on metamemory questions. Both the subjects who categorized and noncategorizers were likely to say that grouping pictures by categories would facilitate memory performance. Moreover, answers to the questions did not predict subsequent categorization on a retest six weeks later. The failure to find substantial metamemory--memory behavior correlations may be due to the complexity of these connections which involve more aspects of memory knowledge than originally thought. One way to approach this issue is to adopt the suggestions of Cavanaugh and Borkowski (1980), that we need to evaluate children's memory knowledge in a broader context by considering that knowledge that several strategies can be used in a particular task, why strategies might be needed, or when they can and should be applied to various situations, is characteristic of an individual possessing mature metamemory. This knowledge is likely to be reflected in the person's strategic behavior. Another reason for the failure to obtain strong metamemory--memory connections may be attributed to the failure to use several tasks in the same study. Cavanaugh and Borkowski (1980) reasoned that these connections should be observed across many tasks that have the same processing demands. In an attempt to clarify this issue, they had children from kindergarten, first, third and fifth grades participate in two sessions. During Session 1 an extensive interview (adopted from Kreutzer et al., 1975) was conducted to assess metamemory. Three tasks--free sort, cognitive cueing and alphabet search--were used to measure the transsituational applicability of strategies and performance during Session 2, about two weeks later. The results of this study, first of all, replicated Kreutzer et al.'s (1975) findings. Third and fifth graders were more aware of their memory capabilities than first graders and kindergarteners. Second, performance on the three memory tasks showed significant correlations between strategy use and recall. Use of strategies during study periods was related to successful recall, and this improved with age. Finally, consistent metamemory--memory correlations were not evident across memory measures within any grade. The amount of strategic knowledge did not discriminate between those who used and those who did not use relevant knowledge, suggesting that metamemory is not a necessary prerequisite for successful memory performance.

Strategy use and recall performance. The available literature regarding children's performance on memory tasks indicates that recall increases with chronological age, and that there are few age differences in recall beyond adolescence (13 to 14 years old) (Wachs, 1969; Willner, 1967). This pattern is evident regardless of the composition of items in the list. That is, if the items are unrelated or if they can be conceptually grouped, older children show superior recall (Cole, Frankel & Sharp, 1971; Wachs, 1969). These changes in memory performance with increasing age may be explained by the observations that, in memory tasks, older children adopt more effective strategies in processing and maintaining information. These active approaches have been found to be associated with higher recall scores. Rehearsal is one active approach that has been investigated extensively. Initial research suggested that items that were rehearsed more frequently had a greater probability of being recalled (Rundus, 1971). Ornstein, Naus and Liberty (1975) argued that it was not simply the quantity of rehearsal that was important, but rather, the quality of rehearsal. They looked at the overt rehearsal techniques used by eight-, 11-, and 13-year-olds in a multi-trial free recall task for unrelated words. The results showed that the number of words recalled increased over trials and with age. More importantly, however, they found that although a word may have been rehearsed several times, the composition of the rehearsal sets was a more critical determinant of recall. Eleven-year-olds tended to rehearse words either alone or with a few other items, whereas 13-year-olds intermixed many of the words in their rehearsal sets. Thus, active approaches become more apparent with increasing age, and together these factors (age and efficient strategies) are associated with superior recall. It has also been suggested that this type of active rehearsal leads to the development of an organizational plan (Ornstein et al., 1975; Ornstein, Naus & Miller, 1977), and that this rehearsal is more important when the structure of the list is less explicit than when list organization is salient (e.g., category groupings).

Categorization is another approach to remembering that has received much attention. Like "active rehearsal," the extent to which items are conceptually grouped is positively related to the number of items recalled (Tulving, 1962), and that the amount of clustering (in the free recall of categorized lists) generally increases with children's chronological age (Appel et al., 1972; Mandler & Stephens, 1967; Paris, 1978; Rossi, 1964). The age, however, at which spontaneous clustering occurs may be a function of the stimuli. If the categories are readily recognizable (i.e., the items are highly associated), even young children may show clustering tendencies (Moely, Olson, Halwes & Flavell, 1969; Myers & Perlmutter, 1977; Rossi, 1964). Yet, when associative relatedness is not as strong, the spontaneous search for categories does not become evident until adolescence (Cole et al., 1971; Furth & Milgram, 1973; Lange, 1973). Moely et al. (1969) have outlined a rough developmental timetable of the strategies used in memory tasks. First, children (kindergarten and older) verbalize the stimulus names during study periods. Second, children nine years of age and older tend to continue to rehearse the stimulus names during the brief delays between the study period and recall testing. Third, children may use a self-testing strategy. That is, they create an isolation condition for themselves, so as to practice reproducing the stimuli from memory. This strategy, the researchers found, is infrequent prior to Grade 3. Lastly, manual clustering during the study intervals is frequently observed for children in Grade 5 and above. These last two stages were described as ". . . a remarkable accomplishment, and not surprisingly, a late-appearing one . . . both which bespeak of a very active learner . . . ." (p. 33). Thus, a spontaneous use of effective strategies (or combination of strategies) shows a dramatic increase with age and this directly affects recall ability.

Metacognitive knowledge for other tasks. The matter of metacognitive development in other skills, such as communication, problem-solving, and perception (attention) has received little attention. Of concern is whether metacognitive insights share commonality among the various cognitive domains. A study by Yussen and Bird (1979) has focused on memory, communication and attention, and children's metacognitive insights for these various activities. Children who were four- and six-years-old were presented with hypothetical situations depicting these three domains. The children were asked questions to assess their understanding of four facts about different variables: (a) length--knowing that a short list is easier to learn than a long list; (b) noise--knowing that the presence of noise makes a task more difficult than if the noise were absent; (c) time--knowing that having more time to study makes a task easier; and (d) age--knowing that an adult or older child finds tasks easier to do than a younger child. Kreutzer et al. (1975) reported that length and noise variables were understood by more children than the age and time variables. A pilot test by Yussen and Bird indicated that children could grasp the concepts of age and time and the activity being performed in the pictures. All children were shown test pairs for three activities with four variables pertaining to each (e.g., one card from a pair portrayed a child memorizing three items, the other card showed a child memorizing 10 items). There were two test pairs for each Activity X Variable concept to reduce the element of chance responding and to serve as a reliability check. The three activities were depicted in the following manner: In the memory situation, the hypothetical child viewed pictures while seated at a table; for communication, a child was shown talking to another child; and for attention, a girl was shown looking at several animals through a window. After viewing the test pairs, the children were asked, "Which child has the harder job?" and "Why?". For both four- and six-year-olds, the pattern of understanding of the four variables was the same across the three cognitive activities. Children were more accurate in answering questions about length and noise than about age and time. Experience with length and the presence or absence of noise may be frequently encountered by children. Time and age are abstract qualities of a situation, and thus, harder to depict. Overall, six-year-olds were more accurate in their metaknowledge than four-year-olds. Thus, this study provides empirical evidence that children hold common insights (metacognition) for different cognitive activities. A question not pursued in this study, and therefore unanswered, is whether there is the synchronous development of other task-specific metacognitions in children, such as knowing that one cognitive strategy is well suited for one activity but not for another and whether these differences in metacognitive knowledge for task-appropriate strategies are reflected in children's behavior for different cognitive tasks.

Purpose of the Study

Based on the previous discussion of task strategies and task goals, the purpose of this study is three-fold: (a) to ascertain the developmental differences in the development of metacognitive knowledge of the interaction of task demands and appropriate task-specific strategies for memory tasks; (b) to investigate the relationship between children's metacognitive knowledge and actual performance for these activities; and (c) to see if children exhibit strategic behavior for tasks demanding less of one's memory, what strategies are used, and how effective these strategies are.

In separate interview questions, Kreutzer et al. (1975) showed that older children generally are more aware of task demands than younger children, and that older children's strategies seem to be more clearly and explicitly planful and means-oriented. Wellman (1978), on the other hand, demonstrated that both young (five-year-olds) and older (10-year-olds) children could identify the relevant variables (e.g., that one person had more items to remember or that one strategy was more efficient than another) in complex problems. Five-year-olds, however, failed to show knowledge of the interaction of these variables (i.e., they did not know how task demands influenced the choice of strategy). The task demands manipulated in this study were length and time. (These variables were chosen because they are the two most frequently encountered by children in learning/memory situations). Length referred to the number of stimuli to be recalled (either a short or long list), and time referred to the amount of time subjects were allowed to study the stimuli (either a short or long time). Given these differences between tasks, subjects were asked to identify under which condition(s) remembering is easier and why. They were asked to generate all the possible strategies that could be implemented under each task demand, and to specify which study strategy would be the "best" to use, given a particular task demand. Children were then presented with memory tasks involving these various task demands, to see if their choice of strategies varied from that specified, and to assess their effect on recall performance. Secondly, children's strategic behaviors for two other tasks, coding and alphabetizing, which place fewer demands on memory than does recall, were assessed. The following predictions were made:

1. Age differences will be evident in children's awareness of the effects of the task demands on the ease or difficulty of remembering pictures, with older children (11- and 15-year-olds) being more aware than younger children (seven- and nine-year-olds). In addition, older children will be able to provide an adequate justification for their choice.

2. With increasing age, the number of different strategies that could be used in the various tasks will increase.

3. Younger children will engage in less efficient strategies, such as rehearsal, whereas older children will exhibit more strategic behaviors, such as categorization. This is predicted for all of the tasks.

4. Performance scores will increase with age.

5. There will be a positive relationship between the type of strategy used and performance scores, with those children who use a more efficient strategy obtaining higher performance scores.

6. Older children will show greater variation and flexibility in adapting their strategies to fit the varying task demands.

Chapter II

Method

Subjects

The subjects were 80 children selected from regular classrooms, in an elementary school and a junior high school, located in adjoining middle-class neighborhoods in Omaha and within the same school district. Twenty children, 10 males and 10 females at each grade, first (M = 86.95 mos., SD = 6.68), third (M = 111.65 mos., SD = 4.28), fifth (M = 134.50 mos., SD = 5.26), and ninth (M = 181.10 mos., SD = 3.99) participated. IQ was not controlled, and children with special education problems were not included in this study. This distinction was based on teacher advisement. All 80 children were given the coding and alphabetizing tasks. For the Memory-Time and Memory-Length tasks, however, 10 children, five males and five females, at each of the grade levels were given these tasks. Assignment to tasks was made using the table of random numbers. Thus, a total of 40 children did the Memory-Time tasks, and a total of 40 children did the Memory-Length tasks.

Stimulus Materials

Memory tasks. The items consisted of 120, 10.8 cm X 7 cm colored pictures of common objects, shapes, or people portraying different occupations, selected from the Basic Word Making Card Series (1975).

The Memory-Time task consisted of 48 pictures, with the remaining 72 used for the Memory-Length task. The categories represented were vegetables, body parts, parts of a house, furniture, vehicles, animals, tools, fruit, musical instruments, buildings, clothing, toys, kitchen utensils, shapes, school supplies and occupations. The selection for the majority of the pictures was based on typicality ratings for the pictures of instances of superordinate categories (Young & Kellas, Note 1). Typicality ratings for individual pictures ranged from 7.00 (i.e., highly typical of the category it represents) to 1.92 (i.e., less typical of the category). The mean typicality ratings for each of the categories ranged from 5.60 to 6.26. Typicality ratings, however, were not available for the pictures in the categories of shapes, occupations and school supplies.

Coding and alphabetizing. The coding task materials were adapted from the WISC Coding subtest. The pairs of numbers and symbols in the coding keys were rearranged each in a different order for forms A and B. The coding exercises were printed on 21.5 X 14 cm white paper. Materials for the alphabetizing task consisted of 35 common words, such as cat, fan, rain and tape. All letters of the alphabet appeared at least once, except for the letters L, V and X. These deleted letters and the words used were chosen at the discretion of the experimenter. The purpose of not using some of the letters and of representing other letters more than once was to increase the difficulty of the task. Children were not given this information prior to doing the task. Each word was individually typed in large, bold print on white, unlined 12.7 X 7.5 cm index cards.

Tasks

Four task situations were used to assess children's use of strategies. These were referred to as Memory-Time, Memory-Length, Coding and Alphabetizing. The order of presentation for each of these tasks was completely randomized across children to reduce any order effects.

Memory-Time. The child was shown two sample groups of pictures for reference when answering the metacognitive questions. The pictures were randomly arranged on the desk, so as to show two separate groups. One group represented a short study time, the other a long study time. Each sample group contained six pictures. The following instructions were given and questions were asked of each child:

> Look at these two groups of pictures. You do not need to remember them. I am going to ask you some questions about how you would learn and remember these pictures. Answer the questions the best you can. There are no "right" answers, so just try to do your best. Now, here are two groups of pictures. They each have the same number of pictures. For this group [pointing to group A], however, you only have a very short amount of time to study and learn these pictures, while for this other group [pointing to group B] you have a longer period of time to study and learn these pictures. Now, is it going to be easier to learn and remember the pictures if you had a short amount of time to study them or a longer period of time, or won't it make any difference? Point to the group that you think would be easier to remember, or tell me if there would be no difference. Why would

that group be easier to remember? Look at this group of pictures [pointing to the one representing a short amount of study time]. Suppose that you only had a very short amount of time to study these pictures so you could tell them to me without looking at the cards. How would you study and learn these pictures? Tell me all the possible things you could do with the pictures to help you remember them, given a short amount of time. [If the child suggested only one way, the experimenter probed further by saying, "Good, and what else could you do?" For younger children, especially seven-year-olds who had difficulty verbalizing their ideas, they were asked to show the experimenter what they would do. To ensure that the children had exhausted all their ideas, the experimenter asked, "Anything else you could do? Think of all the possible ways."] Which of these ways that you mentioned would best help you study them so that you could remember the most pictures? What is the best way, given a short amount of time? [Children giving only one response to the previous question were asked, "Is that the best way to learn the pictures if you had a short amount of time?" If they answered, "No," the experimenter asked, "Then what is the best way to learn the pictures?"] Now, look at the other group of pictures. There are six pictures in this group also. But, suppose for this group you were given a long period of time for studying the pictures. How would you study and remember these pictures so that you could tell them to me without looking? Tell me all the possible things you could do with the pictures to help you remember them, given a long study time. [If the child gave only one response, the experimenter probed further as described earlier.] Which of these ways that you mentioned would best help you study them so that you could remember the most pictures if you had a long period of time? [Similar probing, as described previously, was conducted for a child who gave only one suggestion for learning the pictures.]

The child was then given five practice pictures to study for 30 seconds. This was to ensure that she/he understood the idea of studying and recalling without looking. The following instructions were given for the remainder of the task:

I have four different groups of pictures. Each group has the same number of pictures, but for some of the groups you will only have a very short amount of time to study, and for the other, you will have a long period of time to study. I will give you one group of pictures at a time. You can do anything with the pictures that will help you remember them. You might want to move them around, for example. When I say "Stop," I will take the pictures away and ask you to tell me the ones you remember. You can tell them to me in any order. Remember, keep studying the pictures until I say stop. Do you have any questions?

Four different groups of pictures were used (see Appendix A). Each set contained 12 pictures, representative of three categories. The pictures and categories were not duplicated across the four groups. The time allowed for studying each of two of the groups in the short time condition was 30 seconds. These groups were labeled as

Short Time 1 and 2 (hereafter referred to as ST1 and ST2). The time limit for studying each of the two long time groups was two minutes. These groups were labeled as Long Time 1 and 2 (LT1 and LT2). The order of presentation for the four groups was randomized across subjects. Children were given one of the groups at a time. Each presentation was accompanied by a brief description of the group, such as "you will have a very short amount of time to study these pictures" or "you will have a long period of time to study these pictures." During the study intervals, the experimenter recorded the child's study activity (e.g., putting the cards into categories). Free recall occurred immediately following the study period and was terminated after 15 seconds of nonresponding or after the child indicated that she/he could not recall any more. All responses were recorded in the order recalled. After each group of pictures was recalled, the experimenter asked the child to describe his/her method of studying the pictures, to verify the experimenter's recording.

The independent variables for this task were sex, age (rather than grade because age is more frequently used in the literature) and the amount of time allowed for studying the pictures (30 seconds or two minutes). The dependent measures were responses to the initial interview questions, strategies used for studying the pictures, and the number of pictures recalled correctly for each time group.

Memory-Length. The child was shown two sample groups of pictures for reference when answering the metacognitive questions. The pictures were randomly arranged on the desk in two distinct groups. One group contained six pictures, the other group had 12 pictures. The following instructions were given and questions were asked:

> Look at these two groups of pictures. You do not need to remember them. I am going to ask you some questions about how you would study and remember these pictures. Answer the questions the best you can. There are no "right" answers, so just try to do your best. One group has a few pictures [pointing to the group of six] and the other has a lot of pictures [pointing to the group of 12]. Now, suppose you had the same amount of time to study a few pictures as you did to study and remember a lot of pictures. Would it be easier to remember a few pictures, a lot of pictures, or wouldn't there be any difference? Point to the group which you think would be easier to remember or tell me if there would be no difference. Why would that group be easier to remember? Look at the group of six pictures. How would you study these pictures so that you could tell them to me without looking at the cards? Tell me <u>all</u> the possible things you could do to help you remember a few pictures. [If the child suggested only one way, the experimenter said, "Good, and what else could you do?" Younger children, especially seven-year-olds who had difficulty verbalizing their ideas, were asked to show the experimenter what they would do. To ensure that the child had exhausted all his/her ideas, the experimenter asked, "Anything else you could do? Think of all the possible ways."] Which of these ways that you mentioned would help you study them so you could remember the most pictures? What is the

best way to study and learn them if you only have a few pictures? [Children who gave only one response to the previous question were asked, "Is that the best way to learn a few pictures?" If they answered, "No," the experimenter asked, "Then what is the best way to learn a few pictures?"] Now, look at the group of 12 pictures. This is a lot of pictures. How would you study and remember a lot of pictures so that you could tell them to me without looking? Tell me all the possible things you could do with a lot of pictures to help you remember them. [The experimenter probed further, as described previously, if the child gave only one response.] Which of these ways that you mentioned would best help you study them so that you could remember the most pictures? [Similar probing, as specified earlier, was conducted for children who gave only one suggestion for learning the pictures.]

The child was then given five practice pictures to study for 30 seconds. This was done to ensure that he/she understood the idea of studying and recalling the pictures without looking. The following instructions were given for the remainder of the task:

I have four different groups of pictures. Some groups have a few pictures and some have many pictures. I will give you one group of pictures at a time. You can do anything you want with the pictures that will help you remember them. You might want to move them around, for example. When I say "Stop," I will take the pictures away and ask you to tell me the ones you remember. You can tell them to me in any order. Remember, keep studying the pictures until I say stop. Do you have any questions?

Four different groups of pictures were used. Two groups consisted of 12 pictures each. These groups were labeled as 12A and 12B. The two other groups consisted of 24 pictures each and were labeled as 24C and 24D. Each group contained pictures representative of three different categories which were not duplicated across the four groups. The groups 24C and 24D had three categories represented, also, but the number of pictures per category was increased to eight. The time limit for studying each group of pictures was two minutes. The order of presentation for the four groups was randomized across subjects. Children were given one of the groups at a time. Each presentation was accompanied by a brief description of the group, such as "this group has a few pictures" or "this group has many pictures." During the study intervals, the experimenter recorded the child's study activity (e.g., putting the cards into categories). Free recall occurred immediately following the study period and was terminated after 15 seconds of nonresponding or after the child indicated that she/he could not recall any more. All responses were recorded in the order recalled. After recall of each group, the child was asked to describe his/her method of studying the pictures to verify the experimenter's recording.

The independent variables in this task were sex, age and the number of pictures in a group (12 or 24). The dependent measures were responses to the interview questions, the strategies used for studying the pictures and the number of pictures recalled correctly for each group.

Coding. A sample coding task was shown to the child for reference when answering the following questions:

> Look at these divided boxes. Each box has a number in the top part and a special mark in the bottom part. Each number has its own mark. Now, look down here where the boxes have numbers in the top part, but the squares on the bottom are empty. You will have to put in the empty squares the marks that should go there. Do you understand what you will have to do. This is just a sample. Before you start, I am going to ask you some questions. First, how are you going to do this coding task? That is, if you could do it any way that you wanted, how would you go about filling in the empty squares? Tell me all the different ways you could do this task. [Younger children were asked to show the experimenter what they would do if they had difficulty verbalizing their plan.] Which of the ways that you mentioned would help you fill the most boxes as quickly as possible? What is the best way to do this task? [If the child gave only one response to the previous questions, she/he was asked if that was the best way to fill the most boxes. If the response was "No," the experimenter asked, "Then what is the best way to fill the most boxes?"]

Children were then given a simple practice coding task using shapes in place of numbers and different symbols. This was done to ensure that they understood how to do the task. After completing the practice task, one of the two coding tasks (form A or B) was given to the child face down. The instructions were:

> When I say "begin," try to fill in as many boxes as you can before I say "stop." You can fill the boxes in any way that you think is best and will help you fill the most boxes. Keep working until I say "stop." Remember, work as quickly as you can, doing it any way that you want.

The order of presentation for the two forms, A and B, were randomized across subjects. Two minutes were given for each task. While the child filled in the boxes, the experimenter recorded how the task was being done. The children were asked to describe what they did after completing each form to verify the experimenter's recordings. They were also asked if they had tried to memorize the numbers and their corresponding symbols.

The independent variables were sex, age and trials (forms A and B). The dependent measures included the responses to the interview questions, the strategies used to fill in the boxes, and the number of boxes correctly coded.

Alphabetizing. Prior to beginning this task, the younger children were asked if they knew the alphabet and if they knew how to put words into alphabetical order. No further explanation or demonstration was needed as each child knew the alphabet and was able to alphabetize words. A sample group of words, such as bell, dog, flag, sand and vase, was shown to the child for reference when answering the following questions:

> How are you going to go about putting these words into alphabetical order? Tell me all the different ways that you could alphabetize these words. Which of the ways that you mentioned would

best help you put the most words in alphabetical order? That is, what is the best way to do this as quickly as possible? [If a child gave only one response to the previous questions, she/he was asked, "Is that the best way to do this task?" If his/her response was "No," the experimenter asked, "Then what is the best way?"]

A practice group of five words was given to the child for alphabetizing. All children completed this practice task without any difficulty. A randomized group of 35 words was given to the child with these instructions:

> I have some words on these cards, and they are not in alphabetical order. I want you to put as many of these words as possible in alphabetical order. You can do it any way you want. Do it the way that you think will be the best and fastest for you. Just keep working until I tell you to stop. Do you have any questions?

The time allowed to do this task was two minutes. The experimenter recorded the child's activity during the two minute interval. At the end of the trial, the number of correctly alphabetized words was counted. If there was a question as to which words had been alphabetized, the child was asked to show them to the experimenter.

Chapter III

Results

The results showed that children at each age level were aware of task-appropriate strategies for the memory, coding and alphabetizing tasks, and that their suggestions of "best" strategies for hypothetical situations approximated their actual task behavior. Significant age differences for the performance measures were found on all tasks. Generally, 11- and 15-year-olds showed better performance than seven- and nine-year-olds for recalling pictures, copying coding symbols and alphabetizing words. Significant main effects for strategy on the number of pictures recalled and on the number of words alphabetized were revealed for the memory-time and memory-length tasks and for the alphabetizing task, respectively. Children who used the three strategies, categorization, rehearsal and self-testing, recalled significantly more pictures than those who only looked at or rehearsed the items. This pattern was found for all treatment conditions for the memory tasks. For the alphabetizing task, those who structured their alphabetizing format beginning with the top card in the pile put more words in the correct order within a given amount of time than children who visually displayed all the cards before alphabetizing them. Developmental patterns were found for the types of strategies used for each of the tasks. Older children exhibited the use of more efficient strategies than younger children. Rehearsal and a combination of categorization, rehearsal and self-testing were used most frequently by seven- and nine-year-olds and 11- and 15-year-olds, respectively, on the memory tasks. Strategy changes were not observed when task demands varied (e.g., amount of study time or number of pictures to be remembered). Rather, children continued to use a particular strategy despite the change in the difficulty of a task. For the coding task, older children tended to code all of one number first, whereas younger children coded all the numbers in the order presented. Lastly, more older children than younger children chose to alphabetize a group of words beginning with the top card in the pile.

Detailed descriptions of the children's responses to the interview questions and descriptions of their task behavior and performance follow.

Memory-Time Task

Metacognitive knowledge. Metacognitive knowledge refers to one's knowledge about how different variables affect performance. The variables include one's abilities (Person), task characteristics (Task), or appropriate strategies (Strategy). Chi Square analyses were performed on the responses to the interview questions. The number of strategies generated at each age level was analyzed by a one-way analysis of variance. The two sample groups of pictures were arranged so that one group represented a short study time and the other a long study time. The children were asked to point to the group of pictures which would be easier to remember or to indicate if there was no difference. Most of the children (65%) pointed to the group of pictures representing a long study period. Although there were no age differences, at least half of the children at each age level gave this response (range = 5 to 8). Two children at each age level indicated that there would be no difference between the groups. To a subsequent question, "Why would it be easier to remember that group of pictures?", 57.5% of the sample responded that a long study period would allow more time to study the pictures, and therefore, would make it easier to remember them. The percent of children at each age level giving this explanation was 50, 60, 40, and 80 for seven-, nine-, 11-, and 15-year-olds, respectively. Several children explained their choices by stating that the pictures in their group of choice were easier to remember than the pictures in the other group (N = 3), or that they already knew the pictures in that group (N = 1), or that if they had a long amount of time to study, they might forget the pictures, thus a short time was better (N = 1). More seven-year-olds (40%) than children of the other ages could not give a reason to justify their choice. These differences between ages, however, were not significant.

Children were then questioned about their strategies for learning the pictures, given a short study time. They were asked to state all the possible ways to study and remember the pictures in that group. At least two different strategies were offered by 52% of the children. The most frequently mentioned strategies included categorization, association and rehearsal. Less frequently suggested strategies were remembering the first letter of the picture's label (i.e., making an acronym), writing down the names, visualizing the pictures or having another person quiz them. Specific strategy selection was not significantly associated with age. The number of different strategies generated, however, was influenced by age, according to a one-way analysis of variance, F (3, 36) = 6.17, $p < .002$. A Duncan Range Test showed that 15-year-olds offered more strategies (M = 3) than seven-year-olds (M = 1.1), nine-year-olds (M = 1.2), or 11-year-olds (M = 1.6). The most frequently mentioned best strategy across age levels for a short study period was rehearsal (30%) and categorization (15%) (see Table 1). Of those children suggesting categorization,

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Insert Table 1 about here

50% were 15-year-olds. For rehearsal, more seven- and nine-year-olds (40% at each age level) than 11- and 15-year-olds (20% at each age level) selected this strategy. Over one-third (35%) of the children did not offer a best strategy, although most of this group (88%) previously had suggested at least one strategy. These differences, however, were not significant.

Children's responses to the question assessing strategies that could be used for a longer study time revealed the following patterns. About one-third of the children (35%) suggested at least two different strategies, such as categorization, association and rehearsal. Strategies mentioned less frequently included rhyming the pictures' labels with other words, writing down the name, remembering the beginning letter of the label, visualizing the picture or having another person quiz them. The most frequently mentioned strategy was rehearsal for a longer period of time than with the short study time

Table 1

Number of Children at Each Age Level Selecting a Best Strategy for the Short and Long Study Time Conditions

	Strategy									
	Categor-ization		Rehearsal		Associ-ation		Other		DK/NR	
Age[a]	ST	LT	ST	LT	ST	LT	ST	LT	ST	LT
7 years	1	1	4	4	1	1	0	0	4	4
9 years	1	1	4	5	1	1	1	0	3	3
11 years	1	1	2	3	0	1	2	1	5	4
15 years	3	2	2	5	1	0	2	1	2	2

[a]N = 10 for each age

(27.5%). Although strategy choice did not differ significantly for children across all ages, the number of different strategies for a long study time differed between age groups, F (3, 36) = 4.304, $p < .01$. A greater number of different strategies were given by 15-year-olds (M = 2.3) than seven-year-olds (M = .7) or nine-year-olds (M = 1.2) according to the Duncan Range Test. Eleven-year-olds gave an average of 1.6 different strategies. Six out of the 40 subjects gave no response to the strategy question. The "nonrespondents" included seven- and nine-year-olds exclusively. When quizzed about the best strategy to use for a long study time, the children gave responses similar to those found for the short study time conditions (see Table 1). The most frequent responses for all children were rehearsal (42.5%) and categorization (12.5%). There were no significant differences between age groups for these two strategies or for any of the other strategy classifications, based on two-way Chi Square analysis. Approximately one-third (32.5%) of the children did not suggest a best strategy, although most of them (85%) had previously offered at least one strategy. The "no response" pattern occurred about equally at each age level.

Insert Table 2 about here

Performance. Table 2 presents the mean number of pictures recalled for the short and long study times for each age group. The two groups of pictures representing the short study periods (30 seconds) have been labeled Short Time 1 (ST1) and Short Time 2 (ST2). The other two groups of pictures representing the long study time (two

Table 2

Mean Number of Pictures Recalled for Short and Long Study Periods at Each Age Level

	ST1		ST2		Combined Mean	LT1		LT2		Combined Mean
Age[a]	M	SD	M	SD		M	SD	M	SD	
7 years	5.3	1.77	5.8	1.32	5.55	7.2	1.55	7.9	1.10	7.55
9 years	5.1	2.13	6.6	2.17	5.85	6.8	1.32	8.5	2.37	7.65
11 years	7.5	1.90	9.3	2.11	8.40	10.7	1.16	11.0	.94	10.85
15 years	9.4	2.41	9.1	1.10	9.25	10.6	2.01	11.6	.70	11.10

[a]N = 10 at each age

minutes) have been labeled Long Time 1 (LT1) and Long Time 2 (LT2). Separate two-way analyses of variance were used to assess the effects of age (four levels) and strategy (three levels) on the number of pictures recalled under each of the four time conditions. Significant main effects for age were found for each of the analyses, F (3, 28) = 4.78, $p < .008$ for ST1; F (3, 28) = 6.54, $p < .002$ for ST2; F (3, 28) = 13.35, $p < .0001$ for LT1; F (3, 28) = 11.70, $p < .0001$ for LT2. Subsequent Duncan Range Tests indicated that 11- and 15-year-olds recalled more pictures than seven- and nine-year-olds for all four time conditions, and only for the group labeled ST1 did 15-year-olds recall significantly more pictures than did 11-year-olds. In all other cases, however, there were no differences between seven- and nine-year-olds or between 11- and 15-year-olds.

Insert Table 3 about here

Table 3 shows the mean number of pictures recalled for each strategy used for the four time conditions. Significant main effects were also found for the strategy variable for the two short time conditions (ST1 and ST2), F (2, 28) = 5.19, $p < .012$; F (2, 28) = 4.00, $p < .029$, respectively, but not for the two long time conditions (LT1 and LT2), F (2, 28) = 1.20, $p < .31$; F (2, 28) = 2.20, $p < .13$, respectively. Subsequent Duncan Range Tests for the significant strategy effects indicated that for both ST1 and ST2, children who used the strategies categorization, rehearsal and self-testing (hereafter labeled as group CRST) recalled more pictures than those who only rehearsed the stimulus names or looked at the pictures. Looking and Rehearsal did not

Table 3

Mean Number of Pictures Recalled for Short and

Long Study Periods for Each Strategy

	ST1		ST2		Combined Mean	LT1		LT2		Combined Mean
Strategy	*M*	*N*	*M*	*N*		*M*	*N*	*M*	*N*	
Look	6.11	9	6.10	10	6.1	7.75	8	8.14	7	7.9
Rehearsal	5.58	19	7.35	17	6.4	8.13	16	9.50	18	8.9
CRST	9.33	12	9.38	13	9.4	9.58	16	10.80	15	10.2

differentially affect picture recall for either of the short time conditions. There were no significant interactions for the variables age and strategy on the number of pictures recalled under any of the time conditions.

A second series of analyses examined the study strategy used by the children in the four study time groups. Based on the experimenter's recordings, the children's strategies were classified into one of the following groupings: (a) Look--children looked at the pictures displayed on the desk in a random arrangement. Categorization was not evident and neither movement of the pictures nor lips occurred to indicate rehearsal. (b) Rehearsal--the randomly arranged pictures were kept in a pile in the child's hand and she/he looked at the pictures in that order, or the pictures remained on the desk, but lip movements or audible whispering were evident. (c) Categorization, rehearsal and self-testing (CRST)--pictures were put into appropriate categories, rehearsed and self-testing occurred (i.e., children looked away, closed eyes or turned cards over, so as to reproduce the pictures from memory). Table 4 presents the number

Insert Table 4 about here

of children at each age level who used one of the three strategies for each of the four groups of pictures. Overall, the most frequently used strategy by all children was rehearsal (43.75%), followed by categorization, rehearsal and self-testing (35%), and lastly, looking (21.25%). This pattern was similar for each of the individual lists. Significant Chi Square values were found for each group of pictures

Table 4

Number of Children at Each Age Level Using One of the Three Study Strategies for the Short and Long Study Time Conditions

	Strategy											
	Look				Rehearsal				CRST			
Age[a]	ST1	ST2	LT1	LT2	ST1	ST2	LT1	LT2	ST1	ST2	LT1	LT2
7 years	4	5	3	2	4	3	3	4	2	2	4	4
9 years	3	3	2	3	7	7	8	7	0	0	0	0
11 years	2	2	3	2	5	5	3	4	3	3	4	4
15 years	0	0	0	0	3	2	2	3	7	8	8	7

[a]N = 10 at each age

using age and strategy as factors, $\chi^2(6) = 14.398$, $p < .026$ for ST1; $\chi^2(6) = 19.363$, $p < .004$ for ST2; $\chi^2(6) = 17.643$, $p < .039$ for LT1; $\chi^2(6) = 16.914$, $p < .05$ for LT2. It should be known that about 17% of the cells had frequencies of zero. Subsequent one-way Chi Square analyses indicated that the difference occurred between age levels for each of the groups of pictures, except for LT2, for the strategy group labeled CRST, $\chi^2(3) = 8.667$, $p < .05$ for ST1; $\chi^2(3) = 10.692$, $p < .02$ for ST2; $\chi^2(3) = 8.0$, $p < .05$ for LT1; $\chi^2(3) = 6.599$, $p > .05$ for LT2. More 15-year-olds than nine-year-olds used this strategy for the four groups of pictures ($p < .008$ for ST1; $p < .004$ for ST2; $p < .008$ for LT1; $p < .004$ for LT2, Binomial analysis). Within age group differences were also found for the nine- and 15-year-olds for strategy use on all groups of pictures. An average of 72.5% of the nine-year-olds used rehearsal for the four groups of pictures, whereas an average of 75% of the 15-year-olds used categorization, rehearsal and self-testing most often. No significant differences in strategy use were found for seven- and 11-year-olds.

In order to determine whether children modified their strategies significantly with changing task demands (i.e., the amount of study time), a Cochran Q test for related samples was used. This test is appropriate for comparing the responses (or, in this case, the strategies) of N subjects under k conditions (e.g., short and long study times), using nominal dichotomized data (e.g., "used" and "not used"). The following relationships in the individual strategies between groups of pictures were analyzed: (a) strategies used for ST1 versus LT1; (b) strategies used for ST2 versus LT2; (c) strategies used for ST1 versus ST2; and (d) strategies used for LT1 versus LT2. The comparisons were regarded as related samples because all children were presented with each group of pictures. Table 3 shows the total number of children using each of the strategies for a particular group of pictures. The slight modifications that were observed between the short and long study times did not yield significant Q values. Generally, children used the same study strategy regardless of a change in task demands. Also, strategy choice did not differ significantly for groups of pictures with the same task demands (i.e., comparisons c and d).

Memory-Length Task

Metacognitive knowledge. Chi Square analyses were performed on the responses to the interview questions using age as a factor. One-way analyses of variance examined the relationship between the number of strategies generated and age. The two sample groups of pictures were arranged on the desk before the children, with one group consisting of six pictures, the other 12. Children were asked to point to the group of pictures that would be easier to remember, given that they would have the same amount of time to look at the pictures, or to tell if there would be no difference. Over three-fourths (78%) of the children pointed to the group of six pictures as being easier to remember. Within each age group, at least 70% (seven of 10) responded in this manner. Six children said there would be no difference between the groups. When asked to explain why the group they selected would be easier, 72.5% (29 of 40) said that the small group was easier because it contained fewer pictures. Within each age group, this explanation was offered by 70%. Other children justified their choice by stating that the pictures in the chosen group were more familiar, or because they have a good memory, and therefore, it did not matter how many pictures there were. Only two, nine-year-olds could not provide a reason for their selection. These differences between age groups were not significant.

Children were then questioned about their strategies for learning a small group of pictures. They were asked to state all the possible ways to learn and remember the pictures. The most frequently mentioned strategies were rehearsal and categorization. More younger children (50% of the seven-year-olds and 40% of the nine-year-olds) suggested rehearsal, whereas more older children (80% of the 11- and 15-year-olds) offered categorization as a possible strategy. Four children said they would associate the pictures in some meaningful way. Although age differences for the strategies were not significant, the number of different strategies generated was influenced by age, according to the one-way analysis of variance, $\underline{F}\ (3, 36) = 2.91$, $\underline{p} < .048$. A Duncan Range Test indicated that seven-year-olds gave fewer strategies ($\underline{M} = 1.2$) than children in any of the other age groups ($\underline{M} = 1.7$ for nine-year-olds; $\underline{M} = 2.5$ for 11-year-olds; $\underline{M} = 2.4$ for 15-year-olds). The most frequently mentioned best strategies for the small group of pictures were rehearsal (30%) and categorization (25%) (see Table 5). More younger children (30% of the seven-year-olds

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Insert Table 5 about here

Table 5

Number of Children at Each Age Level Selecting a Best Strategy for the Small and Large Groups of Pictures

	Strategy									
	Categorization		Rehearsal		Association		Other		DK/NR	
Age[a]	Sml	Lrg	Sml	Lrg	Sml	Lrg	Sml	Lrg	Sml	Lrg
7 years	0	0	3	3	2	2	2	1	3	4
9 years	0	0	5	5	1	0	1	2	3	3
11 years	5	4	1	2	1	0	0	0	3	4
15 years	5	5	3	4	1	1	1	0	0	0

[a]N = 10 at each age

and 50% of the nine-year-olds) said rehearsal would be best, whereas half (50%) of the 11- and 15-year-olds thought categorization would be the best strategy. Nine of the 40 children did not respond to the question.

After shifting their attention to the group of 12 pictures, children were asked to state all the ways they could study and remember a lot of pictures. The strategies offered were similar to those given for the small group (rehearsal, categorization or a combination of both). Over half of the children (52.5%) gave a combination of strategies. Rehearsal was mentioned by 22.5% of the children and categorization by 10% of the sample. At least one strategy was given by 90% of the children. However, age differences for the number of different strategies generated were not significant (_M_ = 1.1 for seven-year-olds; _M_ = 1.5 for nine-year-olds; _M_ = 2.0 for 11-year-olds; _M_ = 1.9 for 15-year-olds). When questioned about a best strategy for remembering a large group of pictures, Rehearsal and Categorization were mentioned most frequently. Thirty-five percent of the children said Rehearsal would be the best strategy (this proportion was representative of each age group), while Categorization was offered by 22.5% of the children (11- and 15-year-olds exclusively). Eleven children (27.5%) did not respond to the question (see Table 5).

Insert Table 6 about here

Performance. Table 6 shows the mean number of pictures recalled for the small and large groups of pictures for each age level. The two small groups each contained 12 pictures and have been labeled 12A

Table 6

Mean Number of Pictures Recalled for Small and Large Groups at Each Age Level

Age[a]	12A *M*	12A *SD*	12B *M*	12B *SD*	Combined Mean	24C *M*	24C *SD*	24D *M*	24D *SD*	Combined Mean
7 years	6.6	.97	4.7	1.1	5.65	9.8	3.2	8.7	2.5	9.25
9 years	9.4	1.80	7.5	1.6	8.45	12.1	3.6	14.6	3.7	13.35
11 years	11.3	.82	10.3	1.2	10.80	16.6	2.5	16.9	2.8	16.75
15 years	11.6	.97	10.9	1.4	11.25	18.5	3.2	20.0	3.0	19.25

[a]N = 10 at each age

and 12B. The other two groups contained 24 pictures each, and have been labeled 24C and 24D. Separate two-way analyses of variance were used to assess the effects of age (four levels) and strategy (three levels) on the number of pictures recalled for each of the four list length conditions. Significant age differences were found for each of the analyses, F (3, 28) = 33.95, p < .0001 for 12A; F (3, 28) = 27.79, p < .0001 for 12B; F (3, 28) = 5.21, p < .005 for 24C; F (3, 28) = 9.52, p < .0001 for 24D). Subsequent Duncan Range Tests indicated that for the two small groups of pictures, older children (11- and 15-year-olds) recalled more pictures than younger children (seven- and nine-year-olds). Further, nine-year-olds recalled more pictures than seven-year-olds. A similar pattern was seen for the two large groups of pictures. Older children recalled more pictures than younger children. The previously reported difference between seven- and nine-year-olds for the small groups of pictures, however, was found for only one of the large groups of pictures (24D).

Insert Table 7 about here

Table 7 shows the mean number of pictures recalled for each strategy for the four list length conditions. The two-way analyses of variance also yielded significant main effects for strategy for all list length conditions except 12B, F (2, 28) = 11.72, p < .0001 for 12A; F (2, 28) = 1.96, p < .16 for 12B; F (2, 28) = 6.67, p < .004 for 24C; F (2, 28) = 8.31, p < .001 for 24D). Subsequent Duncan Range Tests showed similar trends in differences between strategies used and the number of pictures recalled for each of the groups of pictures. For

Table 7

Mean Number of Pictures Recalled for Small and Large Groups for Each Strategy

	12A		12B		Combined Mean	24C		24D		Combined Mean
Strategy	M	N	M	N		M	N	M	N	
Look	8.00	11	6.93	15	7.38	10.38	8	9.56	9	9.95
Rehearsal	8.60	11	8.07	15	8.27	10.22	9	12.82	11	11.65
CRST	11.50	18	10.90	10	11.29	17.17	23	18.75	20	17.90

the groups with significant main effects for strategy, children in the group CRST recalled more pictures than those who only Rehearsed or Looked. There were no differences between those who Rehearsed and Looked for groups 12A and 24C, but for group 24D, children who Rehearsed showed better recall performance than those who merely Looked. There were no significant interactions for the variables age and strategy on the number of pictures recalled.

A second series of analyses focused on the study strategy used by the children. Using recordings made during the study periods, children's strategies were assigned to one of the following groupings: (a) Look--children looked at the pictures displayed on the desk, but showed no movement of the pictures for categorization or lip movements to indicate rehearsal. (b) Rehearsal--children either held the pictures in a pile in their hand and went through them in serial order or looked at them on the desk. Lip movements or audible whispering were evident. (c) Categorization, Rehearsal and Self-Testing--pictures were put into appropriate categories, rehearsed and self-tested (i.e., children looked away, closed their eyes, or turned the cards over, so as to reproduce the pictures from memory). Overall, the most frequently used strategy by all children was categorization, rehearsal and self-testing (44.4%), followed by rehearsal (28.75%) and looking (26.9%). This trend was similar for each picture group, except 12B. For that specific group, looking and rehearsal were used by an equal number of children (N = 15), whereas categorization, rehearsal and self-testing was used by only 25% of the children. Table 8 shows the

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Insert Table 8 about here

Table 8

Number of Children at Each Age Level Using One of the Three Study Strategies for the Small and Large Groups of Pictures

	Strategy											
	Look				Rehearsal				CRST			
Age[a]	12A	12B	24C	24D	12A	12B	24C	24D	12A	12B	24C	24D
7 years	5	6	5	5	4	4	3	4	1	0	2	1
9 years	3	4	2	3	5	5	5	4	2	1	3	3
11 years	2	4	1	1	1	4	0	2	7	2	9	7
15 years	1	1	0	0	1	2	1	1	8	7	9	9

[a]N = 10 at each age

number of children at each age level using one of the three strategies for each of the four groups of pictures. Significant Chi Square values were found for each group of pictures using age and strategy as factors, $\chi^2(6) = 16.04$, $p < .014$ for 12A; $\chi^2(6) = 16.267$, $p < .012$ for 12B; $\chi^2(6) = 20.99$, $p < .002$ for 24C; $\chi^2(6) = 17.01$, $p < .009$ for 24D. Subsequent one-way Chi Square analyses indicated that the differences occurred between age levels for the strategy group, CRST, for each group of pictures, except group 24C, $\chi^2(3) = 8.22$, $p < .05$ for 12A; $\chi^2(3) = 11.6$, $p < .01$ for 12B; $\chi^2(3) = 6.13$, $p > .05$ for 24C; $\chi^2(3) = 8.0$, $p < .05$ for 24D. More 15-year-olds than seven-year-olds employed this study strategy for all four groups of pictures ($p < .01$ for 12A; $p < .008$ for 12B; $p < .033$ for 24C; $p < .011$ for 24D, Binomial analysis). Within age group differences in strategy use were found for 15-year-olds on all groups of pictures, $\chi^2(2) = 9.81$, $p < .01$ for 12A; $\chi^2(2) = 6.21$, $p < .05$ for 12B; $\chi^2(2) = 14.61$, $p < .0001$ for 24C; $\chi^2(2) = 20.82$, $p < .001$ for 24D. An average of 82.5% of the 15-year-olds used the strategies labeled CRST. Differences in strategy use were also observed within the 11-year-old age group on three groups of pictures, 12A, 24C and 24D, $\chi^2(2) = 6.21$, $p < .05$ for 12A; $\chi^2(2) = 14.61$, $p < .001$ for 24C; $\chi^2(2) = 6.21$, $p < .05$ for 24D. An average of 76.6% of the 11-year-olds categorized, rehearsed and self-tested when studying the pictures. The three strategies were used about equally by seven- and nine-year-olds.

A Cochran Q Test for related samples was used in order to determine whether children modified their strategies with changing task demands (i.e., the number of pictures to be remembered). The following relationships in the individual strategies between groups of pictures were analyzed: (a) strategies used for 12A versus 24C; (b) strategies used for 12B versus 24D; (c) strategies used for 12A versus 12B; and (d) strategies used for 24C versus 24D. Table 8 shows the total number of children using each of the strategies for the particular groups of pictures. Significant Q values were found for the following comparisons. More children used the strategy Look for group 12B than for groups 24C and 24D. Similarly, more children used the strategy CRST for groups 24C and 24D than for group 12B. Comparisons of strategy choice for groups of pictures with the same task demands (comparisons c and d) indicated significant Q values for comparisons of groups 12A and 12B. More children Rehearsed for group 12B than for 12A. Strategy choice did not differ significantly for groups 24C and 24D.

Coding

Metacognitive knowledge. For the coding task, children were shown a sample with the explanation that the goal was to try to fill in the empty squares within a certain amount of time. They were asked to describe all the possible ways they could do this task. The strategies offered were classified as follows: (a) Go Across--starting at the upper left or lower right corner, and marking the boxes in the order presented; (b) Same First--completing all of one number first (i.e., all the one's, then two's, etc.); (c) Other--the boxes were marked by either going up and down the columns or the child memorized the coding key at the top of the sheet before beginning the task. The most frequently mentioned strategy was to go across in the order presented (30% of the total sample). Fifty percent of the seven-year-olds and 40% of the 11-year-olds gave this strategy. Half of the 11-year-olds and 15-year-olds (50% of each) suggested doing all of the same number first. Memorizing the coding key before filling in the boxes was mentioned by four 15-year-olds (this strategy is obviously more difficult). Some of the seven-, nine-, and 11-year-olds did not offer any description of how they could do the task. When asked "What would be the best way to do the task?", the children gave the following responses (see Table 9). Over half of the total sample

Insert Table 9 about here

(52.5%) said that going across would be the best strategy. This strategy was most evident among the seven-, nine-, and 11-year-olds. The second most frequently suggested strategy was to do all the same first (18.8%). Fifteen-year-olds did not show a strategy preference. Eighteen of the 80 children (22.5%) did not respond to the question, although most of these children (16.3%) had previously offered at least one possible strategy. Age differences in the number of strategies generated was examined with a one-way analysis of variance, with a resulting value of F (3, 76) = 8.437, $p < .0001$. A Duncan Range Test indicated that nine-year-olds offered more strategies than children at any other age group. The mean number of strategies given was 1.3 for seven- and 11-year-olds, 2.3 for nine-year-olds and 1.5 for 15-year-olds. Overall, 93% of the children offered at least one strategy.

Insert Table 10 about here

Table 9

Number of Children at Each Age Level Selecting a

Best Strategy for a Coding Task

Age[a]	Strategy			
	Across	Same First	Other	DK/NR
7 years	13	2	1	4
9 years	12	1	0	7
11 years	11	5	0	4
15 years	6	7	4	3

[a]N = 20 at each age

Table 10

Mean Number of Boxes Coded for Forms A and B at Each Age Level

Age[a]	Form A			Form B			
	M	*SD*	range	*M*	*SD*	range	comb. *M*
7 years	18.6	6.0	2-29	19.2	5.0	5-29	18.9
9 years	34.9	5.1	28-46	34.9	4.8	26-44	34.9
11 years	45.1	10.2	24-64	44.3	9.3	29-62	44.7
15 years	70.0	10.2	48-84	68.5	12.3	41-86	69.3

[a]N = 20 at each age

Performance. Table 10 shows the mean number of boxes coded for forms A and B for each age level. Separate two-way analyses of variance for the effects of age and strategy on the number of boxes coded showed significant main effects for age, F (3, 68) = 101.03, $p < .0001$ for form A; F (3, 68) = 90.27, $p < .0001$ for form B, but not for strategy, F (2, 68) = .47, $p < .63$ for form A; F (2, 68) = 1.84, $p < .18$ for form B. There were no significant interactions for age by strategy on either form. Subsequent Duncan Range Tests for the main effects of age revealed that the coding performance for each age group was significantly different from every other age group. Performance scores increased directly with the children's chronological age.

A two-way Chi Square analysis showed significant differences for age and strategy used on form A and B, $\chi^2(6) = 17.798$, $p < .007$; $\chi^2(6) = 18.679$, $p < .0047$, respectively. These data appear in Table 11. Subsequent one-way Chi Square analyses indicated that differences

Insert Table 11 about here

between age groups occurred for the strategy Same First, $\chi^2(3) = 10.364$, $p < .02$ for form A; $\chi^2(3) = 10.43$, $p < .02$ for form B. More 15-year-olds (55%) used this strategy than seven- and nine-year-olds (see Table 11). Within age group differences were also significant for all age groups, except the 15-year-olds, on both forms and the 11-year-olds on form B. Generally, most of the seven-, nine-, and 11-year-olds coded across the rows, while over half (55%) of the 15-year-olds coded all of one number first. These differences were

Table 11

Number of Children at Each Age Level Using One of the Three Coding Strategies for Forms A and B

	Strategy					
	Across		Same First		Other	
Age[a]	A	B	A	B	A	B
7 years	16	16	2	2	2	2
9 years	17	12	2	2	1	6
11 years	12	9	7	6	1	5
15 years	6	5	11	11	3	4

[a]N = 20 at each age

not significant. Although age trends in the strategy used were evident, these differences did not yield a significant effect on the overall test of strategy used on the number of boxes coded. A Cochran Q test was used to make comparisons between children's suggestions of a best strategy and the strategy actually used. Table 12 shows these

Insert Table 12 about here

data and the significance values. The differences between a "best" strategy and a strategy used may be due to the large number of children (N = 18) who used a certain strategy, but did not offer it as a best strategy initially. A significant number of children (N = 10) changed strategies between forms A and B for the strategies Across and Other. These children began using one of the Other strategies and switched to Across, or the converse. The direction of these changes cannot be determined from this analysis because the forms were randomly presented. Most of the changes in the strategy used occurred in the middle age groups (nine- and 11-year-olds), whereas seven- and 15-year-olds were more consistent in the strategy used between the two forms. When asked if they memorized the key on either form, about three-fourths (78.8%) of the children said "no." An equivalent number of children at each age level gave this response. Those children that said "yes" stated they just remembered a certain number and the corresponding symbol due to repetition, but no child made a deliberate attempt to memorize the key.

Table 12

Comparisons of the Number of Children Selecting a Best Strategy and Using the Strategy on Forms A and B

	Strategy			
	Across	Same First	Other	DK/NR
Best	42	15	5	18
Used (A)	51	22	7	0
Cochran Q	$p < .039$	$p < .008$	$p < .480$	$p < .001$
Best	42	15	5	18
Used (B)	42	21	17	0
Cochran Q	$p < 1.00$	$p < .109$	$p < .005$	$p < .001$
Used (A)	51	22	7	0
Used (B)	42	21	17	0
Cochran Q	$p < .020$	$p < .739$	$p < .012$	$p < 1.00$

Alphabetizing

Metacognitive knowledge. Children were shown a randomized group of words and were asked to describe all the possible ways they could go about alphabetizing the words. Children offered one or several of the following strategies: (a) Visually displaying all the cards on the table in a random arrangement and picking up the cards in alphabetical order. This strategy was labeled "Display." (b) Grouping the words beginning with the same letter (e.g., all A's together) or in larger groups (e.g., all words beginning with letters A to E in one group) and then alphabetizing the words. This strategy was labeled "Group." (c) Begin alphabetizing with the top card of the shuffled pile and then alphabetizing subsequent cards as they appeared in the pile. This was labeled "Top Card." (d) Flipping through the shuffled pile, finding all the A's first, then the B's, and so on. This was labeled "Flip."

The most frequently suggested strategy was "Display," given by 21 of the 80 children (26.3%). More seven-, nine-, and 11-year-olds than 15-year-olds mentioned this strategy. Alphabetizing beginning with the top card was the second most frequently mentioned strategy (19 of 80 or 23.8%), with more 15-year-olds suggesting this plan than any other age group. Flipping through the pile was offered by 18.8% (15 of 80) of the children. Seven-year-olds, predominantly, represented this strategy. Fifteen percent of the children (12 of 80) did not respond or could not generate a plan. This situation occurred more frequently for seven- and nine-year-olds. When responses to the question "How would you do it" were compared with responses to the question "What is the best way to do it," most of the children gave similar responses. The two most frequently offered strategies were "Top Card" (23.8%), followed by "Display (22.5%). Few strategy changes occurred within the four age groups for each of the questions. While more seven-, nine-, and 11-year-olds said displaying the cards would be best, more 15-year-olds thought that beginning with the top card would be the most efficient strategy. As noted previously, more younger children did not respond to this question, "What is the best strategy," although some had offered a strategy earlier. The best strategy selection data appear in Table 13. Age differences in the

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Insert Table 13 about here

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number of strategies offered were examined with a one-way analysis of variance, with a resulting value of F (3, 76) = 4.854, $p < .0038$. A Duncan Range Test indicated that the differences occurred between 15-year-olds as compared to seven- and nine-year-olds, and between nine- and 11-year-olds. The mean number of strategies generated by children at each age were .8 for seven-year-olds, .98 for nine-year-olds, 1.0 for 11-year-olds, and 1.1 for 15-year-olds. Only two 15-year-olds generated two strategies.

Performance. A three-way analysis of variance was conducted to determine the effects of sex, age and strategy used on the number of words alphabetized. Significant main effects were found for age, F (3, 57) = 8.996, $p < .0001$, and strategy used, F (3, 57) = 13.094, $p < .001$), but not sex, F (1, 57) = .03, $p < .863$. There were no significant interactions. The mean number of words correctly

Table 13

Number of Children at Each Age Level Selecting a Best Strategy for Alphabetizing

Age[a]	Strategy				
	Display	Group	Top Card	Flip	DK/NR
7 years	4	0	1	7	8
9 years	5	2	3	3	7
11 years	6	6	5	1	2
15 years	3	5	10	2	0

[a]N = 20 at each age

alphabetized by age are shown in Table 14. A subsequent Duncan Range

Insert Table 14 about here

Test indicated that 15-year-olds alphabetized more words than children in any other age group, and more words were alphabetized by 11-year-olds than seven-year-olds. Table 15 presents the mean number

Insert Table 15 about here

of words alphabetized for each age level using one of the four strategies. Performance scores increased with the type of strategy used. A Duncan Range Test of the significant main effect for the strategy used and the number of words alphabetized indicated that children using the strategy "Top Card" alphabetized significantly more words than children using any other strategy. Table 15 also shows the number of children at the four age levels using the different strategies. A two-way Chi Square analysis indicated a significant difference for age and the strategy used, $\chi^2(9) = 29.023$, $p < .0006$. Subsequent one-way Chi Square analyses provided a more precise assessment of this relationship. Differences between age groups occurred for the strategy "Top Card," $\chi^2(3) = 10.81$, $p < .02$. More 15-year-olds (55%) than seven- and nine-year-olds (5% and 15%, respectively) used this strategy ($p < .003$; $p < .029$, Binomial test). The various age groups also differed on the strategy labeled "Flip," $\chi^2(3) = 12.28$, $p < .01$. More younger children (60% of the seven-year-olds and 45% of the nine-year-olds) used this strategy, compared to 10% of both the 11- and 15-year-olds.

Table 14

Mean Number of Words Alphabetized

at Each Age Level

Age[a]	Mean	*SD*	Range
7 years	5.10	2.7	2-13
9 years	8.85	4.5	0-21
11 years	12.00	6.9	3-29
15 years	20.30	8.6	5-35

[a]N = 20 at each age

Table 15

Mean Number of Words Alphabetized for Each Strategy at Each Age Level

	Display		Group		Top Card		Flip	
Age	M	N	M	N	M	N	M	N
7 years	3.83	6	5.00	1	13.00	1	5.08	12
9 years	7.29	7	0.00	1	15.33	3	8.89	9
11 years	8.63	8	8.25	4	20.00	6	9.00	2
15 years	14.00	3	13.25	4	26.09	11	12.00	2
Column Mean	7.71		9.1		22.19		7.32	

According to Cochran Q tests, children's suggestions of a best strategy did not differ significantly from the strategy they used when given the task, except for the strategy "Flip," $p < .011$. The difference which appeared for this strategy may be due to the large number of children (N = 12) who actually used this strategy, but did not offer it as a best strategy initially.

Chapter IV

Discussion

The results presented in Chapter III helped answer questions regarding children's awareness of task demand variables and appropriate strategies that could be used for different types of tasks, such as recall, coding and alphabetizing tasks. It appears that children at least seven years of age and older are aware of strategies that can be used to achieve a given task goal; however, younger children are not necessarily aware of the most efficient means to do so. Secondly, this study provides information about what children "think to do" in a given situation when the task becomes more difficult or when the goal of the task is different, as well as an indication of children's actual strategic behaviors. Children's knowledge about how to do a task appears to be related to their task behavior. Performance scores and the types of strategies used were directly related to the children's chronological ages. This suggests that as children become older, not only does their performance on these tasks improve, but they also use more efficient strategies and these strategies are used with greater proficiency.

Kail (1979) has suggested that a general strategic ability begins to develop between the ages of eight and 11 years, and may contribute to the variation in ability. The ages at which this "general strategic ability" appears may be related to Piaget's stages of cognitive development. Piaget has suggested that around the ages of 11-12 years, children begin to move from the concrete operational stage to the formal operational stage. During the concrete operational stage, children acquire a variety of cognitive contents (e.g., conservation, seriation, transitive inference and classification) that are used when dealing with concrete objects or tangible information. That is, reasoning can only be produced from that which can be directly perceived by the child. At the formal operational stage, however, the same cognitive contents can be applied to information that is abstract and hypothetical. Thus, cognition is seen to have moved from the concrete to the abstract. Formal operational thinking is characterized by scientific reasoning, in that hypotheses are formulated and experimentation occurs in order to discover cause and effect. This transition from the concrete operations to the formal operations is marked by an ability to assimilate a broader range of information and to generalize rules, formerly applied to concrete things, to new, abstract situations. These changes in cognitive or logical reasoning are also reflected in children's ability to be strategic. Initially children learn to use a particular strategy for a certain task, but as this strategic ability becomes refined with the onset of formal operations, children "experiment" and extend the strategy to fit other appropriate tasks. At this time, children also begin to see that approaching tasks in a strategic manner facilitates and enhances their performance.

Although in the present study major modifications in the types of strategies suggested and the strategies actually used did not occur with the change in demands (e.g., amount of study time and number of pictures to be remembered), for the memory tasks, it does not necessarily imply that children were not aware of the need to adapt their strategies to fit the demands or that they did not have the ability to do so. Rather, this lack of change in strategies may be indicative that the "executive function" does include the continued use of a strategy (Barclay, 1979)--recognizing that the behaviors appropriate for one task demand may also be appropriate and useful for others. Butterfield and Belmont's (1977) idea of "executive functioning" and Kail's (1979) proposal of a general strategic factor seem to be interrelated. That is, a general strategic ability suggests that children are using strategies more frequently for various tasks and using them more effectively. Becoming general strategic may also include monitoring one's ability--that is, selecting, modifying or abandoning a strategy, depending upon changes in the task goals or demands.

Metacognitive Knowledge

The development of metacognitive knowledge involves an increasing awareness of the factors that may interact to affect the outcome of some cognitive undertaking. Such variables include the characteristics of the task (e.g., task demands) and acquiring a repertoire of strategies or plans that are likely to be effective in achieving the task goal. In the present study, specific task demand manipulations were the amount of study time and the number of items to be remembered (i.e., list length). The interaction of task demands--study time and list length--and strategy choice for memory tasks was the focus of this study. Children's awareness of strategies for other cognitive and performance tasks, such as coding and alphabetizing, that place lesser demands on memory, was also examined.

Previous studies have reported that children as young as five years of age have some understanding that memory-relevant variables affect the ease or difficulty of a task (Kreutzer et al., 1975; Wellman, 1978). Children at this age have a general idea that study time influences item recall. Similarly, they realize that the difficulty of a task increases with the number of items to be remembered. These findings received support from the response questions regarding which groups of pictures would be easier to remember, in this study. The majority of children at each age level (60, 70, 50 and 80 percent for seven-, nine-, 11- and 15-year-olds, respectively) pointed to the group of pictures that would be easier to learn when study time was manipulated and 70% at each age level correctly judged the easier group when list length varied. Thus, when the task variables of time and length were presented in isolation for a given hypothetical situation, children accurately judged their possible effects on memory performance. Although age differences were not significant, most children at all ages could identify the less demanding task condition when given a choice, but many younger children were not able to provide an explanation or an adequate justification, with respect to the task demands, for their choice. Instead, the explanations frequently made reference to such factors as familiarity of the pictures, ease of learning some pictures compared to others, or a good memory. Although this last reason does not tell us whether the child recognized the task demand, it may provide information about the child's knowledge of his/her own memory capabilities. Apparently these children are making accurate judgments of the easier tasks, but the factors on which the judgments are made are not the most relevant. This suggests a limited awareness of precisely how certain variables affect the ease or difficulty of a task.

Children at all ages were able to think of an appropriate strategy to use in order to achieve the task goal of recalling pictures, coding or alphabetizing words, but there were developmental differences in the types of strategies suggested for each of the tasks, as predicted. When the amount of study time varied from short to long, rehearsal was mentioned most frequently as a possible strategy, especially among seven-year-olds. Categorization was their second choice, but the first choice of 11- and 15-year-olds. The only apparent strategy modification was that children indicated that they would rehearse for a longer period of time when given more time to study the pictures. This suggests that children may have some sense of the need to alter the strategy to fit the task demand, and this awareness may be reflected in their attempt to alter a strategy. The awareness was more evident among 11- and 15-year-olds who commented that they would not do anything different under the various conditions, except to do whatever they were doing for a longer period of time, or to do "it" with more concentration as the demands increased. These response patterns were evident when the number of pictures to be remembered (e.g., 12 or 24) was varied.

Thus, changing task demands did not seem to affect children's thinking about the need to modify a particular strategy. Perhaps this was due to a lack of awareness of the effect of a particular task variable. That is, although most children could identify the easier task condition, younger children could not say _why_ it was easier. Given this lack of awareness, it is not surprising, then, that these children failed to modify their strategy suggestions. Wellman (1978) argues that children proceed from an understanding of some separate memory-relevant facts and only later develop a more complex interactive system of memory knowledge. He found that both five- and 10-year-olds consistently judged memory performance on the basis of single memory-relevant variables, such as the number of memory items or amount of time, but, only 10-year-olds made accurate assessments on complex-relevant items (i.e., two or more relevant variables interacting in a single task). Asking young children to generate strategies to fit task demands may require this undeveloped knowledge. On the other hand, the older children did not modify their strategy suggestions under the various conditions. Perhaps they know that a specific strategy can be effective in several situations, with only minimal alterations. Butterfield and Belmont (1977) describe this monitoring as characteristic of the "executive function" (that which evaluates the task demands and selects and modifies strategies as the demands change). Barclay (1979) extended this notion by showing that the executive function is also exhibited when children recognize and _continue to use_ a particular strategy on two different tasks, where such use is appropriate. Thus, not finding differences in strategy suggestions as task demands change supports this idea of how the executive function works.

When given a choice among their own suggested alternatives, the children reported that rehearsal and categorization would be best to use under all task conditions. The developmental pattern that was found among these two strategies supports previous findings (Appel et al., 1972; Flavell, 1970; Kreutzer et al., 1975) which show that older children offer more sophisticated strategies for accomplishing memory tasks than younger children. When Kreutzer et al. (1975) asked children how they would remember some pictures, kindergarten and first-graders suggested engaging in some sort of repetitive inspection or naming of the items. Children 11 years and older were more apt to mention categorization, implying that they recognized its advantages for mnemonic purposes. What isn't clear from the present study is whether the younger children noticed that the pictures could have been categorized or whether they were aware of this possibility, but did not realize that it would facilitate recall.

Therefore, it cannot be determined whether the younger children were showing a production or mediation deficiency. Because most of the items had fairly high typicality ratings of instances for superordinate categories ($\underline{M}$ = 5.97, with 7.00 = highly typical of a category), it would seem reasonable to assume that categories were evident, and even more so as the number of instances per category increased for list length. When items were highly associated, Myers and Perlmutter (1977) found that children as young as two years appeared to use adult categories, such as food, animals, and body parts. Other functional and culturally appropriate strategies were given, but they were not necessarily realistic for artificial laboratory conditions. Such strategies included writing down the names of the pictures or having another person quiz them. These responses seemed to reflect the use of external resources, which are suitable in real-life situations, and less reliance on internal memory aids (e.g., self or in-the-head). The restricted use of external resources in this study and previous research may not provide an acccurate assessment of children's memory capabilities in real life situations.

Further, the results of this study confirm that older children not only exhibit a more complex mnemonic understanding than younger children, but they also display greater planfulness in their approaches to the experimental tasks. In both conditions of the memory tasks, 15-year-olds generated more possible strategies than seven-year-olds, although as mentioned previously, the types of strategies did not differ with respect to the task demands. Similar results have been found when children were asked to tell all the possible ways they could remember an object or event (Kreutzer et al., 1975). Older children were more creative and inventive in the number and variety of ideas that were articulated.

Age differences in the types of strategies suggested were also apparent in the two other experimental tasks--coding and alphabetizing. Seven- and nine-year-olds, who indicated they would code the numbers in the random order as presented, seemed more "stimulus bound" than older children, who were more likely to impose their own organization and structure on the task. More 11- and 15-year-olds suggested coding all of one number at a time. This strategy may reflect an awareness that reducing distractions or the amount of different information at any one time, by "clustering" according to similarity, facilitates performance. A few 15-year-olds also suggested memorizing the coding key. This is obviously a more difficult strategy and one that requires an assessment of memory capabilities. This strategy, however, was not mentioned as a best strategy for the task. Rather, more children said that going across would be the best plan. Children apparently know different approaches for doing tasks, without necessarily intending to use them. Similar conclusions were made in a study by Yussen and Levy (1977), where children first were asked to describe retrieval strategies for external problems (e.g., how would you find a lost jacket) and internal problems (e.g., how would you remember an idea), then asked to select the best retrieval strategy from a list of alternatives. The authors found that a child may mention a strategy but not necessarily think it is valuable under the constraints of a forced-choice procedure. It would appear that children are evaluating the efficiency of a particular strategy, based on their experience or formal education.

Contrary to predictions and the findings for other tasks, nine-year-olds offered more strategies for the coding task than children at any other age level. While it is difficult to explain this result, careful inspection of the individual protocols provided some insight. The strategies offered appeared to be "variations on a theme." For example, children suggested coding from left to right across the top, in addition to working right to left across the top, starting at the bottom right and going across, or even going up and down the columns. Although this greater number of variations may account for some of the age difference in the number of strategies given, it does not necessarily indicate that these children were more or less strategic than older or younger children.

Children seemed to have more difficulty thinking of appropriate ways to perform the alphabetizing task. As expected, 15-year-olds gave a greater number of strategies than younger children, but the mean number for older children was slightly more than one. A systematic and concrete approach involving a visual display of all the cards and then selecting the words in alphabetical order, or flipping through the pile and finding all the "A" words first was preferred by more of the younger children, whereas the 15-year-olds, predominantly, thought that alphabetizing a randomized group of words beginning with the top card would be the most efficient strategy. One cannot ignore the fact that older children have had more experience with the alphabet which may have contributed to their awareness of how the task could be accomplished. With this experience comes an awareness of the need to impose organization on an "unstructured" task, in order to achieve the goal most efficiently.

It is evident from this part of the study that developmental trends emerge in the type and number of strategies generated for memory tasks, as well as for tasks, such as coding and alphabetizing, which place less demand on memory. This finding has not appeared previously in the literature. In other words, not only are there changes in children's strategic behaviors for memory tasks, but there may be a "general strategic ability" (Kail, 1979) that also develops, and thus, is reflected in other tasks.

Performance

Performance scores on the memory tasks confirmed the prediction that older children (11- and 15-year-olds) would recall more pictures than younger children. This developmental pattern was found for all conditions when the amount of study time and list length varied. The finding that the performance of 11-year-old's did not differ significantly from that of 15-year-olds may be a function of the task. When children were given more time to study the pictures, for example, the mean number of pictures recalled for both age groups approximated the total number possible. That is, the tasks may not have been sufficiently demanding to show differences in performance. Although there were no significant interactions for age and the strategy used, the type of strategy used did influence children's recall. Not surprisingly, children in the CRST group recalled more pictures than children who used one of the other strategies. This effect appeared for all memory conditions, and generally seemed apparent for children at each of the age levels. However, the small number of children within each of the data cells prevented a precise statistical analysis of this relationship. The apparent relationship suggests that even some young children saw categorization as a possible strategy, but they did not use it as effectively as the 11- and 15-year-olds. Because the superordinate categories that were represented in the lists were assumed to be common to most children's experiences, it is unlikely that the performances differences between older and younger children were due to the younger children's inability to detect the categories.

Children's knowledge of effective learning strategies closely paralleled the types of strategies used for the memory tasks when study time was manipulated, but not necessarily when list length varied. Overall, rehearsal was the most frequently used strategy for the Memory-Time tasks, whereas categorization, rehearsal and self-testing were generally used more often on the Memory-Length tasks. This suggests that a frequently verbalized strategy of what a child "thinks to do" may be quite different when faced with an actual problem than with a hypothetical one. Under all conditions of differing task demands, seven- and nine-year-olds rehearsed more than 11- and 15-year-olds, who categorized, rehearsed and self-tested. This finding lends support to the Moely et al. (1969) study which showed that these three strategies together were indicative of "active learners." Although the prediction that children would modify their strategies according to task demands, or as the task became more difficult, was not supported in the present study, the task demand manipulations may not have been sufficient to induce strategy changes. On the other hand, once children are aware of a variety of strategies and have experienced success with a particular approach, they may not make changes except for minor modifications. Children did make minor adjustments in the strategies for the memory tasks. They continued using a particular strategy when given more time or until the study interval was terminated. However, the strategy, per se, did not change. Again, these performance findings are supportive of Barclay's

(1979) notion that executive functioning includes the continued use of a certain mnemonic activity despite changes in a task.

The observation that children tended to use a different strategy for the study time condition versus the list length conditions suggests that children are reacting differently to the type of task demand. When study time is emphasized, as it was in this study, children may be more likely to exhibit behaviors that permit them to scan at least once all the materials to be remembered. If it was not obvious to the child that the pictures could be categorized relatively quickly, she/he may not have opted to perform this operation, given the time restraints. When list length was emphasized as the major variable, more children exhibited behaviors, such as categorizing, that eased the amount of information to be remembered or that provided cues for subsequent recall. While these explanations are speculative, they seem to fit with the child's level of metacognitive knowledge.

Comparisons of strategy use for the short list length conditions (12A and 12B) and long time conditions (LT1 and LT2), for which study time was two minutes and the total number of pictures to be remembered was 12, showed that strategy use generally was quite similar. Fewer children categorized and more of their behaviors were classified as looking for only one short list condition (12B). This departure may be a function of the pictures included in that list representing the categories toys, furniture and parts of a house. While the chosen pictures were representative of the two categories, furniture and parts of a house, they may have been more difficult to separate and categorize. Perhaps if children could not think of the appropriate category label (such as parts of a house, which may have been unfamiliar), their behavior would not reflect the tendency to categorize.

A developmental trend, similar to that for memory, was found on the coding tasks. Each age level performed better than that of the previous age group. Strategy use differences were noted between seven- and 15-year-olds. The older children coded all of the same numbers first more often, whereas seven- and nine-year-olds coded across in the order presented. This seems to suggest that older children are actively modifying the stimulus input rather than simply reacting to the input as it is offered. Interestingly, there was no significant strategy effect for the number of boxes coded. Thus, performance differences appear to be due to age. Changes in strategy use occurred most frequently for nine- and 11-year-olds. This finding suggests a period of transition during which children are becoming aware of different methods for task completion, but they are not yet aware of their efficiency. Moely (1977) suggested that children six through nine years of age may try out different bases for organization and they become more aware of the need to engage in behaviors designed to meet the task demands, but they may not be able to determine the most effective study strategy. A similar analogy can be made to other tasks in which efficient strategies are needed, such as coding.

As predicted, and consistent with results on the previous tasks, 15-year-olds alphabetized more words than children at any other age level. However, these children have probably had more experience with words and the alphabet, which likely influenced the results. The older children were also observed using a more efficient strategy than younger children (seven- and nine-year-olds). The 15-year-olds started with the top card in their alphabetizing. Children at all age levels who used this strategy alphabetized significantly more words than children using any of the other strategies. The younger children, however, were not using the strategy as effectively. Further, older children may have an awareness of other factors that are likely to affect their performance. For example, they may be more alert to the fact that taking time to visually display all the cards leaves less time to do the task.

Kail (1979) suggested that a "general strategic factor" may be responsible for the individual differences in children's performance on memory tasks. Using a factor analysis approach, he found that strategy-based measures of memory (i.e., measures of tasks requiring strategic behaviors) loaded on a single factor for 11-year-olds but not for eight-year-olds, and when memory tasks did not involve a strategic component, a strategy-free factor emerged. The general strategy factor, however, only accounts for about 28% of the variance for age differences, suggesting that there are other factors contributing to the differences in memory performance. Kail proposes that between the ages of about eight and 11 years children's proficiency in strategy use becomes more consistent and at this point, a general strategic ability accounts for some of the variation. Although precise measures of the strategic components of the tasks used in this study were not made, many of the age differences observed occurred between the ages of nine and 11 years. This notion of a "general strategic factor" may underlie these age differences.

The present study is somewhat limited in interpretation because an analysis of the different strategies that could have been used for the three types of tasks was not performed. Thus, it is difficult to accurately separate that which is due to the child's age and ability from the actual strategic component of a particular task.

In conclusion, the findings of this study suggest that, for the memory task, recall increased with age and recall is facilitated when the items are conceptually categorized. Generally, seven- and nine-year-olds showed little awareness of the usefulness of categorization as a tool for recall and were less likely to adopt categorization as a deliberate study strategy. For those conditions in which categorization was used, the "better-bound conceptual categories" may have facilitated recall and the use of this strategy. Children 11 years and older exhibited strategic behaviors similar to those used by adults. They used categorization as a way of dealing with the recall tasks in a more systematic fashion than was shown by younger children.
Moely et al. (1969) found that between the ages of five and 11 years, children move from a strategy based on the order of presentation, such as serial rehearsal, to a deliberate reordering of items according to categorical relationships. The observation that 11- and 15-year-olds implemented a self-testing strategy also provides evidence of more active learners who spontaneously monitor their learning. The lack of strategy differences relative to the varying task demands suggests that once children acquire an efficient strategy, they learn that it can be applied to a variety of task situations with minor alterations. Developmental differences in strategy use for the coding and

alphabetizing tasks were also found, which shows that older children, especially 15-year-olds, are becoming more strategic in a variety of other tasks. A "general strategic factor" may account for differences in task performance for children eight to 11 years of age. Finally, this study related measures of metacognitive knowledge for various tasks with measures of performance or actual task behavior, a relationship needing further investigation (Yussen & Levy, 1977; Wellman, 1978).

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Appendix A

Names of Pictures and Their Typicality Ratings

Used for Memory Tasks

The following pictures were used for the Memory-Time task for reference when answering the metacognitive questions. The two groups represented a short and long amount of study time. Their corresponding typicality ratings of the category (Young & Kellas, Note 1) are indicated. (A seven-point scale was used for the typicality ratings, 0 = least typical of the category, 7 = most typical of the category, and NA = typicality ratings not available.)

Short Time			Long Time		
Animals:	frog	3.85	Animals:	chicken	NA
	fish	7.00		monkey	NA
Food:	cake	NA	Food:	hamburger	NA
	sandwich	NA		cookie	NA
Toys:	jacks	6.08	Toys:	tricycle	3.78
	jump rope	5.92		blocks	NA

The following pictures were used for the four conditions on the Memory-Time task. The corresponding typicality ratings are given.

Short Time 1			Short Time 2		
Kitchen Utensils:			Clothing:		
	strainer	6.46		pajamas	6.31
	pitcher	5.51		sweater	6.96
	kettle	5.70		scarf	4.66
	pan	6.71		hat	5.40
Body Parts:			Buildings:		
	hand	6.96		church	6.34
	ear	6.70		barn	5.82
	nose	6.62		house	5.96
	tongue	5.92		tent	1.92
Parts of House:			Animals:		
	roof	6.54		skunk	5.58
	chimney	5.96		sheep	6.44
	bathtub	5.59		racoon	5.42
	door	6.40		goat	6.48
Mean typicality rating = 6.26			Mean typicality rating = 5.60		

Long Time 1		Long Time 2
Furniture:		School Supplies:
file cabinet	4.66	glue
bookshelf	6.34	crayons
crib	4.70	pencil
table	6.86	paper clip
Tools:		Shapes:
wheelbarrow	4.65	triangle
rake	6.20	star
broom	NA	cross
ladder	4.54	square
Toys:		Occupations:
jack-in-the-box	6.55	nurse
doll	6.64	butcher
jump rope	5.92	mailman
rocking horse	6.38	sailor

Mean typicality rating = 5.77

Typicality ratings were not available for any of these pictures. It was the experimenter's judgment that these pictures were representative of the categories.

The following pictures were used for the Memory-Length task for reference when answering the metacognitive questions. The two groups represented a small and a large group of pictures. Their corresponding typicality ratings are indicated.

Small Group

Animals:	
chicken	NA
monkey	3.50
Food:	
hamburger	NA
cookie	NA
Toys:	
tricycle	3.78
blocks	NA

Large Group

Animals:	
frog	3.85
fish	7.00
fly	6.60
snake	6.75
Food:	
sandwich	NA
cake	NA
potato chips	NA
ice cream cone	NA
Toys:	
jacks	6.08
jump rope	5.92
puzzle	4.80
balloon	5.17

The following pictures were used for the four conditions on the Memory-Length task. The corresponding typicality ratings are given.

<u>Group 12A</u>

Clothing:	
vest	6.46
tie	5.46
socks	6.26
glove	4.94
Body Parts:	
finger	6.68
leg	6.92
toe	6.64
tooth	4.65
Occupation:	
police	NA
soldier	NA
doctor	NA
dentist	NA

Mean typicality rating = 6.00

<u>Group 12B</u>

Furniture:	
rocking chair	6.91
refrigerator	3.00
bench	5.33
lamp	5.45
Parts of House:	
fireplace	5.92
window	6.38
shutters	5.93
doorknob	5.18
Toys:	
top	6.34
block	6.64
teddy bear	6.06
pinwheel	6.02

Mean typicality rating = 5.76

<u>Group 24C</u>

Vegetables:	
cucumber	6.00
corn	6.58
celery	6.36
carrot	6.56
lettuce	6.34
onion	5.29
peas	6.62
radish	6.16
Animals:	
cat	6.85
cow	6.68
dog	7.00
giraffe	6.46
lion	6.86
pig	6.23
rabbit	5.80
zebra	6.33
Tools:	
ax	5.76
hammer	6.96
hoe	6.08
nail	4.74
rope	3.60
ruler	5.00
saw	6.92
shovel	6.34

Mean typicality rating = 6.15

<u>Group 24D</u>

Instruments:	
banjo	6.46
drum	5.64
flute	6.72
guitar	6.73
harp	5.94
piano	6.46
violin	6.71
xylophone	6.06
Vehicles:	
boat	4.50
bus	6.83
car	7.00
fire engine	5.39
jet	5.71
taxi	7.00
tractor	4.18
van	6.47
Fruit:	
banana	6.75
grapefruit	6.18
grapes	6.88
cherries	6.48
peach	6.82
pear	6.60
pineapple	6.31
orange	6.61

Mean typicality rating = 6.26

Appendix B

Words Used for the Alphabetizing Task

The following words were typed in bold print on white, unlined 12.7 X 7.5 cm index cards. These words were used for practice prior to beginning the alphabetizing task:

bell
dog
flag
sand
vase

These words were used for the Alphabetizing task:

apple
banana
block
cat
church
doll
dress
elephant
fan
fork
giraffe
head
iron
jelly
kite
knife
money
nickel
not
oval
plate
pony
quarter
rain
rice
ship
shoe
tape
toe
umbrella
wall
wax
year
yellow
zebra