Children's Attention Allocation, Understanding of Attention, and Performance on the Incidental Learning Task

Author(s): Patricia H. Miller and Michael G. Weiss

Source: *Child Development*, Vol. 52, No. 4 (Dec., 1981), pp. 1183-1190
Published by: Wiley on behalf of the Society for Research in Child Development
Stable URL: http://www.jstor.org/stable/1129505
Accessed: 09-05-2018 16:58 UTC

Children's Attention Allocation, Understanding of Attention, and Performance on the Incidental Learning Task

Patricia H. Miller and Michael G. Weiss
University of Florida

MILLER, PATRICIA H., and WEISS, MICHAEL G. *Children's Attention Allocation, Understanding of Attention, and Performance on the Incidental Learning Task.* CHILD DEVELOPMENT, 1981, **52,** 1183–1190. 60 children from grades 2, 5, and 8 were given 2 tasks. One task assessed children's strategies of allocating attention to information in a situation similar to the incidental learning task. Children selected either relevant or irrelevant objects to look at by deciding which doors to open on the apparatus. The other task was the typical incidental learning task in which certain objects are to be remembered and others are not. In addition, children's predictions about their recall of incidental objects and their answers to a posttest questionnaire provided verbal measures of their understanding of attention. Most of the increase in the selective allocation of attention and the understanding of attention came between grades 2 and 5. In contrast, most of the improvement in performance on the incidental learning task came between grades 5 and 8. Strategies of attention allocation and performance on the incidental learning task were not significantly related. Second graders' inefficient attention allocation and fifth graders' inefficient performance on the incidental learning task were discussed in terms of metacognitive deficiencies and competing response tendencies.

A general conclusion from two decades of research on children's attention is that older children, but not younger, can adapt their attention to the particular demands of each task. In particular, when a task calls for attending to relevant material and ignoring irrelevant material, attention becomes more selective with increasing age (e.g., Hagen & Hale 1973; Pick & Frankel 1973). Most attempts to account for this change have proposed that children develop strategies which help them allocate their attention to task-relevant information and filter out the less important information (Day 1975; Hagen & Hale 1973).

Much of the research and theorizing about attentional strategies has involved the incidental learning task. In this task, children are asked to remember the location in a spatial array of certain objects designated as central while other objects designated as incidental serve as potential distractors. At the end of the task children are unexpectedly asked to recall the incidental objects as well. Since attentional capacity is not unlimited, attending to central stimuli and ignoring, or filtering out, incidental stimuli would be the most efficient way to approach the task. This research is summarized by Hagen and Hale (1973). In general, recall of the central stimuli increases during the elementary and high school years. At the same time, recall of the incidental stimuli remains constant or increases slightly until ages 11–12 and then decreases. Thus, older children are devoting a higher proportion of their processing capacity to relevant material than are the younger children. Younger children do not effectively filter out the irrelevant information. Evidence for the generality of this lack of selectivity comes from Lane (1979) who, using a different task, found that young children, as opposed to older, allocated no more attention to a high-payoff task than to a low-payoff task.

Although the incidental learning paradigm as a test of selective attention has been criticized on empirical and methodological grounds (Douglas & Peters 1979; Lane 1980) and the age patterns can be altered if the salience of the materials is manipulated (Odom 1978), it

This research was supported by research grant MH32978-01 from the National Institute of Mental Health. The authors gratefully acknowledge the help of Robert Zalenski, Kay Shannon, Robert Jordan, and Lynn Solomon in collecting and analyzing data. The cooperation of Glen Springs and Westwood schools is greatly appreciated. Requests for reprints should be sent to Patricia H. Miller, Department of Psychology, University of Florida, Gainesville, Florida 32611.

[*Child Development*, 1981, **52**, 1183–1190. © 1981 by the Society for Research in Child Development, Inc. 0009-3920/81/5204-0019$0.100]

is our main source of information about children's attention. The incidental learning paradigm, therefore, was chosen as the most appropriate task for an initial study of children's strategies for allocating attention.

Despite the belief that selective attention is critical for efficient performance on the incidental learning task, there is only indirect evidence from the recall data to support this claim. One purpose of the present study is to directly assess attentional strategies that typically must be inferred in the incidental learning task. Covert strategies are made overt. If strategies of attention allocation do in fact underlie much of the developmental change in performance on the incidental learning task, and presumably other tasks as well, then these strategies should become increasingly focused on gathering relevant information during the grade school years. Furthermore, the development of appropriate strategies might be expected to parallel the increasingly selective recall on the incidental learning task. This approach is similar to that of Flavell (1970) who directly assessed the presence or absence of verbal rehearsal and found that the use of this strategy was associated with increased recall.

The second purpose of the current research is to begin to examine what might underlie developmental changes in attention allocation. A largely unexplored variable in research on children's attention is their knowledge about the nature of attention (Miller & Bigi 1977, 1979). The development of this knowledge might contribute to the development of attentional strategies and their appropriate application. If, for example, children do not know that the amount of information present sometimes exceeds their attentional capacity, they are not likely to see the need to allocate their attention exclusively to the most important information in these situations. Measures of children's awareness of their own strategies and attention included their ability to describe any strategies they had used on the incidental learning task and to predict how many incidental objects they would recall.

Method

Subjects

The subjects were 20 second graders (mean age: 7-6), 20 fifth graders (mean age: 10-3) and 20 eighth graders (mean age: 13-6) with equal numbers of males and females in each grade. The children came from a predominantly white, middle class suburban area.

Assessment of Strategies of Attention Allocation

Apparatus.—A wooden box (82 × 23 × 7 cm) rested on a table in front of the child. The top of the box consisted of two rows of six doors each. Each door could be opened up and away from the child by lifting an attached knob. Because the hinge at the top of each door allowed the door to be opened only to an angle of 80 degrees, the door dropped when it was not held open. Black tape covering a vertical wooden strip between each pair of doors visually divided the face of the box into six pairs of doors, one door above the other. Half of the doors had a drawing of a cage on them. When these doors were lifted they revealed a drawing of a familiar animal. The other six doors had a drawing of a house and revealed a familiar household object.

The back of the box was open, allowing the experimenter to insert rectangular pieces of posterboard, each containing 12 line drawings, into the area under the doors. Each vertical pair of drawings contained one animal and one household object (e.g., a cat and a lamp). The same 12 objects appeared on every trial and a given animal was always paired with one particular household object. However, any given pair was under a different set of doors on different trials. There were some animals and some household objects under each row of doors. Each drawing was approximately 4 cm across. Many of the drawings in this task and the incidental learning task were the same as those used by Hagen (e.g., 1967). A vertical posterboard screen rising from the back of the box prevented the child from seeing any drawings when they were removed after each trial.

Procedure.—A male experimenter tested each child individually. He explained that animals were under doors with a drawing of a cage on them and household objects were under doors with a drawing of a house. Half of the children were told that they would be trying to remember which door each animal was under and half were told to remember which door each household object was under. They were instructed to look under whatever doors they wanted, as many times as they wanted. Finally, they were told they could open doors only with their writing hand, in order that only one door could be open at a time. There was a practice trial with three animal–household object pairs not used later.

After the practice trial children were asked to point to doors hiding animals and doors hiding household objects, as a final check that they understood the relationship between the cages or houses on the doors and the pictures hidden underneath. All children understood this relationship. Next, they saw a large card with all the animal pictures and a large card with all the household object pictures. They were told these were the pictures that would be under the doors and were asked to name them. After a final reminder that they were to remember where each animal was (or, for half of the children, where each household object was), the first trial began. Each of the six trials began when the experimenter said "start" and ended when he said "stop" 25 sec later. A second experimenter timed, with a silent stopwatch, the duration of time in which animal doors and household object doors were open. At the end of each trial the experimenter held up a cue card with a picture identical to one of the animals the child had just seen (or one household object for half of the children) and asked the child to open the door where that animal was. Over the six trials there was one test for each of the six spatial positions. There was complete counterbalancing of age, sex, and type of pictures relevant (animal or household object).

Scoring.—Children's strategies of gathering information were assessed by recording which doors they opened, the order in which they opened them, and the amount of time they exposed relevant or irrelevant objects. Several aspects of the data required interrater reliability. Two experimenters recorded the total time that animal doors were open and household object doors were open on each trial of 12 subjects drawn from the three grades. They achieved agreement with .75 sec on 97% of these 72 trials.

The record of the order in which each child opened the doors was used to classify each trial as to the child's pattern of gathering information. Doors were designated either "relevant," (e.g., hid animals when animals were to be remembered) or "irrelevant" (hid household objects when animals were to be remembered). The pattern categories were as follows: (1) opened only relevant doors (allowing for one mistake); (2) opened relevant doors before a mixture of relevant and irrelevant doors; (3) opened adjacent doors following the spatial layout of the doors (e.g., the bottom row then the top row, or the top then bottom of each pair from left to right) for at least 75% of the openings; (4) opened adjacent doors following the spatial order of the doors for 50%–75% of the openings; and (5) no discernible pattern. Two raters, unaware of the child's grade and sex, achieved 94% agreement on classifying 144 trials from 24 children drawn from the three grades.

Incidental Learning Task

Materials.—The incidental learning task used a different set of line drawings of animal–household object pairs. As in the other task, a given animal was always paired with a particular household object, and some animals were on the bottom whereas others were on the top. One object of each pair was immediately above and almost touching the other. The drawings were mounted on a piece of posterboard, 58 × 18 cm. A flap covering each pair could be lifted to expose the pair. The location of each pair varied from trial to trial.

Procedure.—The incidental learning task was always given approximately 1 week after the task, assessing strategies of attention. The incidental learning task could not be presented first because it could suggest to the children that they might be asked to recall incidental material on the subsequent task. The procedures followed those typically used in incidental learning tasks (e.g., Hagen 1967). Each child was told to remember the location of each animal (or, for half the children, the location of each household object). Children were to remember the same type of picture (e.g., animals) in both sessions. After a practice trial with three pairs of objects, the children saw and named the animals and household objects to be used in the real game. The experimenter reminded them of what category of picture they were supposed to remember and proceeded to the first trial. Each flap was lifted in succession, from the children's left to their right, to expose the animal-household object pair for 2 sec. The experimenter then showed a cue card with one animal (or one household object) and asked where it was. After the flap which the children pointed to was raised, all the other flaps were raised in order to equalize the amount of time each child saw the incidental objects. The task continued for a total of six trials, with one test for each of the six spatial positions.

After the last trial testing recall of central objects came the test of incidental learning. The experimenter presented a card with all the incidental objects on it (e.g., household objects). He told the children they would be shown the animal cards one by one and should point to the household object that always went with it. There was one modification of the typical test for incidental learning. Before the attempted matching, children were asked which incidental objects they thought they could match correctly. Then, after they actually tried to match up the pairs, they were asked which objects they thought they had matched up correctly. These two questions examined children's knowledge about their current state of memory.

Following the incidental learning task, children were questioned about their use of strategies during the task. The first question was open ended: "During the game how did you go about trying to remember where the animals were?" Subsequently, children were asked if they had said to themselves the names of the central or incidental objects or had looked at only central or both central and incidental objects. Finally, children were asked not to talk about the game with other children.

Scoring.—The answers to the open-ended question about strategies on the posttest were assigned to four categories: (1) said the names of the objects, (2) looked at the objects, (3) miscellaneous (e.g., noticed the order, associated each animal with the household object), and (4) no appropriate strategy (e.g., no answer, "I tried to remember them"). Two raters, unaware of the child's grade and sex, reached 95% agreement on classifying 44 children from the three grades.

Results

Assessment of Strategies of Attention Allocation

One measure of how much children directed their information-gathering activities to task-relevant information is a proportion score consisting of the number of relevant doors opened (e.g., doors with cages) divided by the total number of doors opened (cages plus houses) on that trial. A four-way analysis of variance was performed on grade (3) $\times$ doors relevant (2: cages or houses) $\times$ sex (2) $\times$ trial block (2: trials 1–3 vs. 4–6). The scores were arc sine transformations of the proportion score. As expected, there was a significant main effect of grade, $F(2,48) = 13.43$, $p < .001$. Duncan's tests ($\alpha = .05$) showed a significant increase in the proportion from grade 2 ($\bar{X} = .53$) to grade 5 ($\bar{X} = .74$), but not from grades 5 to 8 ($\bar{X} = .82$). Thus, there was an increase from grades 2 to 5 in the tendency to open relevant doors.

An unexpected significant main effect was the type of door relevant, $F(1,48) = 9.03$, $p < .005$. There was a higher proportion of doors with house pictures opened when these doors were relevant ($\bar{X} = .77$) than of doors with cages opened when these doors were relevant ($\bar{X} = .62$). There were no significant effects of sex, trial block, or any interactions.

A second measure of the tendency to select relevant information is a proportion score consisting of the amount of time in which relevant doors were open divided by the total amount of time doors were open on each trial. This measure was highly correlated with the above measure ($r = .99$). As above, a four-way analysis of variance was performed on arc sine transformations of the proportions. Because of experimenter error, nine subjects had missing time scores on one or more trials. These missing values were estimated according to the GLM procedure in the Statistical Analysis System (1979). As in the above analysis, there were significant effects of grade, $F(2,46) = 16.69$, $p < .001$, and type of door relevant, $F(1,46) = 12.91$, $p < .001$, but not sex, trial block, or any interactions. Duncan's tests ($\alpha = .05$) showed a significant increase in the proportion from grade 2 ($\bar{X} = .55$) to grade 5 ($\bar{X} = .76$), but not from grades 5 to 8 ($\bar{X} = .85$). Again, performance was better with house doors relevant than with cage doors relevant.

The above analyses of group performance do not present a complete picture of what individual children were doing on the task. Analyses of individual performance, therefore, were carried out. As explained in the scoring section, each trial of every child was assigned to a category based on which doors were opened and the order in which they were opened. In Table 1, children are categorized according to their most frequent pattern over the six trials. The main developmental changes occurred between grades 2 and 5 in two categories. From grades 2 to 5 there was an increase in the number of children who most commonly opened only the relevant doors, χ^2 $(1) = 10.36$, $p < .005$, and a decrease in the number of children who most commonly followed the spatial order of the doors, χ^2 $(1) = 4.38$, $p < .05$.

Incidental Learning

The number of items recalled was examined in a three-way analysis of variance with the factors of grade, type of recall (central vs. incidental), and type of objects relevant (animals vs. household objects). None of the main effects were significant. As expected, there was a significant interaction of grade and type of recall, $F(2,54) = 4.32$, $p < .05$. Recall of cen-

TABLE 1

PROPORTION OF CHILDREN IN EACH GRADE USING EACH PATTERN OF OPENING DOORS MOST FREQUENTLY[a]

GRADE	PATTERN				
	Relevant doors only	Relevant, then relevant and irrelevant	Followed spatial order	Partially followed spatial order	No pattern
2	.05	.05	.47	.16	.26
5	.53	.11	.16	.00	.21
8	.63	.16	.11	.00	.11

[a] Three subjects, one from each grade, who used two patterns equally often, were omitted from the table.

tral objects increased as a function of grade level, $F(2,54) = 4.85$, $p < .05$, whereas incidental recall did not. The pattern typically obtained in past studies is a gradual increase with age in central recall and little or no change in incidental recall until a decline around age 12. This pattern can be seen in the means for grades 2, 5, and 8, respectively: 2.35, 2.95, and 3.65 central objects recalled and 2.80, 3.15, and 2.15 incidental objects recalled. The usual interpretation of this pattern of results is that attention becomes more selective with increasing age. Of their total recall, eighth graders recall proportionately more central information than the younger children.

Relationships between Allocation of Attention and Performance on the Incidental Learning Task

One question of interest was whether the allocation of attention, as assessed on the first task, would be related to the child's performance on the incidental learning task. The first comparison involved correlations between two proportion scores which are measures of selectivity. In the first task the proportion was the number of relevant doors opened divided by the total number of doors opened. In the incidental learning task the proportion was the number of central objects recalled divided by the total number of central and incidental objects recalled. The correlations for grades 2, 5, and 8 were −.13, .19, and .40. None of the correlations were significantly different from zero (but $p < .09$ for grade 8), and no correlation was significantly different from another.

A second analysis used the previously described classification of children's patterns of opening doors. The children in grades 5 and 8 were divided into two groups, those who most frequently had the pattern of opening only relevant doors (10 fifth graders and 12 eighth graders) and those who most frequently had some other pattern (10 fifth graders and 8 eighth graders). Because only one second grader had the pattern of opening relevant doors, no analyses could be performed on this grade. An analysis of variance on grade (2) × type of pattern (2) × type of recall (2: central vs. incidental) did not find a significant interaction of type of pattern × type of recall. This interaction, if significant, would have indicated a relationship between the pattern of gathering information and performance on the incidental learning task. Thus, two different types of analyses provide no evidence for a direct relationship between performance on the two tasks.

Verbal Measures of Knowledge about Attention

One measure was the accuracy of children's predictions of how many incidental pictures they would correctly match up with central pictures and, after actually attempting the matches, their estimate of how many they had matched. A four-way analysis of variance was performed on grade (3), type of measure (3: prediction, incidental recall, and estimation after incidental recall), sex (2), and type of stimulus relevant (2: animals or household objects). There were main effects of grade, $F(2,48) = 10.05$, $p < .001$, and type of measure, $F(2,96) = 12.51$, $p < .001$, but not sex or type of stimulus relevant. These main effects are best understood by looking at the main outcome of interest, the significant grade × type of measure interaction, $F(4,96) = 3.33$, $p < .05$. Follow-up analyses revealed a significant interaction of grade × prediction versus actual recall, $F(2,48) = 3.41$, $p < .05$, and grade × actual recall versus estimation after recall, $F(2,48) = 5.53$, $p < .01$. More specifically, both prediction scores ($\bar{X} = 4.95$) and estimation scores after recall ($\bar{X} = 4.60$) were significantly higher than actual recall ($\bar{X} = 2.80$) for the second graders, $F(1,16) = 15.16$, $p < .005$ for prediction, $F(1,16) = 13.71$, $p < .005$ for estimation after recall. Neither difference was significant for the fifth or eighth graders, that is, for prediction, recall, and estimation after recall, $\bar{X} = 3.95$, 3.15, and 3.60 for grade 5 and 2.60, 2.15, and 2.24 for grade 8. Thus, the second graders overestimated their recall, but fifth and eighth graders were fairly accurate.

The second measure of children's knowledge about their performance was the series of questions about strategies they had used during the incidental learning task. The answers to the question concerning what they had done to help themselves remember the central objects revealed a significant relationship between grade and the type of answer given (naming, looking at objects, miscellaneous, and no appropriate strategy), χ^2 (6) $= 24.70$, $p < .001$. Among grades 2, 5, and 8, respectively, naming was mentioned by 5%, 20%, and 40% of the children, looking at the objects by 20%, 20%, and 10%, miscellaneous strategies by 5%, 45%, and 35%, and no appropriate strategy by 70%, 15%, and 15%.

The next question directly asked the children if they had said the names of the central and incidental stimuli to themselves. It revealed a developmental increase in the number of children reporting that they named the central but not the incidental objects (35%, 60%, and 70% of grades 2, 5, and 8, respectively). The other subjects reported rehearsing both central and incidental objects or neither type of object. This change was significant from grades 2 to 8, χ^2 (1) $= 4.91$, $p < .05$, but not from 2 to 5 or from 5 to 8.

The final question directly asked the children whether they had looked only at the central stimuli, mostly at the central stimuli, or equally at the central and incidental stimuli. Only 16%, 25%, and 40% of grades 2, 5, and 8, respectively, indicated they looked only at the central stimuli, a nonsignificant difference.

Discussion

Children's performance on the incidental learning task and their strategies for allocating attention follow different developmental timetables. Efficient strategies of attention allocation develop primarily between grades 2 and 5, with only moderate further progress by grade 8. In contrast, on the incidental learning task processing becomes selective between grades 5 and 8, with little change before that. More specifically, as in previous studies, memory for central material increases from grades 2 to 5 to 8, while memory for incidental material is fairly constant from grades 2 to 5, then decreases from grade 5 to 8. Thus, the proportion of recalled items that are central is highest at grade 8.

The direct assessment of strategies of selecting information supports the claim that there are developmental changes in the allocation of attention. In contrast to most fifth and eighth graders who efficiently gathered relevant information, second graders opened doors with little concern for whether the information underneath was relevant or irrelevant to the task. Their most common strategy was to open adjacent doors, row by row, following the spatial organization of the doors. One interpretation of this behavior is that second graders do not understand that the goal of the task, remembering only one of two sets of drawings, dictates a particular strategy for gathering information efficiently. Brown (1978) argues that such knowledge about how to orchestrate one's strategies and cognitive skills and fit them to the particular task at hand is derived from metacognition, one's knowledge about any aspect of human thought.

Alternative interpretations consider the possibility that second graders actually know the value of gathering relevant information, but have certain characteristics which may prevent them from demonstrating their knowledge in the task used here. One possibility, that they were simply satisfying their curiosity by looking under all the doors, is unlikely because they saw all the pictures before the task began and therefore knew what objects were under the doors. Furthermore, if curiosity were an important factor, it should be somewhat satisfied after several trials and allow a task-relevant strategy to take over. In fact, performance did not improve over trials.

Another characteristic of young children which could compete with a strategy of selectively allocating attention is their general search behavior. From the preschool to early grade school years, visual and tactual exploration becomes more organized and exhaustive. That is, children learn they should attend to all parts of the array in an orderly fashion (Day 1975; Vurpillot 1976). Looking behind every door and opening adjacent doors is both organized and exhaustive. The salient spatial organization of the doors may even reinforce this strategy. Although this new skill will serve them well in most situations, it is not helpful in situations where selectivity is required.

Other factors that at this point cannot be ruled out include second graders' possible failure to fully understand that they were to remember only relevant objects, failure to utilize feedback from the six trials (e.g., noticing that animals are always asked for), and susceptibility to demand characteristics (e.g., feeling that the experimenter expects them to look at all the stimuli). These will be examined in future research.

A final comment about the strategy assessment task refers to fifth and eighth graders' greater allocation of attention to relevant objects when household objects rather than animals are relevant. This result is uninterpretable at present. Such a difference did not appear on the incidental learning task or in two recent replications using preschoolers (Gaines, Note 1) or Puerto Rican grade schoolers (Miller & Jordan, Note 2).

The assessment of children's awareness of their current state of memory revealed that second graders, but not fifth or eighth graders, overestimated how many incidental objects they could remember both before and after actually trying to remember them. This result complements the finding from previous studies that young children overestimate their memory span (e.g., Flavell, Friedrichs, & Hoyt 1970; Yussen & Levy 1975). The present study extends this finding to incidental materials.

The final measure of understanding, the posttest questionnaire, revealed little evidence of knowledge concerning appropriate strategies on the incidental learning task among second graders. Either they did not use strategies such as looking primarily at the central objects and labeling them, or were not aware that they had used them, or were unable to verbalize the basis of their behavior (see Brainerd 1973). These results are not due solely to the younger children's lesser verbal facility because several of the questions specifically asked about these strategies. The child needed only answer yes or no.

A final issue is the lack of a direct relationship between strategies of attention allocation and performance on the incidental learning task. This outcome is perhaps not surprising given the rarity of positive correlations between metacognitive knowledge and performance in the area of memory (Cavanaugh & Borkowski 1980; Salatas & Flavell 1976). Still, the result needs some explanation. The lack of prediction for second graders is of little concern because so few demonstrate either selective allocation of attention or efficient performance on the incidental learning task. Thus, there are not pronounced individual differences which might produce significant correlations. The lack of prediction for older children, however, is of more interest. The absence of a direct relationship between strategies and performance on the incidental learning task may be due to the different developmental timetables for the two skills. As described earlier, the greatest change in strategies comes between grades 2 and 5, whereas the greatest change in performance on the incidental learning task comes between grades 5 and 8. Thus, in grade 5 approximately half of the children are consistently opening only the relevant doors on the majority of trials, but still show little selectivity in recall on the incidental learning task. There may, then, be a lag between attainment of strategies for gathering relevant information and acquisition of the ability to fully exploit these strategies. Brown and DeLoache (1978) describe young children as "universal novices" who often fail to perform efficiently "not only because they may lack certain skills but because they are deficient in terms of self-conscious participation and intelligent self-regulation of their actions" (p. 13).

A further possible reason for the lack of relationship between attentional strategies and performance on the incidental learning task is that efficient performance on the latter task calls for several skills in addition to the efficient allocation of attention. Hagen and Hale (1973) suggest that there is both initial selectivity, as children analyze the stimulus into its relevant and irrelevant components, and sustained selectivity, as they maintain their attention to these objects by naming or rehearsing them. In the present study the task assessing allocation of attention is more sensitive to the first process, the initial selection of information. Thus, some of the individual differences on the incidental learning task may be due to aspects of attention not directly assessed in the present study.

Reference Notes

1. Gaines, W. M. Attentional behavior and the understanding of attention in preschoolers. Senior honors thesis, University of Florida, 1980. (Available from P. H. Miller, Department of Psychology, University of Florida, Gainesville, Florida 32611.)
2. Miller, P. H., & Jordan, R. Metacognition and attention in Puerto Rican children. Unpublished manuscript, 1981. (Available from P. H. Miller, Department of Psychology, University of Florida, Gainesville, Florida 32611.)

References

Brainerd, C. J. Judgments and explanations as criteria for the presence of cognitive structures. *Psychological Bulletin*, 1973, **79**, 172–179.

Brown, A. L. Knowing when, where, and how to remember: a problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology*. Vol. **1**. Hillsdale, N.J.: Erlbaum, 1978.

Brown, A. L., & DeLoache, J. S. Skills, plans, and self-regulation. In R. Siegler (Ed.), *Children's thinking: what develops?* Hillsdale, N.J.: Erlbaum, 1978.

Cavanaugh, J. C., & Borkowski, J. G. Searching for metamemory-memory connections: a developmental study. *Developmental Psychology*, 1980, **16**, 441–453.

Day, M. C. Developmental trends in visual scanning. In H. W. Reese (Ed.), *Advances in child development and behavior*. Vol. **10**. New York: Academic Press, 1975.

Douglas, V. I., & Peters, K. G. Toward a clearer definition of the attentional deficit of hyperactive children. In G. A. Hale & M. Lewis (Eds.), *Attention and cognitive development*. New York: Plenum, 1979.

Flavell, J. H. Developmental studies of mediated memory. In H. W. Reese & L. P. Lipsitt (Eds.), *Advances in child development and behavior*. Vol. **5**. New York: Academic Press, 1970.

Flavell, J. H.; Friedrichs, A. G.; & Hoyt, J. D. Developmental changes in memorization processes. *Cognitive Psychology*, 1970, **1**, 324–340.

Hagen, J. W. The effect of distraction on selective attention. *Child Development*, 1967, **38**, 685–694.

Hagen, J. W., & Hale, G. A. The development of attention in children. In Pick, A. (Ed.), *Minnesota symposia on child psychology*. Vol. **7**. Minneapolis: University of Minnesota Press, 1973.

Lane, D. M. Developmental changes in attention-deployment skills. *Journal of Experimental Child Psychology*, 1979, **28**, 16–29.

Lane, D. M. Incidental learning and the development of selective attention. *Psychological Review*, 1980, **87**, 316–319.

Miller, P. H., & Bigi, L. Children's understanding of how stimulus dimensions affect performance. *Child Development*, 1977, **48**, 1712–1715.

Miller, P. H., & Bigi, L. The development of children's understanding of attention. *Merrill-Palmer Quarterly*, 1979, **25**, 235–250.

Odom, R. D. A perceptual-salience account of decalage relations and developmental change. In L. S. Siegel & C. J. Brainerd (Eds.), *Alternatives to Piaget*. New York: Academic Press, 1978.

Pick, A. D., & Frankel, G. W. A study of strategies of visual attention in children. *Developmental Psychology*, 1973, **9**, 348–357.

Salatas, H., & Flavell, J. H. Behavioral and metamnemonic indicators of strategic behaviors under remember instructions in first grade. *Child Development*, 1976, **47**, 81–89.

Statistical Analysis System user's guide. Raleigh, N.C.: SAS Institute, 1979.

Vurpillot, E. *The visual world of the child*. New York: International Universities Press, 1976.

Yussen, S. R., & Levy, V. M., Jr. Developmental changes in predicting one's own span of short-term memory. *Journal of Experimental Child Psychology*, 1975, **19**, 502–508.