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GREENSPAN, ELLEN DIANE

VERBAL AND NONVERBAL COGNITIVE STRATEGIES OF YOUNG READERS

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VERBAL AND NONVERBAL COGNITIVE STRATEGIES OF YOUNG READERS

by

ELLEN DIANE GREENSPAN

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April 14, 1981
Date

Shirley Feldmann
Chairman of Examining Committee

April 14, 1981
Date

Shirley Feldmann
Executive Officer

Dr. Shirley Feldmann

Dr. Barry J. Zimmerman

Dr. O. Bernard Leibman

Supervisory Committee

The City University of New York

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CHAPTER I

Introduction

Background of the Problem

One of the highest priorities of education in America is for children to successfully learn to read in the early grades. Millions of dollars have been directed toward the development of new teaching methods. Yet, significant numbers of children who attend school regularly, who have no gross intellectual, organic, emotional, visual, or hearing disorders, fail to make adequate progress in reading. The need to investigate factors which relate to their difficulty in learning to read is of undisputed importance. The fact that minimum reading competency tests are now being administered to high school students as a prerequisite for graduation suggests just how widespread reading difficulty has become.

Learning to read an alphabetic orthography is a difficult task. A whole-word technique requires the child to memorize a tremendous body of sight vocabulary words based on their distinctive features. With a phonics technique, the child must master symbol-to-sound correspondences and rules for their application, must develop skill in analyzing and synthesizing sounds, and must also memorize a smaller body of irregular sight vocabulary words. Even this sketchy analysis of beginning reading tasks is sufficient to point out that, whatever the method, a child's memory will be severely taxed. This point has been particularly emphasized by Smith (1971). He suggests that as children sound out words or progress word by word through a sentence, their short-term memory will be so overloaded that they may lose sense of what they are reading.

The importance of investigating the skills that beginning readers apply to such short-term memory tasks is well justified. This area of research became of interest to the present author when she taught reading in the early-childhood grades and worked as an educational therapist for a reading disabilities program in the New York City public schools. She personally observed case after case of children who had inordinate difficulty with reading tasks involving memory.

During the 1960s, the predominant view held by reading specialists was that the difficulty of many young readers on memory tasks was attributable to dysfunctions of the visual system, particularly to disturbances in spatial orientation and form perception. Many reading specialists became convinced that reading-disabled children literally "saw backwards." As a result of this outlook, training programs focused on improving children's visual perception, with such widely varying techniques as having them trace designs in a left-to-right fashion or teaching them to walk on balance beams.

During the 1970s, reading research has greatly benefited from the widespread adoption of information-processing models of memory by investigators in this field (e.g., LaBerge & Samuels, 1974; Perfetti & Goldman, 1976; Smith, 1971). This recent research has effectively disproven the belief that perceptual deficits were the major cause of reading disability. Controlled testing of the perceptual hypothesis by Vellutino and his colleagues (Vellutino, Harding, Phillips & Steger, 1975; Vellutino, Steger, DeSetto & Phillips, 1975; Vellutino, Steger, Harding & Phillips, 1975; Vellutino, Steger, Kaman & DeSetto, 1975) and others (Blank, Weider & Bridger, 1968; Perfetti & Goldman, 1976; Perfetti, Finger & Hogaboam, 1978; Fisher & Frankfurter, 1977) failed to show that such a deficit existed. Instead, the results of their studies suggested that what appeared to be perceptual deficits were rather the result of children's failure to utilize an active, cognitive strategy on memory tasks. Specifically, they found that reading-disabled children did not tend to apply verbal labels to visual stimuli in order to make the stimuli more distinctive and more easily memorizable.

It has been consistently demonstrated (Blank, Weider & Bridger, 1968; Tarver, Hallahan, Kauffman & Ball, 1976; Groenendaal & Bakker, 1971; Torgesen & Goldman, 1977; Liberman, Shankweiler, Liberman, Fowler & Fischer, 1977) that reading-disabled young children fail to use verbal labeling and verbal rehearsal on visual memory tasks to the same degree as normal readers. This finding has been interpreted in two ways.

The Libermans and Blank propose that subvocal labeling is a crucial aspect of the reading process. They have suggested that deficiencies in verbal encoding are specifically and causally related to reading disability. Liberman, Liberman et al. (1978) hypothesize that only those memory tasks to which a verbal labeling strategy could be applied would differentiate skilled from less skilled readers.

Torgesen (1977, 1978) has not adopted a specific theory of reading, but he has suggested that a general deficiency in strategy use contributes to reading disability and may hamper remediation efforts. He has interpreted the lack of verbal encoding observed among less skilled readers as symptomatic of their general deficiency in strategy use, a deficiency which may be the result of their metacognitive and/or motivational immaturity. He predicted that skilled and less skilled readers should differ on any memory task to which an active cognitive stragegy (verbal or nonverbal) could be applied.

Since the educational implications of these two interpretations are quite different, their relative merits should be carefully examined. The Libermans' position is limited; it suggests poor readers will only demonstrate a deficiency in verbal strategy use. If the Libermans' position receives support, the current trend toward the use of language and linguistic training for slowly progressing readers receives additional backing. The Torgesen position is broader; it suggests a generally deficient use of active strategies by unskilled readers. If this position receives support, techniques which primarily stress methods to overcome such passivity are indicated.

An examination of how young readers perform on tasks that can be facilitated by a nonverbal strategy would be helpful in resolving this issue. The only nonverbal cognitive stragegy that is used spontaneously by young readers and has been touched on by reading researchers, is selective visual attention. Selective visual attention is the ability to focus more of one's visual attention to dimensions of a task identified as relevant than to irrelevant dimensions. It is an important strategy for young readers. Through lack of its application, a child could miss out on important information presented visually, i.e., on charts, blackboards, etc. On a finer grained level, the application of selective visual attention will be crucial to reading the code. For example, the words <u>cot</u> and <u>cat</u> differ by only one small line; to avoid a miscue, one must attend to the relevant feature. A few studies (Tarver, Hallahan, Kauffman & Ball, 1976; Hallahan, Tarver, Kauffman & Graybeal, 1978; Hallahan, Gajar, Cohen & Tarver, 1978) have reported that reading-disabled children display less efficient selective visual attention than normal readers. However, only one study (Tarver et al., 1976) has been conducted with relatively young readers and all have utilized a memory task that uses verbal stimuli. Therefore, such tasks confound selective visual attention with verbal mediational strategies.

Thus, there is no resolution to the issue of whether children's reading achievement is related to a general lack of strategy use (Torgesen's position) or only to a deficiency in the verbal labeling strategy (Libermans' position). The purpose of the present study is to test the relative merits of these two positions.

A second purpose of this study is to investigate two factors which have been hypothesized by Torgesen (1977) to relate to deficiencies in strategy use. The first is incentive. Hallahan, Tarver et al. (1978) have shown that learning-disabled children were more likely to use verbal mediation under tangible reinforcement conditions than under control conditions. Blair (1972) found that low-achieving children performed better on a size discrimination task under tangible reinforcement than under verbal reinforcement. This was not the case for normal achievers. It is possible that a lack of incentive contributes to a production deficiency in strategy use.

The second factor that is considered is the child's metamemory. Metamemory refers to an individual's awareness of processes pertinent to information storage and retrieval (Flavell, 1971). Flavell and Wellman (1977) enumerate three aspects of metamemory: person, task, and strategy variables. The third aspect of metamemory, awareness of potentially employable strategies, is central to this study. Previous research with young children has shown that their knowledge that a specific mnemonic strategy will be valuable on a task does not assure that they will use that strategy (Salatas & Flavell, 1976). However, other research studies (Wellman, 1977; Drozdal & Flavell, 1976) suggest that metamemory knowledge will improve recall. This study extends the research on metamemory using readers of different achievement levels working under different incentive conditions. It investigates how metamemory for a particular strategy relates to performance on a task which could be facilitated by using that strategy. It is expected that evidence concerning the role of incentives and metamemory will be helpful in pointing out ways to improve children's strategic behavior while they are learning to read.

Statement of the Problem

The general problem under investigation involves the following questions:

1. How do children's reading achievement scores relate to their probed memory on (a) a task which minimizes the role of active, cognitive strategies, (b) a task which can be facilitated by a nonverbal cognitive stragegy, and (c) a task which can be facilitated by a verbal cognitive strategy?

2. Does increasing incentives improve performance on strategy-applicable tasks for less skilled readers more than for skilled readers?

3. Does metamemory for a given strategy positively correlate to performance on a memory task which can be

facilitated by using that strategy? How is this relationship affected by incentive conditions for children of varying achievement levels?

CHAPTER II

Review of the Literature

The review of the literature consists of several sections. The first section provides an overview of how the information-processing literature defines strategies. The next several sections examine the literature comparing readers of various levels of achievement on (a) nonstrategic aspects of memory, (b) use of verbal strategies, and (c) use of nonverbal strategies. The next two sections review the literature on how incentive and metamemory relate to strategy use. The final sections describe the rationale and plan of the study, present operational definitions, and outline the hypotheses.

The Distinction between Structural and Control Processes

Atkinson and Shiffrin (1968) describe two types of memory variables. They distinguish between the basic capacities of the individual which facilitate memory but are not typically under conscious control and those behaviors, processes, or strategies which can be selected and used by the subject in adapting to specific task requirements. The former memory variables they refer to as structural, and the latter as control processes. The structural elements (sensory register, short-term memory store, long-term memory store) are built-in features of the system and represent physical limitations to memory. Control processes are cognitive strategies such as coding procedures, rehearsal operations, and search strategies which serve the purpose of maximizing the potential of a limited information processing structure. The relationship of structural to control processes has often been likened to the relationship of hardware to software in a computer.

Examples of structural variables which have been studied in research on beginning readers are the duration of the icon (Stanley & Hall, 1973), short-term memory span (Perfetti & Goldman, 1976; Vellutino, Steger, DeSetto & Phillips, 1975; Vellutino, Steger, Kaman & DeSetto, 1975) and processing speed (Denckla & Rudel, 1976; Perfetti, Finger & Hogaboam, 1978; Katz & Wicklund, 1972). Examples of control processes believed to be related to early reading skill are selective attention (Hallahan, Tarver et al., 1978; Hallahan, Gajar et al., 1978; Tarver et al., 1976, 1977), verbal recoding of visual information (Blank & Bridger, 1966; Blank, Weider & Bridger, 1968; Liberman et al, 1977, 1978; Swanson, 1978) and the use of categorical knowledge to impose organization on task stimuli (Parker, Freston & Drew, 1975). "The use of a particular control process," according to Atkinson and Shiffrin, "will depend upon such factors as the nature of the instructions, the meaningfulness of the material, and the individual subject's history" (1968, p. 90).

A recent model of memory proposed by Craik and Lockhart (1972), places even more emphasis on the active role of the individual in controlling memory. In this model, input is analyzed at a number of levels. The more levels information proceeds through, the more likely it is that it will be retained. At the first level, information is analyzed in terms of its physical features. At deeper levels, it is analyzed at a "meaning" level. Craik and Lockhart describe two types of rehearsal. Maintenance rehearsal allows for continued attention to the stimuli. Elaborative rehearsal, in which the learner relates new information to previously stored memories, strengthens long-term storage. In Craik and Lockhart's depth-of-processing model, the more active and aware the learner is, the more deeply will information be processed.

Both the traditional and the depth-of-processing models emphasize the positive effects of appropriate mnemonic strategies on recall. As Reitman (1970) states, "Current strategies determine what he (the learner) will notice and what he will eventually remember" (p. 118).

Reading researchers have compared young readers varying in ability on both structural and control variables. This research is reviewed in the following sections. The review begins with studies comparing readers on structural variables. Although this line of research has generally not uncovered differences related to reading achievement, these studies have been heuristically important.

Research on Structural Differences Among Beginning Readers Varying in Achievement

There have been many explanations of reading disability based on some type of structural deficit. Inefficient iconic storage, inadequate short-term memory span, and slow processing speed are the most common structural variables blamed for reading failure. This section will highlight the literature which casts doubt on the merits of each of these explanations of reading disability. In contrast to earlier work, the authors of the studies included in this review have taken precaution to use experimental tasks which minimize or control the subjects' use of verbal mediational strategies.

A particularly popular structural explanation of the cause of reading disability was first put forth by Orton (1937) and later championed by Frostig (1968). This position holds that reading-disabled children are deficient in form perception and spatial discrimination. This hypothesis has been severely challanged by the work of such authors as Fisher and Frankfurter (1977), Vellutino, Steger, DeSetto, and Phillips (1975), and Vellutino, Steger, Kaman and DeSetto (1975), which are included in this review.

A. Iconic Storage

When stimuli are presented to individuals for memorization and then removed, an after-image or icon remains for approximately 200 milliseconds. The duration of this after-image shortens somewhat as we get older (Gummerman &

Gray, 1972). Stanley and Hall (1973) hypothesized that in disabled readers this developmental process lags and thus, the duration of the iconic image of disabled readers is longer than that of normal readers. This extended length of iconic storage was thought to disrupt the rate and efficiency with which information was transferred from the sensory register to short-term memory during reading.

Fisher and Frankfurter (1977) investigated this hypothesis. They compared normal and disabled readers on a memory task which included a masking condition designed to limit the duration of the icon to 200 ms. Their assumption was that if disabled readers maintained the iconic after-image longer than normal readers, they should be more disrupted by this time-limiting condition than the normal readers.

Twelve reading-disabled children served as the experimental group. Their mean age was 10 years, 8 months, and all were reading at least two years below grade level. Two control groups were included. The first control group were normal readers matched by age to the experimental group. The second control group were younger, normal readers matched to the experimental group by reading achievement. Reading level was determined by the vocabulary subtest of the Gates MacGintie Reading Test. I.Q. was not equated, but the reading-disabled group was judged not to be intellectually, emotionally, or organically impaired by the staff of the Kennedy School at John Hopkins University.

All subjects were administered 72 trials of a visual memory task. On half the trials, the children viewed sets of alphabet letters for 200 milliseconds. For the other half of the trials, the procedure was identical except that immediately after presentation of the target stimuli, a mask composed of dense, jumbled letter fragments was exposed. The mask was assumed to limit any further maintenance of the iconic image.

The results showed that the disabled readers performed equivalently to their age-mates and, in fact, outperformed the younger ability-matched controls in both the mask and control conditions. The authors conclude that there is no evidence that disabled readers suffer a lag or a deficit in visual perception at the iconic storage level.

B. Short-Term Memory (Visual)

Vellutino and his colleagues (Vellutino, Steger & Kandel, 1972; Vellutino, Pruzek, Steger & Meshoulam, 1973; Vellutino, Harding, Phillips & Steger, 1975; Vellutino, Steger, DeSetto & Phillips, 1975; Vellutino, Steger, Harding & Phillips, 1975; Vellutino, Steger, Kaman & DeSetto, 1975; Vellutino, Bentley & Phillips, 1978) have compiled a body of research on the short-term, visual memory of good and disabled readers. It challenges the hypothesis that disabled readers do not perceive form or spatially discriminate as well as normal readers. Vellutino's work has shown that the visual memory of normal and disabled readers is equivalent when the effects of verbal control strategies are controlled.

He has been instrumental in shifting the attention of reading researchers from investigations of visual deficit to investigations of linguistic ability.

Vellutino, Steger, DeSetto and Phillips (1975) studied the immediate and delayed visual recognition memory of normal and disabled second-grade readers. Disabled readers were selected from a list given by the officials of a large school district. They were screened to meet the following qualifications: no gross neurological or emotional disorders, no history of excessive absence, a Verbal or Performance I.Q. of at least 90 on the Wechsler Intelligence Scale for Children, and a Gilmore Reading Test score at least one year below grade level. Each reading-disabled child was matched with a child from the same school who was reading at or above grade level. A third group composed of normal readers from a Hebrew day school was also included.

The stimuli for the experiment were nine sets of Hebrew letters (three one-letter sets, three two-letter sets, and three three-letter sets). Each stimulus set was presented for 5 seconds. Immediately after presentation, subjects were asked to identify the stimuli sets from a response chart. The response chart contained the nine target items and the 51 distractors arranged in columns of one, two, and three letter sets. The recognition test was given at three intervals: immediately after presentation, 24 hours later, and 6 months later.

A multivariate analysis, covarying on Verbal and Performance I.Q.'s, produced similar results to those obtained by simple analysis of variance. Disabled and normal readers manifested no significant differences in either their immediate or delayed recognition of the Hebrew letter sets. However, the mean recognition scores for the Hebrew school group were significantly greater than for the non-Hebrew groups for both the immediate and 24-hour delay conditions. The findings were replicated with groups of sixth graders. The results demonstrate equivalent visual recognition memory between normal and disabled readers. They also indicate that dramatic increases in visual memory may be observed when verbal control strategies are available to learners as they were with the Hebrew school subjects.

Vellutino, Steger, Kaman and DeSetto (1975) performed a similar experiment with normal, disabled, and normal Hebrew school readers from the second and sixth grades. In this study, rather than their simple recognition, the recall and reproduction of the Hebrew letters was the criterion measure. The stimuli for this experiment were longer (three, four, or five letters), and the presentation times (3, 4, or 5 seconds in accordance with length) were somewhat shorter. Results were analyzed for accuracy as well as types of errors made in each of the following categories: orientation, sequencing, substitution, and omission. There were no significant correlations between I.Q. and the criterion measures. As a result, the authors did not control for observed differences in mean I.Q. among the groups. There were no significant differences between the non-Hebrew reading groups in either overall accuracy or in the pattern of their errors.

As expected, the Hebrew school normal readers significantly outperformed the non-Hebrew school readers. They differed in their pattern of errors in conformance to their left-to-right directional set. These results suggest that neither a difficulty in form perception nor short-term visual memory existed between the normal and disabled readers. Again, the study emphasizes the effectiveness of verbal mediation as a strategy to increase memory for visual stimuli.

In an earlier study by Samuels and Anderson (1973) some contradictory results were reported. Samuels and Anderson also examined the visual recognition memory of second-grade normal and disabled readers. Subjects were selected for the reading groups based on both teacher judgment and the California Achievement Test. I.Q. differed between the groups but did not correlate significantly with visual recognition memory. The subjects were shown six nonlabelable, letter-like stimuli for 3 seconds each. They were then shown the six stimuli interspersed with five distractors. The distractors were made up of highly confusable transformations of the original stimuli. The subjects were asked to identify which stimuli they had previously seen.

Contrary to the Vellutino studies, in the Samuels and Anderson study the good readers were more accurate than the disabled readers. However, an examination of the type of error made (selection of a left-right, line to curve, or up-down transformation) revealed no group differences. This finding is similar to the results of Vellutino's work. It suggests that the normal and disabled readers did not differ in form perception or in spatial discrimination. Samuels and Anderson hypothesize that differences in focal attention between the reading groups were the source of much of the variation in accuracy, particularly as the presentation times were brief and the stimuli were highly confusable.

C. Short-Term Memory (Auditory)

Perfetti and Goldman (1976) examined skilled and unskilled third- and fifth-grade readers on two tasks of short-term auditory memory. Subjects were matched for I.Q. on the Otis-Lennon Test of Mental Ability, and their reading achievement was determined from the Metropolitan Achievement Test. The first task was memory for probed digits. The subjects heard 12 digits and then a probe digit. Their task was to remember which digit immediately followed the probe digit in the sequence. Perfetti and Goldman describe this task as a "cleaner" test of auditory short-term memory than a digit span test because it is less likely that subjects can use grouping and rehearsal strategies. The second experimental task was similar to the first except that the stimuli were discourse units instead of digits. The subjects listened to a story and then heard a probe word. They then had to supply the word from the story which followed the probe word. The second task allowed the readers to make use of semantic and syntactic cues as well as chunking strategies.

The results indicated that there were no differences between the skilled and unskilled readers on the probed digit task. On the discourse memory task, the skilled readers outperformed the unskilled readers. The difference between the groups was particularly great on items in which the probe came from earlier parts of the story as opposed to later parts. Perfetti and Goldman conclude that skilled and unskilled readers do not differ in their short-term memory capacity but rather in how they use their limited capacity. They suggest that the good readers have more effective, spontaneous verbal encoding techniques than unskilled readers of intact intelligence.

D. Speed of Processing Information

Two recent experiments cast doubt on the hypothesis that disabled readers are structurally slower information-processers than are normal readers. Katz and Wicklund (1972) examined good and disabled second- and sixth-grade readers on their ability to scan letters in search of a target stimulus. Reading ability was measured by both the WRAT and Ginn Tests. No differences were found between the normal and disabled readers in either overall scanning accuracy or in scanning rate.

Perfetti, Finger, and Hogaboam (1978) examined skilled and unskilled third-grade readers on their vocalization latencies to identify colors, digits, object pictures, and words. Their aim was to investigate whether a slow retrieval speed was characteristic of the disabled readers.

Reading level was determined by the reading subtest of the Metropolitan Achievement Test. I.Q. was measured by the Otis-Lennon Test of Mental Abilities; it was, on the average, higher in the normal reading group. The authors found that there were no group differences for vocalization latencies to colors, digits, and objects. Not surprisingly, the good readers identified the words more rapidly than the disabled readers. These results suggest that within the range of disability tested (1 year below grade level), there were no basic speed-of-retrieval differences between the groups.

Two other studies (Spring & Capps, 1974; Denkla & Rudel, 1976) which used a similar procedure to Perfetti et al., obtained somewhat different results. Both studies found that young dyslexic readers, ages 7-11, were slower than normal readers in identifying letters, digits, colors, and pictures of objects. In the Denkla and Rudel study, this finding was obtained despite subjects being matched on Full-Scale and Verbal I.Q. as measured by the Wechsler Intelligence Scale for Children. However, both these studies compared normal readers with children from special classes for the severely reading-disabled (over 2 years below grade level with many children who were total nonreaders). These studies suggest that reading disability may be associated with slow retrieval of information when the disability is profound. As Perfetti et al. have demonstrated, this is unlikely to be the case within a less severe range of disability. It should also be noted that in none of the experiments on vocalization latencies was the degree of original learning of the stimuli controlled.

The studies presented in the preceding sections have been representative of a trend in recent reading research. None of the authors were able to identify a structural variable which could consistently differentiate between normal and disabled readers. On the other hand, the research consistently demonstrated that disabled readers may be deficient in their utilization of control strategies.

Research on the Use of Verbal Control Strategies by Beginning Readers

Blank, Weider, and Bridger (1968) published the first study which suggested that young, disabled readers do not use verbal control strategies to the same degree as successful beginning readers. They studied the recognition memory of 24 first graders (mean age = 6 years, 8 months) for spatially and temporally presented light flashes. Twelve children were classified as good readers and 12 as poor readers on the basis of their performance on the Word Recognition subtest of the Gates Primary Reading Test. Disabled readers were, on the average, a half a year below grade level in reading achievement. The subjects were matched for I.Q. as measured by the Slossen Intelligence Test. The major experimental tasks involved matching spatially and temporally presented light flashes to visual representations of these stimuli. The children were also asked how they remembered the stimuli on each task.

The results indicated that the good and disabled readers did not differ in their memory or approach on the spatial task. All the children reported using some sort of counting strategy on this task. On the temporally presented task, the good readers outperformed the disabled readers significantly. An analysis of their task approach revealed that in comparison to the better readers, the disabled readers (a) more frequently reported using no strategy, (b) more often labeled the number of stimuli incorrectly, and (c) made many more errors in labeling the pauses between stimuli. Blank et al. believe that the temporal task requires efficient verbal mediation in order to be performed well. They interpret their findings as demonstrating that the disabled readers were less able to utilize verbal encoding on the more complex task. They conclude that a deficiency in symbolic mediation is present at the onset of reading retardation and may be responsible for the poorer performance of young reading retardates on tasks which are seemingly perceptually based.

Research by Flavell, Friedrichs, and Hoyt (1970) has shown that the verbal labeling and rehearsal of visually presented linguistic stimuli is a memory strategy which is within the competence of almost all young readers. They investigated children's studying behaviors on a serial memory task which used pictures of common objects as stimuli. The authors report that 90% of their nursery and kindergarten groups used some labeling and among the second graders, 100%

used verbal labeling, and 98% produced at least some verbal rehearsal.

Groenendaal and Bakker (1971) tested the hypothesis that reading-disabled children fail to use verbal labeling and rehearsal to the same degree as normal readers. These authors examined 7-year-old Dutch readers' serial memory for two sets of visual stimuli. The first set were meaningful pictures. The second set consisted of random wire drawings. The reading levels of the children were divided into above- or below-average based on test norms of the Leesvaardigheits Test (Wiegersma, 1958). No significant differences between the groups were found in I.Q. as measured by the Pintner, Durost, Cunningham Test. The groups only differed in their serial memory for the meaningful pictures. No differences were found between the groups on the wire drawing task. The authors concluded that their results were most likely the consequence of an inadequate use of verbal labeling by the less skilled readers.

Swanson (1978) replicated these findings with 9 year-old normal and disabled readers using a similar procedure. He additionally showed that successful training in labeling the random designs only improved the performance of the better readers. Swanson's results demonstrate that normal readers take advantage of labeling as a control strategy, while disabled readers do not.

Torgesen and Goldman (1977) studied the delayed serial memory of second-grade readers. The children were administered eight trials of a serial memory task in which the stimuli were common objects. Between stimuli presentation and recall there was an imposed delay period. The children's reading level was estimated from their performance on the Scott, Foresman graded reading series. Verbal I.Q. was controlled by only including subjects who scored in the average range on the Vocabulary subtest of the Wechsler Intelligence Scale for Children. Torgesen and Goldman found that normal second-grade readers overtly rehearsed during the delay period much more frequently than the disabled readers. Overt rehearsal was closely related to improved recall on the criterion task. An open-ended inquiry was conducted to determine the children's task approach. Significantly more normal readers reported using labeling and rehearsal than did disabled readers (15 of 16 normal readers reported rehearsing, 9 out of 16 disabled readers did so). Also, the normal readers who reported rehearsing did so more consistently than the disabled readers who reported rehearsing. Torgesen and Goldman then repeated the task with the additional requirement that all subjects verbally label the objects on a second series of trials. This procedure effectively eliminated the prior differences between the reading groups on the task. The results support the hypothesis that in comparison to normal readers, unskilled readers of average intelligence less frequently used efficient mneumonic strategies and less often demonstrated awareness of rehearsal as a consciously applied strategy. The authors concluded that environmental supports in the use of proper task strategies can significantly improve the performance of reading-disabled children on memory tasks.

Liberman et al. (1977) tested the hypothesis that beginning readers who are progressing well and those who are doing poorly, will be distinguished by the degree to which they rely on phonetic recoding (verbal labeling) of visual input as a control strategy. The subjects for their experiment were children who were completing second grade. Their reading level was estimated from the WRAT Word Recognition subtest. On this basis, 17 children were identified as good readers, 16 as below average, and 13 as poor readers. I.Q., as measured by the Peabody Picture Vocabulary Test, was equivalent between the extreme groups. The authors adopted a procedure used by Conrad (1971) which involves using sets of rhyming and nonrhyming alphabet letters as visual stimuli. Rhyming letter sets are assumed to disrupt verbal rehearsal. Each five-letter set was exposed to the children for 3 seconds, after which they were asked to reproduce the letters they saw. The procedure was repeated with the additional factor of a 15-second delay imposed between presentation and reproduction which allowed time for the verbal rehearsal of the letter names.

The results indicated that (a) the superior reading group made the fewest overall errors, (b) while confusable (rhyming) letters disrupted all subjects' accuracy to some degree, the greatest disruptive effect occurred with the superior readers, and (c) that phonetic similarity had its most deleterious effect on the superior readers after the delay condition. For the disabled readers, there was no interaction between confusability and delay, which suggests that they did not rehearse to the same degree as the good readers. The authors concluded that the superior readers verbally labeled and rehearsed the stimuli to a greater degree than did the less skilled readers. They stated, "The better recall of the superior readers is due to their more efficient use of phonetic recoding, a strategy that ordinarily works to their advantage, but not in the special case of rhyming strings" (p. 220).

The results of the work of Blank, Weider, and Bridger (1968), Groenendaal and Bakker (1971), Torgesen and Goldman (1977), Swanson (1978), and Liberman et al. (1977) are highly consistent. In each study, the normal readers were superior to the less skilled readers in their application of verbal control strategies. This result was obtained with first-grade readers as well as with older readers. It was obtained even when I.Q. and general verbal aptitude were controlled. A final point can be drawn from this literature. The verbal labeling strategy has been shown to be within the competence of beginning readers. Thus, it seems likely that a failure to use verbal labeling would represent a production, rather than a mediational deficiency. The term production-deficient, coined by Flavell (1970), describes a child who has demonstrated that he/she can use a strategy effectively when instructed to do so, but does not spontaneously use this capacity. The term mediationally deficient (Reese, 1962) describes a child who is unable to employ a strategy effectively even when instructed in its use. Reading-group differences in verbal labeling were eliminated when the use of the strategy was enforced by Torgesen and Goldman. This finding reinforces the conclusion that the lack of verbal labeling demonstrated by disabled readers represents a production deficiency.

Two Interpretations of the Research on Verbal Control Strategies

There are a school of reading theorists (the Libermans, Blank, LaBerge, and Samuels) who believe that even during silent reading, each unit of visual analysis must be subvocally labeled before the symbol's meaning can be assessed. These theorists interpret the research on verbal control strategies as showing that this translation process is not as spontaneous a habit for unskilled readers as it is for skilled readers. They suggest that poor readers are visually normal children who do not tend to label what they see. They believe that this deficiency prevents progress in learning to read. Blank and Bridger (1966) stated that,

> Conversion of a group of letters into symbols (i.e., words) is a basic part of the reading process. If the failure in applying words to physical stimuli is representative of the retarded readers' general functioning, then this deficit may, in part, underlie their reading disability" (p. 845).

Liberman, Liberman, Mattingly, and Shankweiler (1978) similarly concluded that,

> Given the effectiveness of the phonological strategy, and given that reading may put working memory under stress, especially in the beginner, we see that failure to use the phonology properly may be a cause as well as a correlate of poor reading" (p. 27).

Noting the research which indicates that normal and disabled readers perform equivalently on nonverbal paired associate and serial memory tasks (Vellutino, Steger, Harding & Phillips, 1975; Swanson, 1978; Groenendaal & Bakker, 1971; Liberman, Mark & Shankweiler, 1978), they state that,

> Deficiencies of poor readers on memory tasks are limited to situations in which phonological representation can readily occur, either because the stimuli are linguistic items to begin with, or because they are objects to which verbal labels can readily be applied" (p. 27).

Another school of thought is represented by such researchers as Torgesen (1977) and Hallahan, Tarver, Kauffman, and Ball (1978), who have been interested in non-specific factors which contribute to reading difficulty. Torgesen has suggested that many children who enter school, despite adequate I.Q. scores, have assumed a passive learning stance as a result of their personal experiences. He hypothesized that motivational and/or metacognitive immaturity underlied such passivity.

School often presents the child for the first time with situations in which he/she must learn material so that it may be efficiently recalled at a later time. In order to master these memory tasks, the child must develop efficient study habits. Torgesen suggested that the passive learner was ill-equipped to meet this challange and would therefore make relatively slow progress at such tasks.

Torgesen has predicted that skilled and less skilled readers should differ on any memory task to which an active verbal or nonverbal strategy could be applied effectively. He has interpreted the lack of verbal labeling by poor readers as symptomatic of their general strategic deficiency. Torgesen would interpret the findings that demonstrated equivalent memory between good and disabled readers on nonverbal tasks as indicating that the tasks used did not leave much room for strategic behavior. Torgesen's position is similar to that of Reitman (1970) and Kahneman (1973). These authors have suggested that in studying control strategies, one is examining the essence of attention and effort.

The major contrast between the Libermans' position and that of Torgesen is that the former hypothesizes slowly progressing readers to have a specifically verbal strategy deficiency, while the latter hypothesizes that they have a general (verbal or nonverbal) strategy deficiency. The next section of the review examines the use of nonverbal control strategies by readers varying in achievement. A clear demonstration that less skilled readers are deficient in this type of strategy would support the Torgesen position.

Research on the Use of Nonverbal Control Strategies by Beginning Readers

This section will focus on reviewing the literature on the selective visual attention of young readers. Verbal labeling allows an individual to maintain selected stimulus items in consciousness. Selective visual attention, proportioning more of one's visual attention to stimuli which have been identified as relevant, accomplishes a similar function. Selective visual attention is also the only spontaneously used, nonverbal control process which has been touched upon in the research on beginning readers.

Before continuing this section, it will be of interest to note some of the other nonverbal strategies which have been looked at in young children and to point out why they were not selected for use in this study. Gestural rehearsal was examined in a study by Daehler, Horowitz, Wynns, and Flavell (1969), but this strategy did not lead to improved recall for those that used it. Imagery, as opposed to simple visual memory, is a widely studied nonverbal control strategy. When used as a mnemonic strategy, imagery involves visualizing the presented stimuli in some associational context. This ability was not selected for study since Rohwer (1973) found that among children aged 5 to 11, it could not be evoked as a mnemonic strategy without maximal prompting. In contrast, Flavell and Wellman (1977) believe that the strategy of "looking more" at relevant aspects of a task is a simple study behavior which a preschooler is likely to have under good control. Yussen et al. (1974) found that under conditions of perceptual distraction, 4-1/2 - 5-1/2-year-olds will selectively attend to a model's behavior to a greater degree if they are explicitly told to remember it. Another area of nonverbal strategies is the use of external media such as writing down information or using replicas of stimuli to mediate memory (e.g., Corsini, Pick, & Flavell, 1968). The focus of this investigation is on internal rather than external methods of facilitating recall, since external memory aids play only a marginal role in reading instruction.

Four studies of beginning readers (Samuels & Anderson, 1973; Turnure & Samuels, 1972; Gascon & Goodglass, 1970; Tarver et al., 1976) indirectly suggest that the selective visual attention of normal readers may be superior to that of disabled readers. Samuels and Anderson's study was described previously. It found that good and disabled second-grade readers did not differ in the types of errors they made on a visual recognition memory task which used short presentation times and highly confusable stimuli. Yet, the good readers still displayed greater overall accuracy. These results were interpreted by the authors as suggesting that the focal attention of the good readers was superior to that of the disabled readers.

Turnure and Samuels (1972) studied the classroom attentiveness of first-grade readers varying in achievement. Classroom attentiveness was measured by the proportion of task-relevant behaviors, such as eye orientation and compliance with teacher's instructions. Reading achievement was measured by the children's performance in reading a list of Dolch sight vocabulary words. Reading readiness, as measured by an unspecified standardized test, was analyzed as a covariate. The partial correlation of reading achievement with attentional behavior when reading readiness was controlled was .44. This correlation was significant ($p < .001$) and was similar to the correlations found between attention and reading achievement in studies of fourth- and sixth-graders (Cobb, 1972; Lahaderne, 1968). Turnure and Samuels did not include an experimental task on which the effectiveness of their behavioral indicators of attention could be direclty assessed. It was possible that their indicators reflected social compliance, as well as a learning strategy.

Gascon and Goodglass (1970) examined the visual-auditory paired associate learning of third-grade normal and disabled readers. Reading achievement was measured by the Stanford Achievement Test. I.Q., as measured by the WISC, was equivalent between the reading groups. The normal readers outperformed the disabled readers when the visual stimuli were highly confusable (two-dimensional line drawings). However, the authors found that making the visual stimuli more distinctive (substituting three-dimensional, colored clay models of the line drawings) resulted in equivalent learning between the reading groups. These results suggested that while both groups were able to attend to highly distinctive characteristics of visual stimuli, the good readers were better able to attend to less salient features.

Tarver et al.'s (1976) study is the only piece of research that directly aimed at examining the selective attention of young readers varying in achievement. The authors administered Hagen's central/incidental task (1967) to two groups of boys aged 7-10. One group was made up of normal readers; the other group of disabled readers. The reading-disabled boys averages 2.23 years below expected grade level in reading achievement as measured by a standardized reading test (not identified by name). The groups did not differ significantly in I.Q. as measured by a standardized intelligence test (also not identified).

The stimuli for Hagen's task are seven cards. On each card, an animal picture appears on one half and a household object appears on the other. The same animal and object always appear together. The central task is a probed serial memory experiment. Children are instructed to only pay attention to the animal pictures on the cards. In Tarver et al.'s study, 14 trials were administered. On each trial, the items were exposed for 2 seconds each and then turned down to form a horizontal row. Immediately following presentation of the item, an animal probe card was presented and the child was asked to turn over the test card containing the same picture. After completion of the central task, the incidental task was administered. The child was presented with separate animal and object cards and asked to match them in the fashion observed during the central task trials.

The results indicated that the two groups did not differ in incidental learning but that the normal readers were superior on the central task. The central recall of the normal readers was significantly better than the reading-disabled children at serial position 1, 2, and 6. The primacy effect (improvement of the normal readers at the first two serial positions) is generally interpreted as the result of verbal mediation in the literature on serial learning. It has been found to correspond to three other indicators of verbal rehearsal in a study by Brown, Campione, Bray, and Wilcox (1973). The normal readers' better performance at position 6 may indicate that they were better able to maintain their selective visual attention over time. Hagen and Stanovich (1977) suggest that performance on the central/incidental task for children under 11 is related to both (a) increases in visual scanning of the central stimuli and (b) use of verbal labeling and rehearsal.

Thus, the results of this experiment do not conclusively answer the questions posed about the selective visual attention of normal and disabled readers. Since only verbal stimuli were used, the measurement of selective visual attention was confounded with the effects of verbal mediation. Also, only boys were included in the study.

Incentive and Control Strategies

Furth (1978) has pointed out that many of the beginning reading tasks, like their experimental counterparts, can be intellectually unstimulating. The motivation for applying control strategies to these tasks often must come from external reinforcement. In the classroom situation, as in most of the research on control strategies, the reinforcement is generally social, i.e., the praise of the teacher or experimenter.

Torgesen (1978) has hypothesized that at the time they began reading instruction, certain children will be relatively unaffected by social reinforcement. For these children, social reinforcement will not stimulate the use of control strategies necessary for mastering beginning reading tasks. This may be particularly true for children whose parents have punished or otherwise discouraged exploration and curiousity (Walters et al., 1961) or for children for whom the connection between social reinforcement and later tangible reward is weak. The effectiveness of social reinforcement may be further modified by the interaction between the sex of the reinforcing agent and the learner. It is interesting to note that in America, where most early childhood teachers are women, most reading-disabled children are male. The situation is reversed in Germany; most teachers are male and most reading-disabled children are female (Preston, 1962).

There is research evidence which shows that for normal readers, social reinforcement is more effective than tangible reinforcement, while the reverse is true for disabled readers (Blair, 1972; Walters & Doan, 1962; Walters & Kosowski, 1963). Blair studied the differential effects of person, performance, and tangible reinforcement on the discrimination learning of normal and low-achieving middle-class third-grade boys. I.Q., as measured by the Kuhlman-Finch Intelligence Test was equivalent between the groups. Achievement level was determined by the Iowa Test of Basic Abilities. The average grade achievement of the normal group was 4.2, while the average grade achievement level for the low achievers was 2.5. The experimental task required subjects to guess which of three boxes of different sizes contained a hidden marble on each trial. The marble was always hidden under the same size box. Person reinforcement consisted of praise following correct responses. Performance reinforcement consisted of feedback after correct responses (e.g., "That's correct"). Tangible reinforcement was a choice of candy and trinkets following correct responses.

Blair's results indicated that there was a significant achievement by reinforcement condition interaction. Verbal reinforcement led to a higher percentage of correct responses than tangible reinforcement for the normal readers, while the reverse was true for low achievers. When the performance of the children was compared under their most effective reinforcement condition, there were no differences in discrimination learning between the achievement groups.

In a replication and follow-up to an earlier study (Walters & Doan, 1962), Walters and Kosowski (1963) examined the effects of tangible reinforcement on the associational learning of sixth-, seventh-, and eighth-grade boys. Children were separated into advanced-, average-, or retarded-reading groups based on the discrepancy between their I.Q., as measured by the Dominion Group Test of Learning Capacity, and their reading achievement, as measured by the Gates Reading Survey. Children with uncorrected visual or hearing problems or severe emotional or behavioral problems, were eliminated from the study. The experimental tasks were matching (a) colored light flashes to compartment locations and (b) auditory tones to compartment locations. The second task was found to be more difficult than the first. On the auditory task, Walters and Kosowski found that,

> The provision of an additional incentive in the form of a reward (prizes) did not equally improve the performance of all subjects. Neither the performance of advanced nor average readers was significantly affected by reward (p. 81).

On the other hand, the performance of the disabled readers who were rewarded was significantly better than that of disabled readers who were not rewarded. In fact, disabled readers who were rewarded did as well as children in the other reading groups.

These experiments have demonstrated that disabled readers perform discrimination and associational learning tasks as well as normal readers under conditions of tangible but not verbal (praise or performance) reinforcement. Given this evidence, it is unfortunate that only one study investigating control strategies among reading-disabled children has examined the role of incentive (Hallahan, Tarver, Kauffman & Graybeal, 1978).

Hallahan et al. examined the influence of incentive on the performance of learning-disabled children on a modified version of Hagen's central/incidental task. The subjects were 48 children who resided in a school for the learning disabled. They ranged in age from 7 to 14 years. The children were divided into three incentive conditions:

positive reinforcement, response cost, and control. The mean age of each of the three groups was 12-1/2 years, the mean I.Q. was 94 (test unspecified) and they were, on the average, reading 2 years below grade level as measured by the reading comprehension part of the Gates MacGintie Reading Test.

The authors modified Hagen's task so that both the central and incidental tasks measured serial learning. Their modification also permits the task to be used more than once. In their adaption of the task, three pictures appeared on each of 11 cards--an animal, a household object, and a geometric form. The subjects were instructed to pay attention to the household and animal pictures only. For each of 15 trials, five cards were presented to the subjects. Each card was displayed for 2 seconds and then turned down to form a horizontal row. The child was then shown two consecutive probe cards, one from the household category and one from the animal category. The child had to match the probe cards to their targets.

In the reinforcement condition children were told that they would be paid 3 cents for each correct first category probed and 1 cent for each second category probed. The category that was identified as the high payoff category was counterbalanced among the subjects. In the response cost condition, the children were given 60 cents at the beginning of the session and lost 3 cents for each incorrect response to the first category probed and 1 cent for the second category probed. In the control condition, subjects received 2 cents for each correct response regardless of category.

The dependent variable was the difference between the number of correct first-probed responses and the number of correct second-probed responses. This difference was greater in the reinforcement group that in either the response cost or control groups which did not significantly differ from each other. The greater payoff for remembering first-probed stimuli produced its desired effect. The difference between first-probed responses and second-probed responses was greatest at the primacy and recency positions for the reinforcement group, but only at the recency positions for the other conditions. This result strongly indicates that the subjects in the reinforcement group utilized verbal rehearsal to help them remember the high payoff category. The authors feel that the response cost condition contained distracting elements (experimenter removing money) which interfered with the subjects' use of task appropriate strategies. In comparison to the body of research which shows that learning-disabled children tend not to use verbal rehearsal, this study suggests that it may take a higher degree of payoff for learning-disabled children to use this strategy appropriately.

Hallahan et al.'s research on the effects of incentive on encouraging the use of verbal mediation among the reading-disabled suggests that this may be a possible factor in overcoming production deficiencies. However, it should be noted that his subjects were selected from children residing in a residential learning disabilities facility and may represent children whose emotional and behavioral difficulties are more severe than the reading-disabled child from an average school. Walters and Kosowski (1963) suggest that there is some advantage, at least in preliminary investigations of reading disability, in confining attention to children receiving education through the regular school curriculum. They believe that placement in special classes may produce emotional reactions which could influence performance in selected perceptual and cognitive tasks.

In the present study, the incentive factor was examined with younger children selected from public school classes. An aim of the study was to determine whether incentive conditions would differentially affect the memory performance of readers of varying achievement levels.

Metamemory and Control Strategies

Torgesen (1977) has suggested that many children who have learned sufficiently in their early years to obtain an average I.Q. score may still be relatively immature with regard to the kind of cognitive awareness required to use efficient learning strategies. He related this phenomenon to a habit of overdependency on adults. He suggested that metacognitive immaturity may be related to poor reading achievement in the early grades. It is interesting to note that dependency is frequently cited as a factor related to reading disability in analytically oriented research (see Berman, 1975).

The term metamemory refers to an individual's verbalizable knowledge and awareness concerning aspects of information storage and retrieval. Flavell and Wellman (1977) have enumerated three aspects of metamemory: (a) personal variables--knowledge of one's capacities, (b) task variables--knowledge of the memory relevent aspects of a task, and (c) knowledge of potentially employable strategies. There has been no research attempting to demonstrate a relationship between young readers' awareness of control strategies and their spontaneous use of these strategies.

Research from outside the field of reading (Flavell, Beach & Chinsky, 1966; Salatas & Flavell, 1976; Drozdal & Flavell, 1975; Wellman, 1977) has not shown that metamemory for a strategy is a necessary prerequisite to utilization of that strategy. The research has been equivocal in demonstrating any relationship between metamemory judgments and memory behavior.

Flavell, Beach, and Chinsky found that more children in grades two and five were observed to use a verbal rehearsal strategy than could report use of this strategy. Their procedure for probing metamemory was simply to ask the child how he/she remembered the stimuli with which he/she had been presented. This method calls for fairly sophisticated verbalizations on the part of the subjects; some of the discrepancy between observed and reported strategy use may reflect this factor.

Salatas and Flavell used a technique to measure metamemory for the strategy of categorization which did not rely on the subjects' verbal ability. Their subjects were 60 first-grade children. They showed two stimuli sets to the subjects: one containing pictures from the same category, another containing random pictures. They asked the children to indicate which set would be easier for them to remember. Despite the nonverbal method of metamemory probing, Salatas and Flavell's results were discouraging. Metamemory knowledge did not relate to the use of the categorization strategy on the subsequent experimental task. The authors concluded that,

> There was no evidence that knowledge of the facilitative effect of categorization was a necessary condition for the use of this strategy. Whether a different form of metamemory questioning would give more positive results, remains for future work (p. 89).

Drozdal and Flavell (1975) were able to demonstrate a strong relationship between metamemory for a search strategy and search behavior for children aged 6-10. Their study was concerned with search behavior; how a child would go about hunting for a lost object. They presented the children with a story about a doll walking through a series of locations and at some point, losing a toy he was carrying. All subjects were able to remember when the doll noticed the toy was missing and the last location he had his toy. The rooms between these two points were defined as the critical search area. A child was designated as understanding the concept of a critical search area if, under questioning, he/she maintained that only those rooms in the critical search area were good ones to search. Metamemory questioning was designed to probe whether the child understood the concept of critical search area.

Of the subjects who understood the concept of critical search area, the following percentages of each age group of children first searched in that area are: age 6-63%, age 7-70%, age 8-63%, age 9-83%, age 10-79%. Of the children who did not understand the concept, the following percentages of children first searched the critical area are: age 6-9%, age 7-11%, age 8-0%, age 9-0%, age 10-0%. For this task, knowledge of a potentially employable stragegy was strongly related to use of that strategy.

Wellman (1977) conducted a study with children from grades kindergarten, one, and three. Although it was not concerned with a specific strategy, it did demonstrate a positive relationship between metamemory judgments and memory behavior. Pictures which were difficult to name were presented to the children. When a child could not name a picture, he/she was asked whether he/she felt he/she knew its name (i.e., if the child felt he/she would be able to recognize the name among a number of foils). These judgments were compared with the results of an actual recognition test which was subsequently administered. Wellman's scoring system ranged from 1.0 for perfect recognition accuracy to 0.0 for completely chance judgments. The scores for the children from kindergarten, grade one, and grade three were .27, .39, and .59, respectively. Thus, there was a greater than chance relationship between metamemory judgments and memory behavior even at the kindergarten level, and the strength of the relationship increased developmentally.

Wellman (1979) suggested that metamemory knowledge is influential but not necessary or sufficient to produce specific memory behaviors. He added that, "a host of mediating factors can intervene, such as motivation" (p. 6). The strongest relationship between a metamemory judgment and a subsequent memory behavior was reported by Drozdal and Flavell. It should be noted that the task of their study (searching for a lost toy) was probably more naturally motivating for its subjects than any of the other tasks described.

Flavell and Wellman (1977) suggested several other reasons for the discouraging lack of evidence that metamemory is related to memory behavior. They stated that knowledge of a strategy may not ensure that the child knows it is useful on a particular task; that the child may think it unnecessary as the task is too easy or not recognize its applicability to the experimental situation.

The present study examined the metamemory awareness of beginning readers for the strategies of selective visual attention and phonological recoding. The purpose of including the metamemory questions was two-fold: to determine whether awareness of a given strategy related to performance on a task which could be facilitated by that strategy, and to shed light on Torgesen's speculation that slow readers are metacognitively immature.

The study probed metamemory with several precautions. It assessed metamemory for the strategy on the target tasks to make sure the child was aware that the strategy applied to the experimental situation. It combined metamemory assessment with the manipulation of incentive in order to examine the interaction of these factors for children varying in reading achievement. It assessed the metamemory of only a portion of the subjects so that the possible influence of the probing procedure itself could be examined. The metamemory questions used in the study were designed to minimize the role of verbal fluency.

Summary of the Literature

The preceding review of research has made the following points:

1. Studies comparing normal and disabled readers on structural aspects of memory have generally failed to find group differences

2. Studies examining the use of verbal mediational strategies by normal and disabled readers have consistently found that normal readers use these strategies more often and more consistently

3. Studies examining the use of nonverbal control strategies by normal and disabled readers have been confounded with verbal mediational effects

4. There has been disagreement among reading researchers as to whether the lack of observed strategy employment by disabled readers reflected a specifically verbal

strategy deficiency or was the result of their general passive learning stance.

5. Tangible reinforcement has triggered the use of control strategies in older, learning-disabled children

6. Metamemory for task-appropriate strategies has been hypothesized to be a factor, by itself or in combination with high incentive, that will lead to improved recall

The review highlighted several gaps in the current knowledge about the use of control strategies among beginning readers. There have been no studies which directly compared young readers, varying in achievement, on a memory task which permitted only an active nonverbal strategy. There have been no studies of the use of control strategies among young readers which have manipulated incentive. There have been no studies which have compared young readers, varying in achievement, on their metamemory for potentially employable strategies. The current study attempted to fill these gaps in the research.

Rationale of the Study

The review of research presented strong evidence that children's beginning reading achievement is related to their spontaneous utilization of verbal control strategies, particularly their tendency to phonologically recode visual input. However, there was disagreement regarding the interpretation of this finding.

The Libermans interpreted the finding as the result of a specific deficiency in verbal encoding exhibited by less skilled readers. They hypothesized that memory tasks which did not involve phonological encoding would not differentiate skilled from less skilled readers. Torgesen suggested that the finding was a result of a general lack of strategy use among slowly progressing readers. He predicted that skilled and less skilled readers should differ on any memory task to which an active, cognitive strategy (verbal or nonverbal) could be applied.

The present study was designed to test the relative merits of these two positions, particularly within the ranges of reading ability found in the normal classroom. In order to do this, it measured the memory of young readers, varying in achievement, on tasks which differed in the type of strategy (minimal, nonverbal, verbal) that could be applied to them.

The study also examined two factors hypothesized to relate to the spontaneous use of control strategies by young readers. These factors were incentive and metamemory.

The study by Hallahan, Tarver et al. (1978) suggested that less skilled readers, in comparison to skilled readers, needed a higher degree of payoff to use control stragegies effectively. Following this lead, the author of the present study varied incentive conditions.

It was suggested (Wellman, 1977; Torgesen, 1977); Flavell & Wellman, 1977) that metamemory knowledge of task-appropriate strategies will lead to improved recall. The relationship is a logical one since such metacognitive information should serve as a guide for the learner in the task situation. Metamemory knowledge should serve to reduce the learners' dependency on a trial and error approach. In order to build on this research and try to demonstrate its relevance to reading, the author included metamemory probing in the current study.

Design of the Study

The primary independent variables of the study were reading achievement, incentive condition, and metamemory for the strategies of selective visual attention and phonological recoding. Reading achievement and metamemory for the two strategies were measured variables, while incentive was a manipulated variable.

Reading achievement was estimated from the Total Reading subscore of the Stanford Achievement Test. This test was administered to the subjects at the end of their second-grade year by school personnel.

Metamemory knowledge for the strategies of selective visual attention and phonological recoding were measured by the children's responses to a series of task-approach questions. These questions were administered to the children immediately after the sample trials of the corresponding tasks. In order to control for the influence of the probing procedure itself, 20% of the children from each incentive condition were not probed for metamemory.

There were two incentive conditions in the study. Low incentive consisted of only verbal feedback following correct responses. High incentive consisted of verbal feedback and token rewards for correct responses.

The dependent variables of the study were the number of correct responses to each of three probed memory tasks. The Minimal Strategy Task (MST) used only nonlabelable stimuli and allowed for little strategic application. The Non-Verbal Strategy Task (NVST) used nonlabelable stimuli paired with incidental distracting stimuli. This task could be facilitated by selective visual attention, focusing more of one's visual attention on stimuli identified as relevant than on the distracting stimuli. The Verbal Strategy Task (VST) utilized labelable stimuli paired with incidental distracting stimuli. This task could be facilitated by selective visual attention but to an even greater extent, by the phonological recoding of the central visual stimuli.

Hypotheses Regarding the Relationship Between Reading Achievement and Task Performance

The first theoretical hypothesis of the study is that skilled readers, in comparison to less skilled readers, use active, cognitive strategies on memory tasks to a greater degree. The following are the operational hypotheses derived from this theoretical hypothesis:

1. Reading achievement will be uncorrelated to recall on the Minimal Strategy Task (MST)

2. Reading achievement will be positively correlated to recall on the Non-Verbal Strategy Task (NVST)

3. Reading achievement will be positively correlated to recall on the Verbal Strategy Task (VST)

Hypotheses Regarding Incentive Interactions

The second theoretical hypothesis of the study is that less skilled readers, in comparison to skilled readers, need a higher degree of payoff to apply active, cognitive strategies to memory tasks. The following operational hypotheses were derived from this statement:

1. There will be no interaction between incentive and reading achievement on MST recall

2. The differenee in NVST recall between the skilled and less skilled readers will be greater under conditions of low incentive than under conditions of high incentive

3. The difference in VST recall between skilled and less skilled readers will be greater under conditions of low incentive than under conditions of high incentive

Hypotheses Regarding the Main Effect of Metamemory

The third theoretical hypothesis of the study is that metamemory of task-appropriate strategies is a facilitative influence on recall. The operational hypotheses relating to this theoretical statement are:

1. Subjects who demonstrate metamemory for selective visual attention (sva) will have greater NVST recall than subjects who do not

2. Subjects who demonstrate metamemory for phonological recoding (pr) will have greater VST recall than subjects who do not

Hypotheses Regarding
<u>Metamemory Interactions</u>

The fourth theoretical hypothesis of the study is that metamemory knowledge will be most facilitative when combined with adequate incentive. The following operational hypotheses were derived from this statement:

1. There will be a triple interaction in the way reading achievement, incentive, and metamemory (sva) relate to NVST recall such that:

   a. For skilled readers, metamemory (sva) will be equally beneficial under both incentive conditions,

   and

   b. For less skilled readers, metamemory (sva) will be more beneficial under conditions of high incentive than under conditions of low incentive

2. There will be a triple interaction in the way reading achievement, incentive, and metamemory (pr) relate to VST recall such that:

   a. For skilled readers, metamemory (pr) will be equally beneficial under both incentive conditions

   and

   b. For less skilled readers, metamemory (pr) will be more beneficial under conditions of high incentive than under conditions of low incentive

CHAPTER III

Method

Subjects

The sample of the study was composed of 101 students selected from six second-grade classes. The classes were drawn from two elementary schools in a predominantly middle-class, suburban school district. The subjects met the following screening requirements:

1. No uncorrected visual or hearing disorder or gross emotional or organic disorder as reported by the classroom teacher and/or school psychologist

2. No excessive absence (over 20%) during kindergarten, first, or second grade

3. Not retained in either kindergarten or first grade

4. I.Q. of 90 or above on the Otis-Lennon Test of Mental Abilities, or a judgment by the teacher and/or school psychologist that the child is of at least average intellectual ability

5. Parental permission available

The percentage of children who received parental permission to participate was 84.6. Among the children who did not receive permission or neglected to return the slips, there were readers of all ranges of ability.

The subjects were assigned to either the control or token-reinforcement incentive condition by a stratified sampling procedure based on their first-grade reading achievement. The stratification was accomplished in the following manner. A list of all the subjects was compiled in which the subjects' names appeared in descending order of reading achievement. Odd-numbered names were assigned to the control (low incentive) condition and even-numbered names were assigned to the tangible-reinforcement (high incentive) condition. This procedure was used to insure that the range of reading achievement of the children in each incentive condition was similar. In the final sample, there were 50 children in the low incentive condition and 51 in the high incentive condition. Ten of the low incentive subjects and 11 of the high incentive subjects were randomly selected to form the metamemory control groups and did not receive metamemory probing. The final sample consisted of four treatment groups: (1a) high incentive, metamemory probed (N=40), (1b) high incentive, no probing (N=11), (2a) low incentive, metamemory probed (N=40), and (2b) low incentive, no probing (N=10).

Experimenter

The experimenter was a female graduate student.

Pre-Experimental Testing

The Otis-Lennon Test of Mental Abilities had been administered to all second graders in the cooperating school district at the beginning of the school year. These scores were made available to the experimenter for screening purposes. While four children in the study did not have Otis-Lennon scores on their school records, these children were judged to be of at least average intelligence by their teachers and school psychologist.

In May of each school year, the Stanford Achievement Test was administered to all students in the district by school personnel. The results of these tests were made available to the author. Stratification of the sample was based on the scores obtained by the subjects at the end of first grade. The experiment was conducted in April 1980, toward the end of the subject's second-grade school year. The final statistical analyses used the reading achievement scores achieved by the subjects in May of that year. Specifically, the Total Reading subscore of the Stanford Achievement Test was the measure of a subject's reading achievement. Rankin reviewed the Stanford Achievement Test in Buros (1978). He cited impressive reliability coefficients for the test (in the high .80s and low .90s) and found it to have convincing content and construct validity.

Materials

Each of the three experimental tasks measured probed memory for a different set of stimuli. Each set consisted of 12 cardboard strips (24" x 5"), one strip for each trial. There were five white cards (3" x 4") glued to each strip with half-inch borders all around. The actual stimuli designs for each trial were drawn on these white cards.

Central stimuli were always drawn in blue ink. Incidental stimuli were always drawn in red ink.

The stimuli for the Minimal Strategy Task were abstractions of five Hebrew letters: gimmel, lahmedh, mem, phe, and sin. On each strip the five stimuli appeared in a different order.

The materials for the Non-Verbal Strategy Task were similar to those used on the Minimal Strategy Task. However, on each array strip, the five Hebrew letters appeared paired with different distracting, incidental stimuli. The incidental stimuli were 12 geometric designs. On each strip, three cards were drawn with the central (Hebrew) stimuli on the left half of the card and the incidental (geometric) stimuli on the right half of the card. For the other two cards in the strip, the order was reversed.

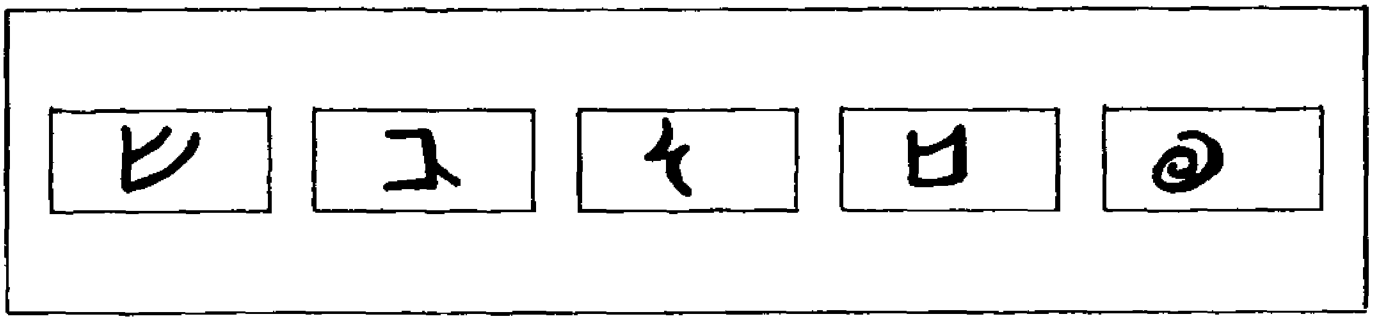
The stimuli for the Verbal Strategy Task were identical to the Non-Verbal Strategy Task materials with one important exception. The Arabic numerals 1, 2, 3, 4, and 5 replaced the Hebrew letters as the central stimuli. Figure 1 diagrams a sample trial for each of the three experimental tasks.

The order of the arrays was randomly determined with the exception that the following conditions were met:

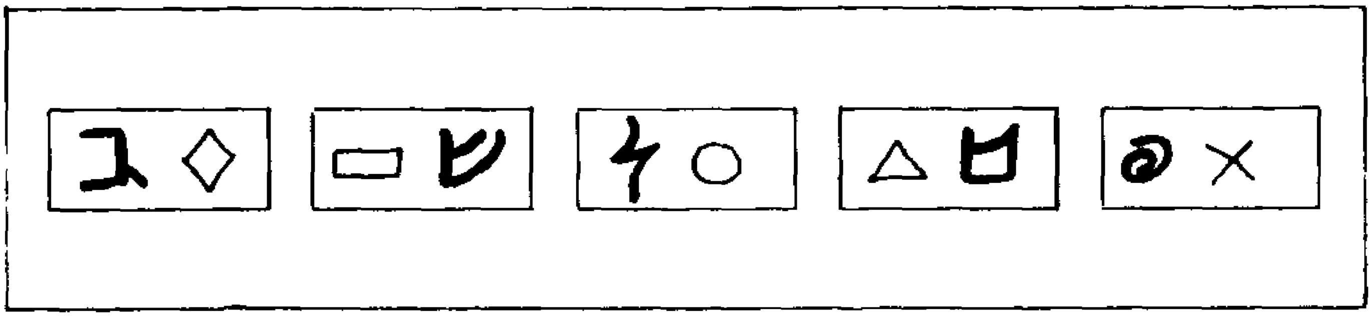
1. Each serial position be probed at least twice per task

2. Each central stimulus be probed for at least twice a task

(a) Minimal Strategy Task



(b) Non-Verbal Strategy Task



(c) Verbal Strategy Task

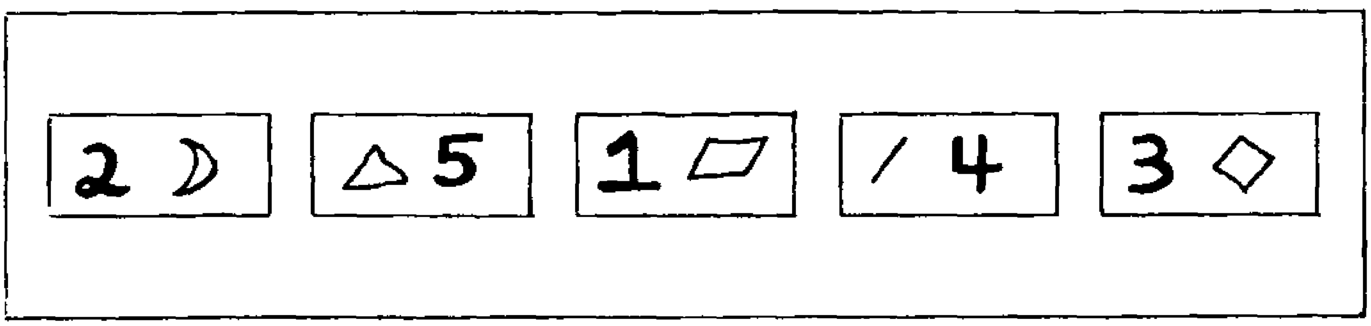


Figure 1. Examples of Array Strips for the Three Memory Tasks (Heavy lines denote blue central stimuli, light lines denote red incidental stimuli.)

3. No central stimulus appear at a given serial position more than three times in a given task

4. No central stimulus be paired with a given incidental stimulus more than one time.

Appendix A contains a complete description of the three sets of stimuli with the correct responses for each trial underlined.

Two sets of probe cards were also constructed. A set of five white (3" x 4") cards, each containing one of the Hebrew letters, served as the probe cards for the Minimal Strategy and Non-Verbal Strategy Tasks. Another set of cards, each containing one of the Arabic numerals 1-5, served as the probe cards for the Verbal Strategy Task.

Apparatus

A covering board (25" x 5") was constructed from hard cardboard covered with wood-grained contact paper. Five holes were cut out to correspond to the locations of the five stimuli on the array strips. These holes were replaced with highly salient, white cardboard doors. The covering board was constructed so that the stimuli could be simultaneously presented when it was flipped open and simultaneously covered when it was flipped down. For each task, the 12 array strips were placed in their experimental order under the covering board.

Procedure

The subjects were individually administered the three experimental tasks and the metamemory probing (where applicable). The testing took, on the average, 20 minutes. The testing was conducted within the child's school in a private room. The subject was seated at a comfortable chair next to a low desk on which the stimuli were presented.

The order in which the three experimental tasks were administered was counterbalanced among the subjects in the following way. Two lists were constructed, each containing the names of the students in an incentive condition appearing in ascending order of reading achievement. There were six possible orders of presentation. The numerals 1-6 were respectively assigned to the first six students on each list, and the process was repeated for each successive group of six students.

The general procedure for each of the three tasks was identical. There were two sample trials and ten experimental trials of each probed memory task. On each trial, an array strip was exposed to the subject for 5 seconds by flipping up the covering board. Following presentation, the covering board was flipped down. The experimenter then showed the subject a probe card and asked him/her to open the door of the covering board that would reveal the probed picture. If the response was correct, the experimenter said, "That's right." If the response was incorrect, the experimenter opened the correct door of the covering board, revealed the matching stimulus and said, "Here it is." When a trial was completed, the array strip for that trial was placed at the bottom of the pack. Prior to the start of each task a set of instructions was read to the child as shown in Appendix B. The instructions stressed that the child would only be asked to find the central (blue) stimuli. Each subsequent presentation was introduced with the words, "Study these cards" and each time a probe was presented, the experimenter said, "Open the door that covers this picture."

The subject's score on each task was the number of correct responses he/she achieved on the 10 experimental trials.

The following additional procedures pertain only to subjects in the high incentive treatment groups. Instructions related to the high incentive condition were inserted in the general instructions and also after the fifth trial of each task as shown in Appendix B. These instructions informed the children that they would receive a poker chip for each correct response and that after the experiment, they could trade the chips in for prizes (the more chips, the better the prize).

In addition to the experimenter saying, "That's right" after correct responses, she also gave the subject a poker chip. The chips were kept in a cardboard box placed near the subject, but out of the way of the array cards. After all the tasks were completed, the experimenter counted the subject's chips. She then asked the child which prize he/she preferred. After the child's response, the experimenter would conclude that the child had enough chips to trade in for that prize. The author considered this procedure adequate to maintain high incentive and did not believe it was necessary to assign actual values to the different prizes.

Prizes consisted of candy and other items worth up to $1.00. Examples of prizes were packages of candy, grab-bag toys, and stationery and art supplies. The subjects in the low incentive condition were also allowed to select a prize after they completed the experiment. In each school, subjects in the low incentive condition were run before subjects in the high incentive condition to minimize intrasubject contamination effects.

The following procedures were added for subjects in the metamemory-probed treatment groups. Instructions related to the probe procedure were read to the subjects after sample trial 1 of the Non-Verbal and Verbal Strategy Tasks. These instructions informed the children that they were going to be asked some questions about the way they studied the cards that had two parts ("a blue picture and a red picture"). As the stimuli for the second sample trial were exposed, the children were asked these questions:

1. Will you look at both parts of the cards for the same amount of time, or will you look at one part of the cards longer than the other part?

2. (If one part longer) Which part will you look at longer? Why?

3. When you study the cards, will you say anything to yourself or out loud?

4. (If yes) What will you say?

To be scored as having demonstrated metamemory for selective visual attention, the child had to respond in a specific manner to the probes given during the Non-Verbal Strategy Task. The child had to answer question 1, "One part longer," and indicate on question 2 that he/she would spend more time looking at the blue pictures.[1] To be scored as having demonstrated metamemory for phonological recoding, the child had to respond in the following manner to the probes given during the Verbal Strategy Task. The child had to respond to question 3, "Yes," and respond to question 4 with appropriate labels for the central stimuli.

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[1] If a child, while being probed on the NVST, answered question 3 affirmatively and responded to question 4 with more than two appropriate labels for the stimuli, he/she was dropped from the study. Two children met this requirement. They both responded with ideographic but adequate labels for the Hebrew letters. These labels only appeared to help one of the two children.

CHAPTER IV

Results

The presentation of the results is divided into several sections. The first section reports some descriptive data. The second section outlines the models for the main data analyses. The next four sections report the results of the study as they relate to (1) the relationship between reading achievement and task performance, (2) incentive interactions, (3) the relationship between metamemory and task performance, and (4) metamemory interactions. The next two sections present the findings of several supplementary data analyses. The final section summarizes the results.

Descriptive Data

The sample was composed of 101 second-grade students from a middle-class, suburban school district. Ninety-nine percent (N=100) were Caucasian. Eighty subjects were probed for metamemory and made up the experimental group. Twenty-one subjects were not probed for metamemory and made up the metamemory control group.

Males made up 54.5% of the entire sample, while females made up 46.5%. The median reading achievement of the experimental subjects was 3.9, which was approximately 1 year higher than that of the population of second graders in general, but was not unusually high for a population of suburban children. Reading achievement ranged from 1.5 to 7.0 or from one and a half years below grade level to four years above. Teachers reported to the experimenter that although the test scores might give an inflated impression of student reading ability, their students were typical of second graders in the community. The mean I.Q. of the sample was approximately 111. This mean was somewhat higher than that of the population at large but was not unusually high for a middle-class, suburban school district. Among the probed subjects, 75% were able to demonstrate metamemory for selective visual attention, while only 46.25% were able to demonstrate metamemory for phonetic recoding.

Table 1 presents the means and standard deviations of the subjects in each incentive condition for the reading achievement, I.Q., and task performance variables. The data from the probed and nonprobed subjects are listed separately. Table 2 presents the percentage of probed subjects in each incentive condition who demonstrated metamemory for selective visual attention and metamemory for phonetic recoding.

There were significant differences in the difficulty of the three experimental tasks. Mean Minimal Strategy Task (MST) recall was 4.14, mean Non-Verbal Strategy Task (NVST) recall was 3.66, and mean Verbal Strategy Task (VST) recall was 6.39.

Table 1

Means and Standard Deviations of Selected Variables by

Incentive Conditions for Probed and Nonprobed Subjects

Variables Group[a]	Combined Incentive Mean	Combined Incentive S.D.	Low Incentive Mean	Low Incentive S.D.	High Incentive Mean	High Incentive S.D.
Read. Ach.[b]						
Total Sample	4.04	1.24	4.01	1.37	4.06	1.16
Probed	4.10	1.27	4.05	1.34	4.14	1.21
Nonprobed	3.80	1.14	3.84	1.34	3.77	0.97
MST Recall[c]						
Total Sample	4.15	1.50	4.02	1.44	4.27	1.56
Probed	4.06	1.57	3.95	1.55	4.18	1.60
Nonprobed	4.48	1.17	4.30	0.82	4.64	1.43
NVST Recall[c]						
Total Sample	3.65	1.60	3.54	1.45	3.76	1.74
Probed	3.56	1.64	3.55	1.52	3.58	1.77
Nonprobed	4.00	1.41	3.50	1.18	4.45	1.51
VST Recall[c]						
Total Sample	6.38	2.45	6.12	2.45	6.63	2.44
Probed	6.34	2.42	6.13	2.40	6.55	2.45
Nonprobed	6.52	2.60	6.10	2.77	6.91	2.51
I.Q.[d]						
Total Sample	111.17	11.43	111.54	11.42	110.82	11.53
Probed	110.83	11.32	110.46	11.58	111.18	11.21
Nonprobed	112.45	12.05	116.00	10.15	109.55	13.14

Note. [a]N's are as follows:

	Combined Incentive	Low Incentive	High Incentive
Total Sample	101	50	51
Probed Subjects	80	40	40
Nonprobed Subjects	21	10	11

[b]Total Reading Achievement--Grade Equivalent, Stanford Achievement Test, administered at the end of grade two.

[c]Raw Scores--Number of correct reponses.

[d]Otis-Lennon Test of Mental Abilities--Scores not available for four subjects.

Table 2

Percentage of Probed Subjects' Demonstrating

Metamemory by Incentive Condition

Metamemory Type	Low Incentive (N=40)	High Incentive (N=40)	All Subjects (N=80)
Selective Visual Attention	75.00%	75.00%	75.00%
Phonetic Recoding	42.50%	50.00%	46.25%

The results of *t* tests reveal that VST recall was significantly higher than MST recall ($t=8.66$, $p<.001$), which in turn was significantly higher than mean NVST recall ($t=2.23$, $p<.05$).

Analyses of variance were performed to check whether performance on any of the three experimental tasks was related to task order. None of these analyses reached significance at the .05 level (highest $F=1.34$, $p=.25$).

Data Analysis Procedure

Except where indicated, the data were analyzed with a series of univariate regression analyses. The models are outlined on the following page.

$$Y_1 = INC + R.A. + R.A. \times INC + e.$$

$$Y_2 = MM_1 + INC + MM_1 \times INC + R.A. + R.A. \times INC + R.A. \times MM_1 + R.A. \times INC \times MM_1 + e.$$

$$Y_3 = MM_2 + INC + MM_2 \times INC + R.A. + R.A. \times INC + R.A. \times MM_2 + R.A. \times INC \times MM_2 + e.$$

Key: INC = incentive condition, R.A. = total reading achievement score on the S.A.T., MM_1 = metamemory for selective visual attention, MM_2 = metamemory for phonetic recoding, Y_1 = raw score on MST, Y_2 = raw score on NVST, Y_3 = raw score on VST, e = error.

Task performance and reading achievement were continuous variables. Incentive and metamemory were categorical and were treated as dummy variables. A system of 1,-1 coding was employed for these terms. For each regression equation, the amount of unique variance in the dependent variable explained by each term was calculated and tested for significance. As reading achievement, metamemory and incentive were substantially uncorrelated, order effects were not considered to be a source of difficulty. Since metamemory was a term in two of the equations, data from the nonprobed subjects could not be used in these analyses.

Reading Achievement and Task Performance

Three hypotheses dealt with the direct relationship between reading achievement and task performance. It was hypothesized that (1) reading achievement would not be significantly correlated to performance on the Minimal Strategy Task, (2) reading achievement would be positively and significantly correlated to performance on the Non-Verbal Strategy Task, and (3) reading achievement would be positively and significantly correlated to performance on the Verbal Strategy Task. The results of the regression analyses confirm the first hypothesis but reject the second and third hypotheses. The amount of unique variance in MST, NVST, and VST recall, respectively, explained by the reading achievement term, was 1.8%, 3.4%, and 4.8%. None of these percentages are statistically significant at the .05 level.

However, when one examines the results by incentive condition, the picture changes dramatically. The product-moment correlations between reading achievement and MST, NVST, and VST recall, respectively, for subjects in the low incentive condition, are .16 ($p > .05$), -.10 ($p > .05$), and .03 ($p > .05$). On the other hand, the correlations between reading achievement and MST, NVST, and VST recall, respectively, are .10 ($p > .05$), .46 ($p < .001$), and .42 ($p < .01$). Thus, while only the first hypothesis was confirmed in the overall analysis, all three hypotheses would have been confirmed for the subjects in the high incentive condition. It is obvious that an analysis of the relationship between reading achievement and task performance must take incentive condition into account. The next section will examine these interactions in more detail.

Incentive Interactions

Three hypotheses dealt with the interaction between incentive condition and reading achievement in the way they related to task performance. It was hypothesized that (1) there would be no interaction between incentive and reading achievement on recall of the Minimal Strategy Task, (2) the difference between skilled and less skilled readers in NVST recall would be greater in the low incentive condition than the high incentive condition, and (3) the difference between skilled and less skilled readers in VST recall would be greater in the low incentive condition than in the high incentive condition. Only the first hypothesis was confirmed by the results of the regression analyses. The R.A. X INC term did not explain a significant amount of variance in MST recall (0.0%). As can be seen in Figure 2, the slopes of the reading achievement groups are nearly identical for the two incentive conditions.

Despite a significant R.A. X INC interaction on NVST recall which explained 9.7% of the variance (F=7.92, $p < .01$), the second hypothesis was rejected. Low incentive was not related to a greater divergence in NVST recall between skilled and less skilled readers. In fact, a Tukey post-hoc test revealed that the two groups did not significantly differ in NVST recall under conditions of low incentive (t=1.13 $p > .05$). Instead, it was under the high incentive conditions that the two groups significantly diverged. A Tukey post-hoc test showed that the skilled readers outperformed the less skilled readers under conditions of high

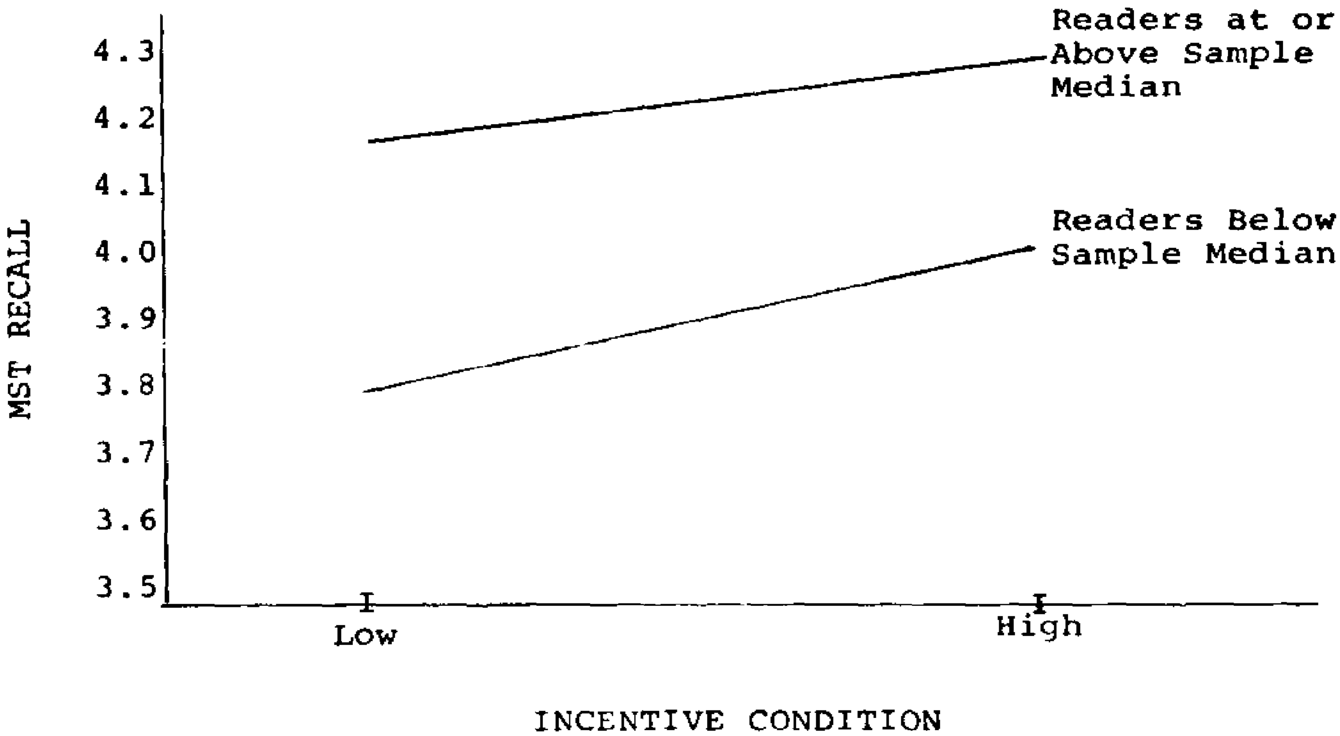

Figure 2. Lack of interaction between incentive condition and and reading achievement level on MST recall.

incentive ($\underline{t}$=-2.78, $\underline{p}$ <.01). As can be seen in Figure 3, increasing incentive was beneficial for the skilled readers, but deleterious for the less skilled readers.

The same pattern of results occurred in the analysis of recall on the Verbal Strategy Task. The amount of unique variance in VST recall contributed by the R.A. X INC term was 5.5% ($\underline{F}$=4.76 $\underline{p}$ <.05), significant at the .05 level; however, the third hypothesis was rejected. Figure 4 clearly shows that low incentive was not related to a greater divergence in VST recall between skilled and less skilled readers. A Tukey post-hoc test revealed that the two reading groups only differed in VST recall under conditions of high incentive

($\underline{t}$=3.59 $\underline{p}$ < .001). Again, increased incentive was beneficial for the skilled readers but deleterious for the less skilled readers.

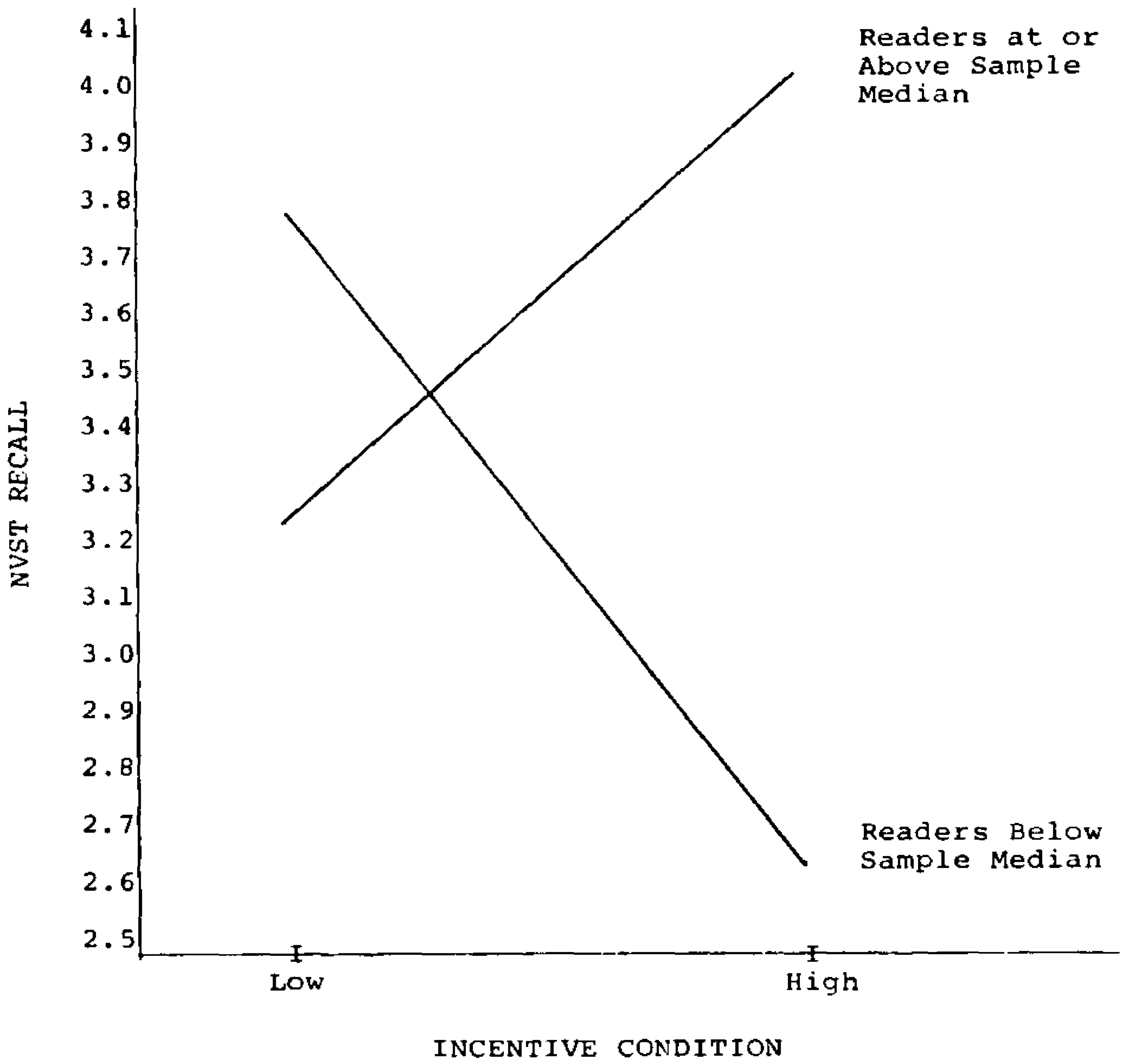

Figure 3. Interaction between incentive condition and reading achievement level on NVST Recall.

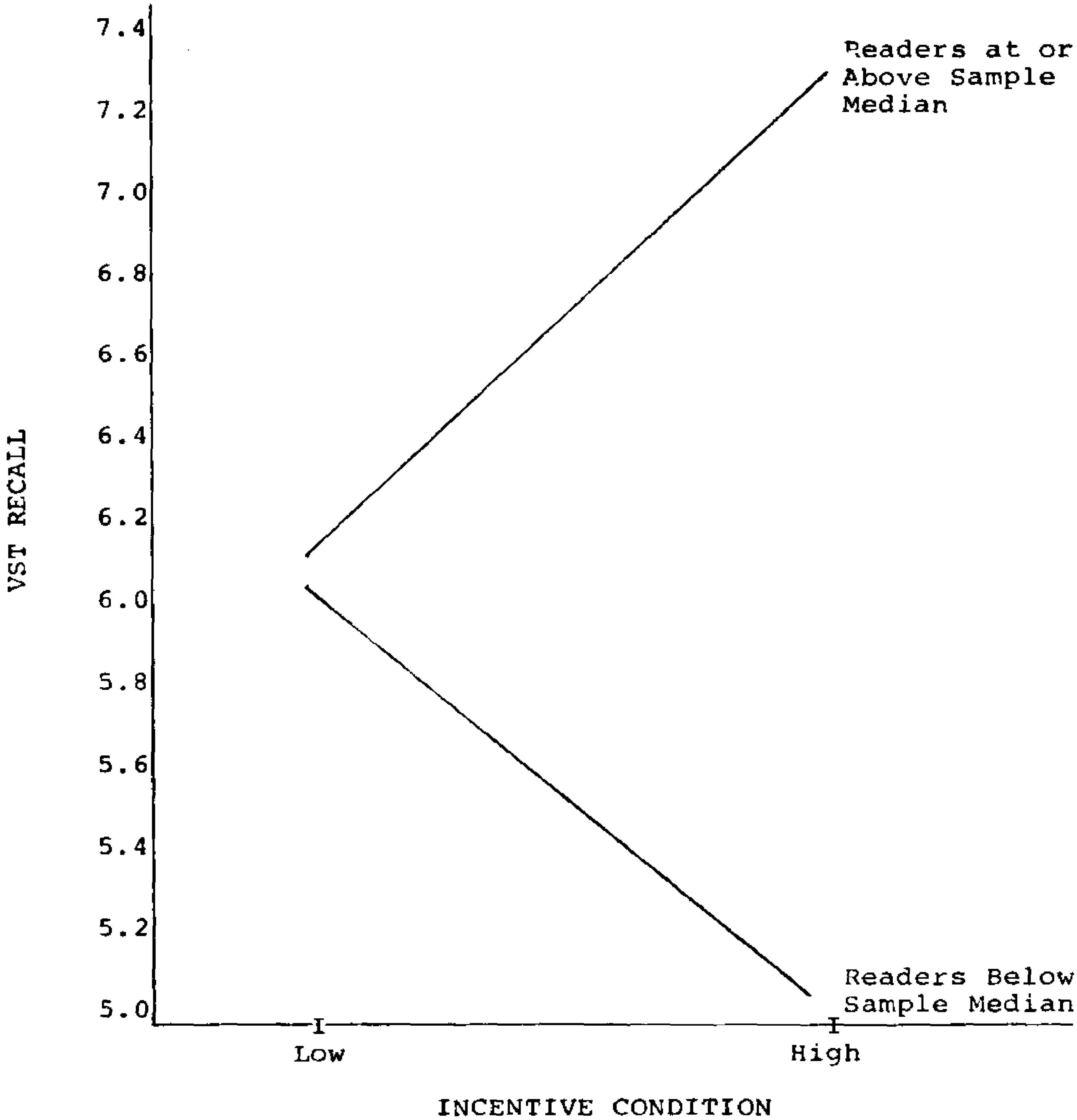

Figure 4. Interaction between incentive condition and reading achievement level on VST Recall.

Metamemory and Task Performance

Two hypotheses dealt with the direct relationship between metamemory and task performance. The first stated that subjects who demonstrated metamemory for selective visual attention (sva) would have greater recall on the Non-Verbal Strategy Task than subjects who did not. This hypothesis was rejected. The amount of unique variance in NVST recall explained by the MM_1 variable was 0.6% (F=0.42, p >.05). The respective means in NVST recall for subjects who demonstrated metamemory (sva) and those who did not, were 3.65 and 3.35.

The second hypothesis stated that subjects who demonstrated metamemory for phonetic recoding (pr) would have higher recall on the Verbal Strategy Task than subjects who did not. This hypothesis was confirmed. The amount of unique variance in VST recall explained by the MM_2 term was 9.0% (F=7.47, p <.01). The respective means in VST recall for subjects who demonstrated metamemory (pr) and subjects who did not, were 7.02 and 5.74.

Metamemory Interactions

Two hypotheses dealt with the expected triple interaction among the variables of reading achievement, incentive, and metamemory in the way they related to performance on the two strategy tasks. The first dealt with recall on the Non-Verbal Strategy Task. It was expected that for less skilled readers, metamemory (sva) knowledge would be more beneficial under conditions of high incentive than under conditions of low incentive; while for skilled readers, metamemory (sva) would be helpful under both incentive conditions. This hypothesis was not confirmed. The amount of unique variance in

NVST recall explained by the triple interaction term was 0.6% (F=0.49, $p>.05$). Although the interaction was not significant, the trend of the results was for metamemory (sva) knowledge to be positively correlated to NVST recall for all groups except the less skilled readers working under the high incentive condition.

The second hypothesis dealt with recall on the Verbal Strategy Task. It predicted that for less skilled readers, metamemory (pr) knowledge would be more beneficial under conditions of high incentive than under conditions of low incentive; while for skilled readers, metamemory (pr) would be helpful under both incentive conditions. This hypothesis was also not confirmed. The amount of unique variance in VST recall explained by the triple interaction term was 0.1% (F=0.16, $p>.05$). Metamemory (pr) was positively correlated to VST recall for both skilled and less skilled readers under both incentive conditions.

Tables 3, 4, and 5 contain a complete description of the results of the univariate regression analyses of MST, NVST, and VST recall.

Supplementary Data Analyses Related to Metamemory

It was expected that there would be no difference in probed memory on any of the three tasks between the 80 subjects who were probed for metamemory and the 21 nonprobed controls. This prediction was tested with a t test for samples with uneven n's. The t values for MST, NVST, and VST recall, respectively, were 1.16 ($p>.05$), 1.09 ($p>.05$),

Table 3

Results of Univariate Regression Analysis of the Effects of Incentive and Reading Achievement on MST Recall

Source	df	% Unique Variance	F
Incentive	1, 76	0.5%	0.36
Reading Achievement	1, 76	1.8%	1.44
Reading Achievement X Incentive	1, 76	0.0%	0.03

and .39 ($p > .05$). The probabilities listed were for a two-tailed test. Since none of the t values reached significance level, the prediction was supported. If anything, the trend was for nonprobed subjects to do slightly better on the three tasks.

It was found that metamemory for selective visual attention and metamemory for phonetic recoding did not correlate significantly. The product-moment correlation between the terms was 0.07 ($p > .05$). It was found that the type of incentive instructions the subjects received prior to the metamemory probing did not relate to their subsequent metamemory knowledge. A 2 X 2 chi square test was used to analyze whether there was any evidence of dependency between incentive condition and metamemory (sva). The results showed no dependency ($\chi^2=0.0$, $p=1.00$). Another 2 X 2 chi square test analyzed whether there was any dependency between

Table 4

Results of Univariate Regression Analysis of the Effects of Metamemory (SVA), Incentive, and Reading Achievement on NVST Recall

Source	df	% Unique Variance	*F*
Metamemory (sva)	1, 72	0.6%	0.42
Incentive	1, 72	0.0%	0.01
Metamemory (sva) X Incentive	1, 72	0.0%	0.01
Reading Achievement	1, 72	3.1%	2.31
Reading Achievement X Incentive	1, 72	9.7%	7.92**
Reaching Achievement X Metamemory (sva)	1, 72	0.0%	0.02
Reading Achievement X Incentive X Metamemory (sva)	1, 72	0.6%	0.49

Note. **Significant at the .01 level

incentive condition and metamemory (pr). The results again showed no dependency (χ^2=0.20, p=.65).

Finally, reading achievement did not correlate significantly with either of the metamemory variables. The correlation between reading achievement and metamemory (sva) was 0.08 ($p > .05$), and the correlation between reading achievement and metamemory (pr) was 0.06 ($p > .05$).

Table 5

Results of Univariate Regression Analysis of the Effects of Metamemory (PR), Incentive, and Reading Achievement on VST Recall

Source	df	% Unique Variance	*F*
Metamemory (pr)	1, 73	9.1%	7.47**
Incentive	1, 73	0.0%	0.13
Metamemory (pr) X Incentive	1, 73	0.0%	0.15
Reading Achievement	1, 73	3.5%	2.89
Reading Achievement X Incentive	1, 73	5.5%	4.76*
Reading Achievement X Incentive X Metamemory (pr)	1, 73	0.0%	0.16

Note: The *F* value for the Reading Achievement X Metamemory term was less than 0.01 and therefore the term was eliminated from the regression equation by default operation of the SPSS regression program.

* Significant at the .05 level.

** Significant at the .01 level.

Other Supplementary Data Analyses

I.Q.: Supplementary regression analyses were conducted which included the subjects' I.Q. scores on the Otis-Lennon Test of Mental Abilities as the first term in each model. I.Q. did not contribute a significant amount of variance to performance on any of the three tasks. The amount of unique variance in MST, NVST, and VST recall explained by the I.Q. term was 0.9%, 3.8%, and 0.4%, respectively. Partialling out variance related to I.Q. by the addition of the I.Q. term in the first position of each regression analysis only changed the substantive nature of the results in one way. The amount of variance in VST recall attributable to reading achievement, which had nearly achieved significance in the original model, now became significant (F=7.38, p <.01) and accounted for 8.7% of the variance. Thus, reading achievement was positively correlated to VST recall when I.Q. was controlled.

I.Q. did not correlate significantly with either type of metamemory--selective visual attention (r=0.01, p >.05) or phonological recoding (r=-0.08, p >.05). As expected, I.Q. correlated significantly with reading ability (r=0.53, p< .001).

Sex: Three expanded statistical models were created to test for the presence of sex-related effects on MST, NVST, and VST recall. Additional dummy variables were created to represent the following effects: sex, sex x incentive, sex x metamemory (pr), sex x metamemory (sva), sex x reading achievement, and all the corresponding triple and four-way interactions. These supplementary regression analyses revealed no sex effects on any of the three experimental tasks.

Improvement: A comparison was made between subject's performance on the first three items of each task and their performance on the last three items of each task. *T* tests revealed no significant improvement on any of the three experimental tasks. The *t* values for MST, NVST, and VST recall were -0.42 ($p > .05$), 0.89 ($p > .05$), and -1.29 ($p > .05$), respectively.

Summary of Results

As expected, reading achievement did not significantly correlate to recall on the Minimal Strategy Task. Reading achievement was significantly and positively correlated to recall on the two strategy tasks, but only for subjects in the high incentive condition.

As predicted, incentive did not interact with reading achievement to influence MST recall. On the two strategy tasks, the interaction of reading achievement and incentive on recall was in the direction opposite to prediction. Increased incentive was beneficial for the skilled readers but deleterious for the less skilled readers.

Metamemory for phonological recoding was positively related to recall on the Verbal Strategy Task, as expected. However, metamemory for selective visual attention did not relate to overall recall on the Non-Verbal Strategy Task.

There was no significant triple interactive effect among reading achievement, incentive, and task-related metamemory on either NVST or VST recall. However, there was a trend for metamemory (sva) to be positively correlated to NVST recall for all groups except the less skilled readers working under high incentive conditions.

Metamemory-probed subjects did not differ from metamemory controls in MST, NVST, or VST recall. Neither reading achievement nor I.Q. was significantly correlated to either of the metamemory variables.

I.Q. did not significantly correlate to MST, NVST, or VST recall, but when I.Q. was partialled out, reading achievement was significantly and positively correlated to VST recall. There were no sex-related effects on task performance.

CHAPTER V

Discussion

Use of Verbal Control Strategies

Prior research (Groenendaal & Bakker, 1971; Swanson, 1978; Torgesen & Goldman, 1977; Liberman et al., 1977) which examined the memory skills of normal and disabled readers, equated in I.Q., found that the disabled readers performed less adequately on tasks to which verbal control strategies could be applied. The present study extended this research using readers from within the range of achievement typical of the suburban classroom. In this extension of the research, regression techniques were used which permitted the analysis of continuous data. This technique was an improvement on prior research which only compared the performance of extreme groups. It was found that under conditions of high incentive or when I.Q. was controlled, the suburban children's reading achievement was positively correlated to their recall on a task to which phonetic recoding was applicable. This result suggests that a relative failure to use verbal control strategies is not a problem unique to severely disabled readers. Instead, it implies that use of verbal control strategies covaries with reading achievement, particularly for children working for rewards.

The study also presented evidence supporting Vellutino's contention that when strategy use is minimized, there will be no difference in memory among readers varying in achievement. In the present study, there were no differences in recall on the Minimal Strategy Task which were related to reading achievement.

Libermans' vs.
Torgesen's Position

A major interest of the study was to assess the relative merits of the Libermans' and Torgesen's position on the mnemonic ability of young readers. The Libermans' position suggested that reading achievement would only correlate to performance on memory tasks which involved labelable stimuli, due to a specifically verbal encoding deficiency on the part of the low achievers. Torgesen, on the other hand, suggested that reading achievement should correlate to any strategic memory task, due to a general lack of strategy use (visual or verbal) among low achievers. The Non-Verbal Strategy Task tested visual memory utilizing nonlabelable stimuli while allowing for an effective, nonverbal, strategic behavior (selective visual attention). Since, at least for subjects in the high incentive condition, there was a significant positive relationship between reading achievement and NVST recall, the Liberman position was not supported. The results of the study offered the Torgesen position partial support, since less skilled readers in the high incentive condition did show a generally poorer performance on both the strategic tasks. While the information provided by this study more nearly supported the Torgesen position, it also implies the need for Torgesen to take motivational conditions into account.

Role of Incentive

Building on the research of Hallahan, Tarver et al. (1978), this study sought to show that increasing incentive would improve the performance of less skilled readers on strategic tasks. Instead, it was found that increasing incentive interfered with the performance of less skilled readers on strategic tasks. Specifically, the following conclusions can be drawn with regard to incentive: (a) incentive had no overall main effect on task performance, (b) incentive condition had no interactive effect on the task which minimized strategy use, (c) increasing incentive through the use of a token reward system, increased skilled readers' performance on tasks which allowed for either a visual or a verbal strategy, and (d) increasing incentive through the use of a token reward system, decreased the performance of less skilled readers on tasks which allowed for either a visual or a verbal strategy.

These findings do not support the hypothesis that lack of strategic behavior on the part of less skilled readers is related to lack of incentive. Rather, it suggests another motivational variable related to strategic mnemonic behavior. The nature of this motivational factor seems more closely related to the research on anxiety.

A possible explanation for these unexpected findings is suggested by the research on anxiety. There is evidence that anxiety is related to academic achievement. Reviewing the literature, Gaudry and Spielberger (1971) concluded that high anxiety was associated with low academic achievement at all levels of academic experience. Lunneborg (1974) found that high anxiety was associated with poor reading achievement in elementary school children. Further, the effects of anxiety have been found to be most debilitative on tasks taxing selection of relevent cues (West et al., 1966; Sarason, 1975). Both the Non-Verbal and Verbal Strategy Tasks in the present study contained incidental stimuli which made the selection of relevant cues more difficult. Wine (1971) suggested that the self-preoccupations of the anxious student may compete with appropriate problem-solving behavior.

The effects of anxiety have been found to interact with task instructions. Reviewing the work on anxiety and instructional set, Sarason (1972) concluded that evaluative or achievement-oriented environments seemed to have a negative effect on the performance of high-anxious students but a positive effect on the performance of low-anxious students. In the present study, the high-incentive instructions stipulated that, "the more chips you get, the better will be your prize." These instructions can be considered achievement oriented.

Extrapolating from the literature on anxiety, one might expect less skilled readers to be more anxious than skilled readers. The lower achievers might therefore be expected to perform less well than skilled readers on tasks which tax selective attention, particularly after receiving achievement-oriented instructions. These deductions, while highly speculative, may explain the results of the present study.

The results of the current study differed somewhat from those of Hallahan, Tarver et al. It should be noted that the present study used token reward as its high incentive condition, while Hallahan, Tarver et al. used immediate, tangible reinforcement. In that study, a response cost condition was also included and found to be ineffective in increasing strategic behavior. The response cost condition was hypothesized to have "distracting elements (experimenter removing money)." It is possible that the response cost condition in the Hallahan study and the token reward condition in the current study, both raised anxiety more than the immediate, tangible reward condition.

Role of Metamemory

The hypothesis that metamemory knowledge relates to mnemonic behavior received partial support from this study. Metamemory knowledge of the phonetic recoding strategy had a strong main effect on Verbal Strategy Task recall. Metamemory for selective visual attention was not significantly related to NVST recall, but there was a trend for metamemory (sva) to be helpful for the skilled readers in both incentive conditions and the less skilled readers in the low incentive condition. The less skilled readers in the high incentive condition showed no improvement in NVST recall related to metamemory (sva). The performance of these subjects who have been suggested to be the most anxious, may have been partially responsible for the lack of an overall significant correlation between metamemory (sva) and NVST recall. Another speculation regarding this disappointing finding relates to the type of probing procedure used in this study. The method that was employed minimized the role of verbal fluency but still required subjects to make a verbal response. It is possible that knowledge of a nonverbal strategy might be measured in a more valid manner if the procedure permitted either a verbal or nonverbal demonstration of such awareness.

In any case, the speculation that less skilled readers may lack metamemory knowledge when compared to skilled readers received no support. Metamemory knowledge was equally distributed between the groups. Among the less skilled readers, 45.9% demonstrated metamemory for phonetic recoding, while 72.9% demonstrated metamemory for selective visual attention. Among the skilled readers, the percentages were similar; 46.5% demonstrated metamemory (pr), while 76.7% demonstrated metamemory (sva). Lack of metamemory, thus, does not seem to be a fruitful hypothesis for explaining differences in the utilization of strategic behavior among young readers who vary in achievement.

The data do not support the hypothesis that reading achievement, incentive, and metamemory have a triple interactive effect on recall.

The metamemory probing procedure did not influence task performance. The probed and nonprobed subjects did not significantly differ in memory performance on any of the three tasks. Therefore, the procedure seems to be one which can be continued in future research without fear that it will confound the results.

Suggestions for Future Research

The results of the present study suggested that under achievement-oriented conditions, children's use of active, cognitive strategies will covary with their reading achievement. Further investigation is merited to determine whether strategy use and reading achievement are causally related. Training studies are needed where children are taught stragegic mnemonic behaviors (visual and verbal) so that their performance on subsequent early reading tasks or reading-like tasks can be compared to that of children who did not receive such instruction.

In the current study, metamemory for a verbal strategy appeared to be a facilitative variable with regard to verbal mnemonic behavior. In order to ascertain whether a cause-and-effect relationship exists, this area will also need experimental investigation. Future investigators studying metamemory for nonverbal strategies might consider using both verbal and nonverbal assessment procedures.

The direction of the incentive interaction was unexpected and merits further investigation under a wider variety of motivational conditions. It is important to discover which types of reinforcement will lead to the most strategic mnemonic behavior for children of varying reading achievement levels. Measures of anxiety (state and trait) should be included in these investigations, since that variable seems the most promising in explaining the nature of the obtained interactions.

Educational Implications

This study is relevant to current educational technique and theory. The belief that less skilled readers are deficient in visual memory per se again received no support. The blanket use of visual memory training exercises which do not emphasize strategic behaviors is therefore a highly questionable technique.

The findings of this study suggested that verbal labeling deficiencies were not unique to severely disabled readers, but existed among the less skilled readers of middle-class, suburban classrooms as well. Thus, training in verbal strategy use (Meichenbaum & Goodman, 1971; Weithorn & Kagen, 1979) need not only be employed as a special education technique; such training also has relevance to the needs of children in the normal classroom.

On the other hand, the study presented evidence that a tendency to attribute all differences in memory between skilled and less skilled readers to a specifically verbal deficiency, is premature. Nonverbal aspects of attention may also be deficient and merit remediation. In the present study, the less skilled readers appeared to be deficient in nonverbal strategy use only in the more evaluative, achievement-oriented, token reward condition. This condition may parallel classroom learning conditions more closely than the low incentive condition, however. Tobias (1977) points out that, "in the conventional classroom environment, a fair amount of evaluative stress is likely to be present" (p. 86). Based on the findings of the present study, teachers should not expect that any one set of incentive conditions will achieve a similar effect for all children, regardless of achievement level. Efforts should be made to ascertain the specific motivational conditions under which individual children's memory performance is optimal.

APPENDIX A: ORDER OR ARRAY CARDS FOR THE THREE TASKS

Minimal Strategy Task Arrays[a]

Sample Trial 1	=	1	2	3	4	5
Sample Trial 2	=	2	3	4	5	1
Trial 1	=	3	4	5	1	2
Trial 2	=	4	5	1	2	3
Trial 3	=	5	1	2	3	4
Trial 4	=	1	3	4	5	2
Trial 5	=	3	4	5	2	1
Trial 6	=	4	5	2	1	3
Trial 7	=	5	2	1	3	4
Trial 8	=	2	1	3	4	5
Trial 9	=	5	4	1	3	2
Trial 10	=	1	5	2	4	3

[a]Key: 1=Gimmel, 2=Lamedh, 3=Mem, 4=Phe, 5=Sin

Non-Verbal Strategy Task Arrays[a]

Sample Trial 1	=	5/C,	R/2,	3/O,	Q/4,	1/X
Sample Trial 2	=	1/M,	R/5,	2/O,	Q/3,	4/X
Trial 1	=	1/D,	S/4,	3/T,	E/2,	5/M
Trial 2	=	5/E,	L/1,	4/D,	S/3,	2/T
Trial 3	=	4/C,	P/3	2/L,	D/5,	1/R
Trial 4	=	4/M,	E/1,	5/O,	Q/2,	3/X
Trial 5	=	2/M,	E/3,	4/T,	S/1,	5/X
Trial 6	=	3/L,	D/2,	5/S,	C/1,	4/P
Trial 7	=	1/Q,	R/3,	5/P,	C/2,	4/O
Trial 8	=	5/L,	P/2,	4/R,	0/1,	3/C
Trial 9	=	3/M,	E/4,	1/T,	Q/5,	2/X
Trial 10	=	2/S,	T/5,	1/P,	L/4,	3/D

[a]Key: 1=Gimmel, 2=Lamedh, 3=Mem, 4=Phe, 5=Sin
C=Cone, D=Dot, E=Ellipse, L=Line, M=Diamond, O=Circle
P=Parallelogram, Q=Square, R=Rectangle, S=Star,
T=Triangle, X=Cross.

Verbal Strategy Task Arrays[a]

Sample Trial 1	=	1/M,	R/5,	2/O,	Q/3,	4/X
Sample Trial 2	=	5/C,	R/2,	3/O,	Q/4,	1/X
Trial 1	=	2/S,	T/5,	1/P,	L/4,	3/D
Trial 2	=	3/M,	E/4,	1/T,	Q/5,	2/X
Trial 3	=	5/L,	P/2,	4/R,	O/1,	3/C
Trial 4	=	1/Q,	R/3,	5/P,	C/2,	4/O
Trial 5	=	3/L,	D/2,	5/S,	C/1,	4/P
Trial 6	=	2/M,	E/3,	4/T,	S/1,	5/X
Trial 7	=	4/M,	E/1,	5/O,	Q/2,	3/X
Trial 8	=	4/C,	P/3,	2/L,	D/5,	1/R
Trial 9	=	5/E,	L/1,	4/D,	S/3,	2/T
Trial 10	=	1/D,	S/4,	3/T,	E/2,	5/M

[a]Key: 1=1, 2=2, 3=3, 4=4, 5=5

C=Cone, D=Dot, E=Ellipse, L=Line, M=Diamond, O=Circle, P=Parallelogram, Q=Square, R=Rectangle, S=Star, T=Triangle, X=Cross.

APPENDIX B: INSTRUCTIONS TO THE SUBJECTS

General Instructions for the Minimal Strategy Task

"Do you see these five cards? Each one has a blue picture on it. I will show them to you for 5 seconds and then cover them with this board. Then I will show you one of the blue pictures and ask you to open the door that covers that picture. (For subjects in the high incentive condition, insert incentive instruction here). Let's try it a couple of times before we start for real."

General Instructions for the Non-Verbal and Verbal Strategy Tasks

"Do you see these five cards? Each card has two parts to it, a blue picture and a red picture. I will show you the cards for 5 seconds and then cover them with this board. Then I will show you one of the blue pictures and ask you to open the door that covers that picture. I will only be asking you where the blue pictures are. Which pictures will you have to find? (For subjects in the high incentive condition, insert incentive instructions here). Let's try it a couple of times before we start for real. Remember, you will only have to find the blue pictures." (Administer sample trial 1 to all subjects. For subjects who are metamemory controls, administer the second sample trial. For probed subjects, insert metamemory instructions immediately after sample trial 1.)

Metamemory Instructions

"This time before we try it, I want to ask you some questions. Here are the cards. They have two parts to them, a blue picture and a red picture. I want to find out how you are going to study the cards so later you will know where the blue pictures are."

Incentive Instructions

"Every time you find a picture on the first try, I will give you a chip to put in this box. Later you will be able to trade the chips in for a prize. The more chips you get, the better will be your prize."

High Incentive Reminder

"Remember, when you find a picture on the first try, you get a chip. Later you can trade the chips in for a prize. The more chips you get, the better will be your prize."

REFERENCES

Atkinson, R. C., & Shiffrin, R. M. Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation (Vol. II). New York: Academic Press, 1968.

Berman, B. U. Dependency in the preschooler as a predictive factor in reading disability. Unpublished doctoral dissertation, Hofstra University, 1975.

Blair, J. R. The effects of differential reinforcement on the discrimination learning of normal and low-achieving middle-class boys. Child Development, 1972, 43, 251-255.

Blank, M., & Bridger, W. H. Deficiencies in verbal labeling in retarded readers. American Journal of Orthopsychiatry, 1966, 36, 840-847.

Blank, M., Weider, S., & Bridger, W. Verbal deficiencies in abstract thinking in early reading retardation. American Journal of Orthopsychiatry, 1968, 38, 823-834.

Brown, A. L., Campione, J. C., Bray, N. W., & Wilcox, B. L. Keeping track of changing variables: Effects of rehearsal training in normal and retarded adolescents. Journal of Experimental Psychology, 1973, 101, 123-131.

Buros, O. K. The eighth mental measurements yearbook. Highland, N.J.: Gryphon Press, 1978.

Cobb, J. A. Relationship of discrete classroom behaviors to fourth grade academic achievement. Journal of Educational Psychology, 1972, 63, 74-80.

Conrad, R. The chronology of the development of covert speech in children. Developmental Psychology, 1971, 5, 398-401.

Corsini, D. A., Pick, A. D., & Flavell, J. H. Verbal and non-verbal mediators in young children. Child Development, 1968, 39, 53-58.

Craik, F. I. M., & Lockhart, R. S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 671-684.

Daehler, M. W., Horowitz, A. B., Wynns, F. C., & Flavell, J. H. Verbal and non-verbal rehearsal in children's recall. Child Development, 1969, 40, 443-452.

Denckla, M. B., & Rudel, R. G. Rapid "automatized" naming (R. A. N.): Dyslexia differentiated from other learning disabilities. Neuropsychologia, 1976, 14, 471-479.

Drozdal, J. G., & Flavell, J. H. A developmental study of logical search behavior. Child Development, 1975, 46, 389-393.

Fisher, D. F., & Frankfurter, A. Normal and disabled readers can locate and identify letters: Where's the perceptual deficit? Journal of Reading Behavior, 1977, 9, 31-43.

Flavell, J. H. Developmental studies of mediated memory. In L. Lipsitt & H. Reese (Eds.), Advances in Child Development & Behavior (Vol. 5). New York: Academic Press, 1970.

Flavell, J. H. What is memory development the development of? Human Development, 1971, 14, 227-235.

Flavell, J. H., Beach, D. R., & Chinsky, J. M. Spontaneous verbal rehearsal in a memory task as a function of age. Child Development, 1966, 37, 283-299.

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

Flavell, J. H., & Wellman, H. M. Metamemory. In R. V. Kail & J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Lawrence Erlebaum Associates, 1977.

Frostig, M. Visual modality, research and practice. In H. K. Smith (Ed.), Perception and reading. Newark, Del.: International Reading Association, 1968.

Furth, H. Reading as thinking. In F. B. Murray & J. J. Pikulski (Eds.), The acquisition of reading: cognitive, linguistic, and perceptual prerequisites. Baltimore: University Park Press, 1978.

Gascon, G., & Goodglass, H. Reading retardation and the information content of stimuli in paired associates learning. Cortex, 1970, 6, 417-429.

Gaudry, E., & Spielberger, C. D. Anxiety and educational achievement. Sydney, Australia: Wiley, 1971.

Groenendaal, H. A., & Bakker, D. J. The part played by mediation processes on the retention of temporal sequences by two reading groups. Human Development, 1971, 14, 62-70.

Gummerman, K., & Gray, C. R. Age, iconic storage, and visual information processing. Journal of Experimental Child Psychology, 1972, 13, 165-170.

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

Hagen, J. W., & Stanovich, K. G. Memory: Strategies of acquisition. In R. V. Kail & J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Lawrence Erlebaum Associates, 1977.

Hallahan, D. P., Tarver, S. G., Kauffman, J. M., & Graybeal, N. L. A comparison of the effects of reinforcement and response cost on the selective attention of learning-disabled children. Journal of Learning Disabilities, 1978, 11, 430-438.

Hallahan, D. P., Gajar, A. H., Cohen, S. B., & Tarver, S. G. Selective attention and locus of control in learning-disabled and normal children. Journal of Learning Disabilities, 1978, 11, 47-52.

Kahneman, D. Attention and effort. Englewood Cliffs, N.J.: Prentice Hall, 1973.

Katz, L., & Wicklund, D. A. Letter scanning rates for good and poor readers in grades 2 and 6. Journal of Educational Psychology, 1972, 63, 363-367.

Lahaderne, H. M. Attitudinal and intellectual correlates of attention: A study of four sixth-grade classrooms. Journal of Educational Psychology, 1968, 59, 320-324.

Liberman, I. Y., Liberman, A. M., Mattingly, I. G., & Shankweiler, D. Orthography and the beginning reader. Paper presented at the Cross-Language Conference on Orthography, Reading and Dyslexia, Bethesda, Maryland, September, 1978.

Liberman, I. Y., Mark, L. S., & Shankweiler, D. Reading disability: Methodological problems in information processing analysis. Science, 1978, 200, 801-802.

Liberman, I. Y., Shankweiler, D., Liberman, A. M., Fowler, C., & Fischer, F. W. Phonetic segmentation and recoding in the beginning reader. In A. S. Reber & D. L. Scarborough (Eds.), Toward a psychology of reading. Hillsdale, N.J.: Lawrence Erlebaum Associates, 1977.

Lunneborg, P. W. Relations among social desirability, achievement and anxiety measures in children. Child Development, 1964, 35, 169-182.

Meichenbaum, D. H., & Goodman, J. Training impulsive children to talk to themselves: A means of developing self-control. Journal of Abnormal Psychology, 1971, 77, 115-126.

Orton, S. Reading, writing and speech problems in children. London: Chapman & Hall, 1937.

Parker, T. B., Freston, C. W., & Drew, C. J. Comparison of verbal performance of normal and learning disabled children as a function of input organization. Journal of Learning Disabilities, 1975, 8, 53-60.

Perfetti, C. A., Finger, E., & Hogaboam, T. Sources of vocalization latency differences between skilled and less skilled readers. Journal of Educational Psychology, 1978, 70, 730-739.

Perfetti, C. A., & Goldman, S. R. Discourse memory and reading comprehension. Journal of Verbal Learning and Verbal Behavior, 1976, 15, 33-42.

Preston, R. Reading achievement of German and American children. School and Society, 1962, 90, 350-354.

Reese, H. W. Verbal mediation as a function of age level. Psychological Bulletin, 1962, 59, 502-509.

Reitman, W. What does it take to remember? In D. A. Norman (Ed.), Models of Human Memory. New York: Academic Press, 1970.

Rohwer, W. D. Elaboration and learning in childhood and adolescence. In H. W. Reese (Ed.), Advances in child development and behavior. New York: Academic Press, 1973.

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

Samuels, S. J., & Anderson, R. H. Visual recognition memory, paired associate learning and reading achievement. Journal of Educational Psychology, 1973, 65, 160-167.

Sarason, I. Experimental approaches to test anxiety: Attention and the uses of information. In C. D. Spielberger (Ed.), Anxiety: Current trends in theory and research (Vol. II). New York: Academic Press, 1972.

Sarason, I. Anxiety and self-preoccupation. In I. Sarason & C. D. Spielberger (Eds.), Stress and Anxiety (Vol. II). Washington, D.C.: Hemispheric Publishing Corporation, 1975.

Smith, F. Understanding reading. New York: Holt, Rinehart, & Winston, 1971.

Spring, C., & Capps, C. Encoding speed, rehearsal and probed recall of dyslexic boys. Journal of Educational Psychology, 1974, 66, 780-786.

Stanley, G., & Hall, R. A comparison of dyslexics and normals in recalling letter arrays after a brief presentation. British Journal of Psychology, 1973, 43, 301-304.

Swanson, L. Verbal encoding effects on the visual short-term memory of learning disabled and normal readers. Journal of Educational Psychology, 1978, 70, 539-544.

Tarver, S. G., Hallahan, D. P., Cohen, S. B., & Kauffman, J. M. The development of visual selective attention and verbal rehearsal in learning disabled boys. _Journal of Learning Disabilities_, 1977, _10_, 491-500.

Tarver, S. G., Hallahan, D. P., Kauffman, J. M., & Ball, D. W. Verbal rehearsal and selective attention in children with learning disabilties: A developmental lag. _Journal of Experimental Child Psychology_, 1976, _22_, 375-385.

Tobias, S. Anxiety-treatment interactions: A review of research. In J. E. Sieber, H. F. O'Neil, & S. Tobias (Eds.), _Anxiety, learning and instruction_. Hillsdale, N.J.: Lawrence Erlebaum Associates, 1977.

Torgesen, J. K. The role of non-specific factors in the task performance of learning disabled children: A theoretical assessment. _Journal of Learning Disabilities_, 1977, _10_, 33-40.

Torgesen, J. K. Performance of reading disabled children on serial memory tasks. _Reading Research Quarterly_, 1978-79, _14_, 57-87.

Torgesen, J. K., & Goldman, T. Verbal rehearsal and short-term memory in reading disabled children. _Child Development_, 1977, _48_, 56-60.

Turnure, J. E., & Samuels, J. _Attention and reading achievement in first grade boys and girls_ (Research Report #3). University of Minnesota, Minneapolis: Research Development and Demonstration Center in Education of Handicapped Children, 1972.

Vellutino, F. R., Bentley, W. L., & Phillips, F. Inter- versus intra-hemispheric learning in dyslexic and normal readers. Developmental Medicine and Child Neurology, 1978, 20, 71-80.

Vellutino, F. R., Harding, C. J., Phillips, F., & Steger, J. A. Differential transfer in poor and normal readers. Journal of Genetic Psychology, 1975, 126, 3-18.

Vellutino, F. R., Pruzek, R. M., Steger, J. A., & Meshoulam, U. Immediate visual recall in poor and normal readers as a function of orthographic-linguistic familiarity. Cortex, 1973, 9, 368-384.

Vellutino, F. R., Steger, J. A., DeSetto, L., & Phillips, F. Immediate and delayed recognition of visual stimuli in poor and normal readers. Journal of Experimental Child Psychology, 1975, 19, 223-232.

Vellutino, F. R., Steger, J. A., Harding, C. J., & Phillips, F. Verbal vs. non-verbal paired associates learning in poor and normal readers. Neuropsychologia, 1975, 13, 75-82.

Vellutino, F. R., Steger, J. A., Kaman, M., & DeSetto, L. Visual form perception in deficient and normal readers as a function of age orthographic-linguistic familiarity. Cortex, 1975, 11, 22-30.

Vellutino, F. R., Steger, J. A., & Kandel, G. Reading disability: An investigation of the perceptual deficit hypothesis. Cortex, 1972, 8, 106-118.

Walters, R. H., & Doan, H. Perceptual and cognitive functioning of retarded readers. Journal of Consulting Psychology, 1962, 26, 355-361.

Walters, R. H., & Kosowski, I. Symbolic learning and reading retardation. Journal of Consulting Psychology, 1963, 27, 75-82.

Walters, R. H., VanLoan, M., & Crofts, I. A study of reading disability. Journal of Consulting Psychology, 1961, 25, 277-283.

Weithorn, C., & Kagen, E. Training first graders of high activity level to improve performance through verbal self-direction. Journal of Learning Disabilities, 1979, 12(3), 82-88.

Wellman, H. M. Tip of the tongue and feeling of knowing experiences: A developmental study of memory monitoring. Child Development, 1977, 48, 13-21.

Wellman, H. M. The role of metamemory in memory behavior: A developmental demonstration. Unpublished paper, Center for Human Growth and Development, University of Michigan, 1979.

West, C. K., Lee, J. F., & Anderson, J. H. The influence of test anxiety on the selection of relevant from irrelevant information. Journal of Educational Research, 1969, 63(2), 51-52.

Wiegersma, S. Leesvaadigheidstest. Nederlands Instituut voor Praeventieve Geneeskunde, Leiden, 1958.

Wine, J. D. Test anxiety and direction of attention. Psychological Bulletin, 1971, 76(2), 92-104.

Yussen, S. R., Gagne, E., Garguilo, R., & Kuner, S. The distinction between perceiving and memorizing in elementary school children. Child Development, 1974, 45, 547-551.