MEMORY AND METAMEMORY DIFFERENCES BETWEEN POTENTIALLY LEARNING DISABLED AND NORMAL-ACHIEVING GRADE FOUR STUDENTS

ROBERT FRANCIS PATRICK RYAN

MEMORY AND METAMEMORY DIFFERENCES BETWEEN POTENTIALLY LEARNING DISABLED AND NORMAL-ACHIEVING GRADE FOUR STUDENTS

BY

© ROBERT FRANCIS PATRICK RYAN, B.A.

A Thesis submitted to the School of Graduate
Studies in partial fulfillment of the
requirements for the degree of
Master of Education

Department of Educational Psychology
Memorial University of Newfoundland
July 1988

St. John's Newfoundland

ISBN 0-315-45078-9

ABSTRACT

The subjects for this investigation were fourth grade students identified as either Potentially Learning Disabled (PLD) or Normal-Achieving (NA). Study 1 utilized two research strategies to examine recall and strategy use (using an individually administered, picture-cued memory task) and metamemorial knowledge (using an adaptation of Kreutzer, Leonard, Flavell, 1975 instrument). The first research strategy was to examine possible differences between NA and PLD students in recall performance, strategy use and metamemorial knowledge. The second research strategy was to examine, within each group, the intercorrelations among recall performance, strategy use, study time and metamemorial knowledge. Study 2 (substudy) tested for differences between PLD and NA students on a group administered, picture-cued memory task exploring differences in recall under intentional and unintentional memory conditions.

The results of Study 1 indicated that the PLD group were significantly less efficient in their utilization of memory strategies, verbalized significantly less knowledge about memory, and studied for significantly less time. PLD boys were especially quick in their approach. While the NA group recalled slightly more pictures, this difference was not statistically significant. The NA and PLD groups displayed two common correlation patterns (i.e. recall with strategy use; strategy use with metamemory). The findings

of Study 2 indicated the NA group recalled significantly more in both unintentional and intentional memory conditions, contrary to evidence from some earlier studies on automatic processing.

These findings are discussed with particular emphasis on their implications for strategy training in particular and instructions in general.

ACKNOWLEDGEMENTS

The completion of this thesis would not have been possible without the support and cooperation of a number of people. Above all I want to express my gratitude to my advisor, Dr. Kofi Marfo, for his continued encouragement and guidance, and for his permission to conduct this study as part of his research programme on the affective and cognitive characteristics of learning disabled children. Dr. Marfo's exceptional dedication to understanding and helping learning disabled children inspired me to become more knowledgeable and sensitive to the needs of these special children. I am also deeply indepted to the principals and students of the ten schools in the Roman Catholic School Board for St. John's for their participation in the research. Mrs. Geraldine Roe, Mrs. Thomasina Cleal, and Ms. Joan Hartery of the Roman Catholic Board provided a great deal of administrative support throughout the study; I am most grateful to them. I wish to give a special thanks to Lawrence Ryan, my brother and friend, whose involvement and input was invaluable. Also, thanks to Liz Russell whose typing skills created a respectable-looking manuscript out of a handwritten mess. Lastly, and most importantly thanks to my mother, Mrs. Josephine Ryan, who instilled in me the lasting value of education and the importance of helping others.

Dedicated to my wife, Joanne, and our children Chad, Mallory, and Katelin.

TABLE OF CONTENTS

APPENDIXES

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Background to the Study

The history of interest in memory reaches back in time to the great Greek philosophers. Plato (427-347 B.C.) theorized that ideas and concepts are born with the person. All learning and all experiences are thus the recollection of the ideas that are within the individual from birth (cited in Wittrock, 1981). Aristotle (384-322 B.C.), a student of Plato's, believed that all knowledge was developed by sense impressions, and was made meaningful by quantity, quality, relation, place, time, action, and passion (cited in Wittrock, 1981). Because of his ideas, Aristotle is often referred to as the founder of "associationism" in memory. He theorized that memory consisted of two processes: memory (storage), and recollection (retrieval from memory). He believed that imagery was the basis of memory, and association and order were the basis of recollection.

Approximately 2000 years later, in 1879, Ebbinghaus (cited in Hett, 1964) advanced ideas about memory from the theoretical world of the philosopher to the testable world of the scientist. Ebbinghaus is credited with carrying out the first reported experimental investigation of learning and memory (Boring, 1950; Sahakian, 1975). As part of his experiment Ebbinghaus invented the nonsense syllable by placing a vowel between two consonants: e.g., TOB, SAB, placing a vowel between two consonants: e.g., TOB, SAB, GEN, etc. His rationale for developing the nonsense syllable was based on their meaninglessness to the individual. By being meaningless, they reduced the process of learning completely to memorization, ruling out factors such as relevance to what already has been learned. Using himself as the subject, Ebbinghaus could measure how long it took him to learn or relearn a list of nonsense syllables. As well, this equipment provided a method for investigating the rate of decay of information. Ebbinghaus demonstrated that forgetting takes place rapidly within the first hour, and then more slowly. He also compared a list of nonsense syllables to learning a stanza of poetry. He found that learning the poem was easier, even though the poem contained many more syllables than the list, thus demonstrating that the more organized material is, the easier it is to learn. Although Ebbinghaus's results demonstrated the significance of association in memory efficiency, his biggest contribution to science was the way he established a scientific research program to study human memory.

In the years since Ebbinghaus's memory investigation, much research has been focused on how learning takes place within the individual. Behaviorist psychologists committed themselves to studying only what they could observe, namely human behavior. The cognitive orientation directed attention towards covert, higher order processes that mediate behavior. More specifically, the Cognitive

Information Processing (CIP) perspective regards humans as information processors who take in information through the senses, process it, store it in memory, and make decisions and behave as a result. The focus for understanding individual differences in learning then becomes understanding what the learner does to incoming information to enhance his/her learning, and, equally important, to enhance his/her recall of that information. Although the CIP theorist does not suggest that all students have equal learning ability, this conceptualization of the learner does present the idea that some individual differences in learning are a result of varying degrees of voluntary, active participation in learning situations on the part of the learner. Torgesen (1977) and Torgesen and Licht (1983) emphasize this approach to understanding individual differences by suggesting that some children do not learn in a manner consistent with their peers because they are unable to assume the role of "active learner".

To understand individual differences in learning, one must first understand the components of the learning process. One undisputed component of the learning process is the ability to remember information. Brown (1978) stresses the fact that memory and learning are inseparable. Although learning is dependent on such processes as attention, motivation, and understanding, one can easily argue that the ability to remember information is essential for learning to take place.

What variables influence one's ability to remember? Certainly one must look beyond the unidimensional "holding" operations of memory to consider multi-dimensional areas such as cognitive planning and study strategies, and by so doing create links between memory and the memorizer.

Brown (1978) suggested that, "there must be close ties between what one knows about memory and how one goes about memorizing" (p.441). Flavell (1971) labelled the introspective knowledge one has about memory systems, "metamemory". He hypothesized that students with a well developed metamemory should show an increased ability to recall information. Torgesen and Licht (1983) defined this metamemory as "one's knowledge of specific memory strategies, as well as the knowledge and skill required to apply them appropriately in a variety of situations" (p.15). Recent investigations of metamemory have tended to focus on exploring the relationship between a students' verbalizable knowledge about memory, and his/her ability to efficiently memorize material (Cavanaugh & Borkowski, 1980; Douglas, 1981; Byrd & Gholson, 1985).

Memory investigations have also explored the connections between a students' ability to remember information, and his/her use of memory enhancing strategies. In early studies on memory, Miller (1956) postulated that the ability to impose organization on encoded information will increase an individual's memory span. An early study by Flavell, Friedrichs, & Hoyt (1970) suggested that the ability to rehearse information will increase the retention of that information.

Recently a great deal has been written concerning the memory deficits of learning disabled (LD) students. Compared to their non-disabled peers, LD students were reported to recall less information (Ceci, Lea, & Ringstrom, 1980; Dallego & Moley, 1980), underutilize organizational strategies (Parker, Freston & Drew, 1975; Bauer 1982), and display less insight into the workings of their memory systems (Torgesen, 1979; Wong, 1982). Two additional studies (Bauer, 1977; Shepherd, Gelzheiser, & Solar, 1985) have produced evidence that suggests groups of LD children on average do not use rehearsal strategies as consistently as their normal-achieving peers.

Although not without controversy, it can be hypothesized that individuals possessing well articulated metamemorial knowledge should be more likely to demonstrate strategic memory behaviors, resulting in a more efficient use of the innate human memory capacity. Thus, this efficient use of memory is ultimately translated as an ability to retain more information in memory. Empirical verification of the metamemory-memory and metamemory-strategy use relationships is necessary on both theoretical and practical grounds. First, empirical support will validate the usefulness of metamemory as a useful theoretical construct. Second, empirical evidence that metamemory influences or is related significantly to strategic behavior and recall performance would have important implications for educational practice.

It is these considerations that informed the design of the present study. Two research strategies were identified to examine the role of metamemory and strategic behavior in memory performance. The first was to examine normal achievers and poor achievers for possible differences in metamemory and strategy use. The second was to undertake both within-and-across-group analyses of variations in memory performance and of the relationsips between such variations and metamemory and strategy use.

Purpose of the Study

The main purpose of the present study was thus two-fold: (1) to investigate whether differences exist between potentially learning disabled (PLD) students and normal-achieving (NA) grade four students, on a number of variables pertaining to memory (recall of 15 pictured objects), memory strategy use (self reported and observed use of memory strategies while studying the 15 pictures), and metamemory (including verbalizable knowledge about memory functioning and awareness of the role of strategic behavior in memorization); and (2) to examine the nature of relationships that may exist among recall performance, strategy use, and metamemory. A secondary objective of the study was to test a specific hypothesis about NA-PLD recall performance differences under intentional (explicit instruction to memorize) and unintentional (no explicit instruction to memorize) conditions.

Significance of the Study

As will be seen in the review of the pertinent literature in Chapter II, most of the studies reported on memory, especially those comparing different groups of children along the dimensions of age, cognitive ability, or learning characteristics, have been unidimensional in approach. Recall (retrieval) performance, strategy use, or metamemorial knowledge have been studied independently of each other. The significance of the present study lies, first, in its attempt to examine all three dimensions of the memory equation simultaneously. Such an approach, rarely seen in existing literature, has the potential to provide a better understanding of the role that strategic behavior and metamemorial knowledge or awareness play in memorization and recall performance.

Second, studies examining strategic behavior have generally tended to assume that subjects already possess the basic concepts necessary for utilizing related strategies. For example, children's use of the categorization strategy has been examined frequently without testing for evidence of the presence or absence of categorization skills in children. In the absence of such a test, failure to adopt the categorization strategy cannot always be attributed to deficient strategic behavior. The present study addressed this critical conceptual-methodological problem, making it possible to make more conclusive comments pertaining to the role of strategy use in memory performance.

Definition of Relevant Terms

Following is a list of definitions used in this study.

Short Term Memory (STM)

The model of an individual having three seperate memory systems (Atkinson & Shiffrin, 1968) was adopted for the purposes of this research: (1) sensory memory; (2) short term memory; and (3) long term memory. The memory sytem of interest in this investigation was short term memory (STM). Leahey and Harris (1985) define STM as "containing all the information that we are thinking about and working on right now" (p. 121). This includes information activated from long term memory, and new stimulus information entering through the perceptual senses and sensory memory.

Metamemory

Metamemory is operationally defined as verbalizable knowledge about memory and memory processes. Flavell (1971) defined it as "introspective knowledge of the memory system" (p. 441). For the purpose of this research, metamemory referred to a student's verbalizable knowledge about his/her memory abilities and knowledge of the effectiveness, or ineffectiveness, of some memory strategies in various verbally presented hypothetical memory situations.

Memory Strategies

Memory strategies are control processes which students utilize when confronted with a memory task. They are goal directed activities or plans that help maintain information in memory.

Potentially Learning Disabled (PLD)

The PLD students were identified as those children who had a 1 1/2 year lag in achievement but who were of average intelligence as measured on the Canadian Cognitive Abilities Test. Achievement was assessed using the Canadian Test of Basic Skills. The PLD students scored at least 1 1/2 grade equivalency years below their grade level in either reading, math or both. Testing for these grade four students took place in October, consequently all the PLD group scored on, or below the 2.7 grade equivalency. The term "potentially learning disabled" (PLD) is preferred to "learning disabled" (LD) because of the group selection process used to identify the students. To accurately diagnose a student as being learning disabled involves a much more comprehensive and detailed assessment procedure. The term potentially learning disabled implies that their 1 1/2 year lag in achievement <u>may</u> be the result of an unspecified learning disability. In fact, the students in the present study met one of the most frequently employed criteria for identifying LD children by schools and researchers. This researcher's choice of the term "PLD" reflects his strong concern for the loose manner in which the term LD is often applied in the literature and in schools. In choosing PLD over LD, this researcher was not ruling out the possibility that the depressed achievement levels among some of the children may have been related to such factors as low motivation or lack of effort. In practical terms, however, it is conceivable that poor strategic skills and depressed metamemorial knowledge are problems that may characterize not only truly LD children but also severe underachievers. Thus, although a less precise label has been adopted, the students selected under the label were deemed appropriate for investigating differences between good and poor memorizers.

Unintentional Memory

In this study, unintentional memory referred to the spontaneous and unconscious extraction of some aspect of stimulus meaning. The absence of intent to remember strongly suggests that performance on the unintentional memory task should be based on the non-strategic processing of information. On the unintentional memory task, the students were unaware that the task was a memory task.

Intentional Memory

Intentional memory referred to the awareness on the part of the memorizer that recall was required. As such, intentional memory provided the student with the opportunity to utilize what was known about various memory strategies to enhance both storage and retrieval of information.

CHAPTER II

REVIEW OF THE LITERATURE

Development of Information Processing Approaches to Learning

The computer's ability to successfully simulate human achievements such as playing chess and doing numerical calculations led researchers and theorists to suggest that parallels may be drawn with human learning. Leahey and Harris (1985) describe this analogous relationship as "the study of computational devices both of wire and steal and of nerve and tissue" (p.100). In discussing the rationale for paralleling a computer and an individual, Torgesen and Licht (1983) state:

> The availability of clear descriptions of the different processes by which computers solve human-like intellectual problems led researchers to hope that similar descriptions of internal psychological events intervening between receipt of a stimulus and emision of a response might also be developed for humans. Thus information processing accounts treat mental processes in terms of different operations performed on information. (p.5)

Obviously the information processing approach views learning in relation to how information is transformed, reduced, elaborated, stored, retrieved and used.

Swanson (1987) identifies three general components that underlie information processing theory: (a) a structural component, analogous to the hardware of a computer, which defines the parameters that information can be processed within; (b) a control or strategy component which describes the operations at various stages; and (c) an executive process by which the learners' activities (e.g. strategies) are overseen and monitored. In rationalizing the conceptualization of an information processing theory to describe intelligent behavior, Swanson (1985) writes:

> The major advantage of an information processing perspective when compared with other approaches is the assessment of intelligent behavior into the mental components assumed to be important to performance. (p.227)

Generally, the learner is viewed as an information processor taking in information through the senses, processing it, storing it in memory, and making decisions and behaving as a result. Specifically, theories vary as to their models of how information is processed, stored and retrieved from memory.

Memory Models

Atkinson and Shiffrin (1968) proposed that memory involves the sequential movement of information through three levels of memory storage. First, sensory information is perceived by the senses. For sensory information to pass on to the short-term memory store, it must take on meaning, primarily verbal meaning. To enter the long-term memory store, the information in short-term memory must be further analyzed by organizational strategies such as association and/or chunking, or the information must be rehearsed. The implications of this model is the suggestion that memory enhancing strategies would increase the rehearsal and the meaning of information and thereby increase the retention of that information.

Craik and Lockhart (1972) proposed an alternative metaphor for conceptualizing memory. Instead of a memory model involving sensory, short-term, and long-term memory, they proposed that memory involves different levels of processing. They theorize that memory is a function of the level or depth of processing required by the memory task. A stimulus is first encoded and analyzed at the perceptual level. The memory trace is a by-product of some type of perceptual analysis, with the persistence of the trace being determined by the depth or level at which the information is processed. This model, often referred to as the "level of processing model", identifies the type of information and degree of analysis information is subjected to as being fundamental to understanding human memory. It implies a hierarchy of stages that incoming information must pass through in order to be remembered. Information with more meaning will pass through more stages and thus gets processed at a deeper level. For long-term storage, information is encoded semantically and associatively, implying more meaning, and therefore is processed at a greater depth.

While agreeing with the level of procesing model, Ritchey (1980) suggests that rather than focusing complete attention on the depth of processing, one should be focusing on the elaboration carried out on the incoming information. He defines elaboration as "the breadth of analysis carried out in each domain or level" (p. 460). Ritchey (1980) states, "The basic perceptual core of the event could be elaborated on in many different ways" (p.461). Thus to understand memory differences one has to understand differences in the elaboration or organization imposed on the information by the individual.

The memory models presented above differ in their conceptualization of the processes involved in the retention of information. Atkinson and Shiffrin (1968) hypothesized that information passes through a sequence of memory stores. Before information can be encoded in long term memory, it must pass through sensory memory (perceptual), and short term memory. The ultimate retention of information is dependent on the movement of information through the memory stores by the use of memory strategies. Unlike Atkinson and Shiffrin (1968) Craik and Lockhart (1972) attribute the retention of information to hierarchical levels of processing. In this model emphasis is put on the type and meaning of information presented, with semantic being the most memory-efficient. These authors also emphasize the type of analysis the individual imposes on incoming information as being significant to recall. Ritchey (1980), while agreeing with the depth of processing model, suggests that much more attention should be focused on the analysis imposed on the incoming information.

While these differences are present, all three approaches emphasize the active role that the individual plays through the use of memory strategies, or the imposition of analysis on the incoming information. In its broadest terms this "active role" suggests that information which has meaning and organization imposed on it will remain in memory longer.

Information Processing Views of Learning Disabilitites

Swanson (1987) rationalizes attempts to describe information processing operations when studying learning disabilitites:

> Of particular importance to our understanding of learning disabilities is the identification of components and stages that influence performance. To understand learning disabilities, we need to know what mental processes underlie such children's performance as well as to determine how accurately and efficiently those processes are performed. Knowledge about such operation provides a basis for the study of individual differences between and within ability groups, for the study of changes as a result of learning and instruction, and most importantly, for the division of learning disabled deficiencies into reasonable sets of mental operations for instruction. (p. 4)

DeRuiter and Wansart (1982) offer four basic assumptions about how learning takes place. First, they identify that learning is the result of an "active interaction" between the environment and the learner.

Secondly, learning is the result of an active reconstruction of the reality that is experienced. Knowledge is not a carbon-copy of reality, but rather a formed perception of what reality is. This is what DeRuiter and Wansart (1982) term a "constructive representation of the world" (p. 6). Third, DeRuiter and Wansart (1982) theorize that this constructive process results in the actual construction of living "mental structures".

> Mental structures are characterized by having parts that relate to a whole in a living way and by being self-regulating. A simple copy of reality in our minds would represent form but not structure...Mental structures consist of an interrelated, ordered system of knowledge and active mental processes. (p. 6)

Fourthly, they suggest that learning is accomplished by the generation and adaptation of mental structures which are constantly in a state of change.

> Learning is the adaptation of the structures that represent what is known at one point in time into qualitatively different structures that can represent a more complete understanding of the world. This is actually a transformation process, not merely an additive procedure. (p. 7)

As development of the individual occurs, new and more complex structures develop. DeRuiter and Wansant (1982) therorize that differences between learning disabled and non-disabled individuals is the result of "the development of atypical mental structures in particular areas of learning" (p. 14) on the part of the LD student. They hypothesize that these qualitatively different mental structures are the product of deficits in the learning processes of attention, perception, memory, cognition, and encoding. A deficit produces inaccurate accounts of reality, resulting in qualitatively different mental structures in one or more of these processes of the information processing system within the individual. Errors are theorized to be consistent with the structures that gave rise to them. The performance deficit of LD students is viewed as being the result of the construction of these qualitatively different mental structures. DeRuiter & Wansart (1982) state, "we must look at the thinking strategies and subsequent behavior of individuals as an expression of the mental structures that underlie them" (p. 9).

Sternberg (1979, 1980, 1984) provides an alternative, detailed, and comprehensive framework with which to view the individual as an information processor. His theoretical model is what he labels a "componential framework". Sternberg (1979) identifies a component as the basic construct in his theoretical framework, and defines it as "an information process that operates upon internal representations of objects or symbols" (p. 221). Each component has three important properties: (a) duration; (b) degree of difficulty; and (c) probability of execution. Sternberg (1980) distinguishes between the three basic kinds of components: (a) metacomponents; (b) performance components; and (c) knowledge-acquisition components.

Sternberg (1984) describes the major components involved in his model. The metacomponents, are "executive processes used in planning and decision making" (p. 160), such as: (1) recognition of what the problem is; (2) selection of a lower order component (performance components and knowledge-acquisition components) for task performance; (3) the choice of a mental depiction of information upon which the lower order components can act; and (4) as well as others? The performance components are processes that are used in the execution of a task. "The actual working through of the problem one has decided to solve, and the way one has decided to solve it is done via the performance components" (p. 165). The knowledge-acquisition components are used in acquiring new information. This is accomplished by: (a) selective encoding (selecting relevant from irrelevant information); (b) selective combination (integrating new information in a more meaningful way); and (c) selective comparison (relating new information to information previously stored) (Sternberg, 1984, p. 167).

In Sternberg's proposed system, the metacomponents play the central role. "These metacomponents are the processes by which subjects determine what components, representations, and strategies should be applied to various problems" (p.226). The other two components indirectly activate each other, and receive information from each through the metacomponents. Sternberg (1984) summarizes his proposed system:

> The component "knowledge acquisition" provides the mechanisms for a steadily developing knowledge base. Increments in the knowledge base in turn allow for more sophisticated forms of later acquisition and possibly for greater ease in the execution of the "performance component". As the base of old knowledge becomes deeper and broader, the possibilities for relating new knowledge to old knowledge--and consequently for incorporating that new knowledge into the existing knowledge base--increase. Thus there is the possibility of an unending feedback loop: the components lead to an increased knowledge base which leads to more effective use of the components, which leads to further increases in the knowledge base, and so on. (p. 171)

Sternberg also makes the distinction between "controlled" information processing and "automatic" information processing. He describes controlled information processing as intentional and defines it as:

> ...hierarchical in nature, with the executive metacomponents consciously directing the nonexecutive performance and knowledge-acquisition components. Controlled processing is also of strictly limited capacity, primarily serial; but it has unlimited ability to call upon all of an individual's stored knowledge base. (p. 173)

He describes automatic information processing as being without purpose, and states that it is:

> ...preconscious and thus not under the voluntary direction of the individual: in automatic processing there is no functional distinction between executive and nonexecutive processing. (p. 175)

Sternberg theorizes that if a person has little expertise in an area, information is processed in the "controlled" system, with the higher-order metacomponents activating the lower-order components. As expertise developes, greater and greater proportions of processing are transferred to the automatic system. The advantage of the automatic information processing system is that the activation is of the system as a whole rather than the attention demanding activation of the individual components within the system. As a result, the amount of attention that needs to be allocated to an individual task is viewed as being much less in automatic processing. Sternberg suggests that the attention necessary to activate the whole automatic system is equal to that necessary to activate a single lower-order component in the controlled system. In discussing the significance of the individual developing the automatic processing system Sternberg (1984) states:

> Complex information processing tasks can feasibly be executed only because many of the operations involved in their performance have been automatized. Failure to automatize such operations, whether fully or in part, results in a breakdown of information processing and hence in impaired intelligent task performance. (p. 177)

Sternberg conceptualizes learning differences among students to be the result of either an "inadequate functioning of the componential subsystem, or the inadequate automatization of componential subsystems, or both" (p. 175). As a result learning disabled students are viewed as having problems in the processing of information in the controlled ,componential? system, or problems with automatically processing information to the same extent as their normal counterparts. A failure to automatize the processing of information results in more direct attention needed to carry out tasks, reducing the individual's learning efficiency.

Finally, Sternberg's "Triarchic Theory" of human intelligence also includes a contextual subtheory (Kolligan & Sternberg, 1987) which attempts to combine the components of the theory with an explanation of the context to which they are applied in real life experiences. The emphasis here is on the LD student's ability to adapt to the environmental demands placed on him/her. Inability on the part of the student to adapt may create the belief that the student's difficulties are insurmountable, resulting in avoidance behavior towards the subject or area of disability. This very behavior would work to reduce the chances of the disability being remediated. Here we see Sternberg's theory including an affective-cognitive variable so important in the understanding of learning disabilities.

Torgesen (1977, 1980, Torgesen & Licht 1983) conceptualizes the learning disabled child as an "inactive learner", suggesting that "these children fail because they don't efficiently utilize the intact intellectual abilitites available to them" (Torgesen & Licht, 1983, p. 3). Torgesen (1977) presents a profile of the efficient memorizer as an individual who is able to apply adaptive strategies in the learning situation. In other words, the learner is able to recognize and adapt to the demands of a task. An individual ability to use adaptive learning strategies is theorized to be a result of his/her general cognitive awareness. Torgesen (1977) identifies two factors which increase an individual's cognitive awareness: (a) an awareness of his/her cognitive strengths and weaknesses; and (b) a sensitivity to the task demands that confront him/her. Torgesen and Licht (1983) and others (Tarver, Hallahan, Kauffman, & Ball, 1976; Ritchey, 1980; Hulme, 1981; Wong, 1982) suggest that learning disabled students' memory performance deficits may be the result of poor control processes which they define as "voluntary, goal-directed, strategic plans that help organize and maintain information to be remembered" (Torgeson & Licht, 1983, p. 6). This suggestion implies that students who don't voluntarily incorporate effective control processes in the learning of information ultimately develop maladaptive learning styles.

Torgesen and Licht (1983), in qualifying their theory, point to the research that suggests that some LD children do not utilize the same cognitive strategies on experimental tasks (Bauer, 1977; Done & Miles, 1978; Dallago & Moley, 1980) as children who learn normally. Torgesen and Licht (1983) suggest that this inactivity might be the result of a lack of knowledge on the part of the individual about specific cognitive strategies, or a lack of knowledge about the skill required to apply the appropriate strategies. In discussing the claim that many LD children have processing problems (e.g. attentional and memory problems) Torgesen (1977) states "these strategic inefficiences can result from within-organism limitations related to the ability to profit and learn from experience" (p. 16).

Torgesen and Licht (1983) present three ways that these "within-organism limitations" in LD children may account for the failure of some LD students to adapt to the demands of some cognitive tasks. First, they propose that strategic memory behavior may involve the "co-ordination of well developed subskills into an organized pattern of behavior" (p. 14). If structural or organic factors limit a child's acquisition of these subskills then their ability to carry out complex memory strategies is limited. Secondly, they suggest that perhaps a "developmental lag" in the growth of strategic behavior exists. Although they warn that there is no universally accepted description of the development of strategic behavior in children Torgesen and Licht (1983) state:

> The failure of LD children at a given age to use a strategy spontaneously in accomplishing a goal might be due to the fact that they had only recently mastered the subskills necessary for the execution of the strategy. (p. 17)

Torgesen & Licht (1983) also point to a third within-organism limitation that may affect LD children's development of "strategic-adaptive" cognition as involving the development of metacognitive skills. They suggest that LD children may have specific deficits related to general abstraction and reasoning processes that are necessary for an individual to learn from experience, processes which are viewed as being necessary for the development of metacognitive knowledge and skills. They suggest that:

> In the process of repeatedly observing the relationships between tasks that are given them, their own cognitive activities, and the success or failure that follows their intellectual activity, children gradually become aware not only of specific strategies which are useful in many situations, but also of the value of certain general routines such as self-checking, forming a plan for action, etc. (p. 20)

Torgesen (1977) and Torgesen & Licht (1983) cite some environmental factors, and their possible influence on the "activity" level of some LD students. They hypothesize that it is possible that many LD students start school unprepared to assume the new role of self-conscious learner, resulting in their school performance being below their ability to learn in the preschool environment. They also suggest that perhaps repeated failure of the LD student may lead to the belief on their part that "the termination of this failure is beyond one's control, which in turn leads to the cessation of goal directed learning activitites" (Torgesen & Licht, 1983, P. 20). These authors suggest that when LD students are faced with a difficult task they may focus their attention on their inability to overcome the task and concentrate on the fact that they are failing. Torgesen and Licht suggest that LD students have a low self-concept in regards to their abilities, and low expectations of success when performing academic tasks.

Torgesen and Licht (1983) caution the reader, stating that this conceptualization of the learning disabled student as "inactive" is best viewed as:

> A conceptual framework for understanding the difficulities of some LD students on certain kinds of task, such as those requiring active, organized, and goal directed strategies for successful performance. (p. 25)

Perhaps in response to Wong's (1979) criticism suggesting that Torgesen has not specified the source of this inactivity, Torgesen and Licht (1983) state, "We are much more able to describe how these children are deficient than how they came to be that way" (p. 14).

In summary, Torgesen (1977) and Torgesen & Licht (1983) explain LD students' inactivity in their information processing in terms of processing deficits, environmental factors, and affective variables. DeRuiter and Wansart (1982) present a more structure theory of how learning takes place within the individual. Their theory focuses on the construction of living mental structures which are created by an individual's experiences. Thus learning is viewed as the ability of these mental structures to incorporate newly acquired information. LD students' deficits are perceived to be the result of qualitatively different mental structures which may be the result of one or more processing deficits. Sternberg (1979, 1980, 1984) presents the reader with a "componential" framework in which metacomponents activate and receive feedback from both performance components and knowledge-acquisition components. He distinguishes between the two processes of acquiring information within the componential framework. Information can be processed through control involving increased attention and awareness, or through automaticity which evolves as the individual acquires more relative information. When it is automatic, it demands less in the way of attention and awareness, and thus frees the individual to attend to more in his stimulus field. Learning is viewed as consisting of a combination of both controlled and automatic processes. As a result, LD students' deficits are viewed to be either a failure of the system to adequatley process information through the less demanding automatic processing system, or the inadequate functioning of the componential system.

Memory Differences Between Learning Disabled and Normal-Achieving Students

Unintentional vs. Intentional Memory

As defined earlier in the Introduction, unintentional memory refers to the unconscious and spontaneous extraction of some aspect of stimulus meaning. Unintentional memory, or the absence of intent, strongly suggests that recall performance should be based primarily on the non-strategic processing of information. As such, it should provide an indication of one's ability to remember without the use of memory enhancing cognitive activities. Some researches have referred to unintentional memory as "incidental memory", while referring to intentional memory as 'central recall' (Hagen & Hale, 1973; Tarver, Hallahan, Kaufman & Ball, 1976). One method of investigating central and incidental recall has been to focus on studying selective attention in students. Tasks are chosen which enable investigators the opportunity to study the effects of students' consciously attending and being made aware of task demands.

Tarver, Hallahan, Kaufman, and Ball (1976) conducted two experiments to study selective attention and the effects of verbal rehearsal instructions, using two different age groups of children with and without learning disabilities. In the first study the subjects were 33 white, middle class boys, 18 with learning disabilities and 15 without learning problems. The average age was 8 years, 6 months. The two groups were matched on mental age, chronological age, and IQ. All children were presented with Hagen's Central-Incidental Learning Task (Hagen & Hale 1973). This task involves showing the child a series of cards on which two figures, an animal and a common tool, are drawn. The child is instructed to remember one of the objects (animal) on each presentation. After each presentation the cards are turned face down in rows and columns. After all the cards had been presented, each student was shown a probe item (animal) and asked to point to the face down card with the same animal (central recall). A serial scanning of the cards was thought to reflect the use of a cumulative rehearsal strategy. Incidental (unintentional) learning was assessed by presenting the child with individual animal and object cards and asking him/her to place together the ones that were originally presented on the same card. The results of the Tarver et al, (1976) experiment indicated that central recall (intentional memory) was significantly greater for children without learning problems when compared to those with learning problems. However, incidental memory was similar for both groups.

In a second experiment Tarver et al, (1976) studied learning disabled readers using the same central-incidental task. However, in this experiment they had no control group of normal readers. The disabled readers were assigned to one of two conditions: a standard condition which followed the same procedure as the first study, or a verbal rehearsal condition in which they were instructed to label, chunk, and rehearse the items. Tarver et al concluded that instructions to rehearse led to a slightly improved performance in the central recall task (intentional memory) but the effect was not significant.

In a literature review of selective attention and memory, Lloyd, Hallahan, and Kauffman (1980) concluded:

> LD children, compared to normal peers, are deficient in selective attention performance. They score lower in central recall, but their incidental recall is at least equal and sometimes superior to that of normal children. In addition, compared to normal children there tends to be a positive correlation between central and incidental recall for LD children, suggesting that the latter are less likely to adopt a strategy of giving up the processing of incidental in favor of central information. (p. 46)

A recent study by Ceci (1984) investigated the unintentional (automatic) and intentional memory of seven-, ten-, and thirteen-year-old LD and non-disabled students. Ceci concluded that the recall of non-disabled students was governed by purposive semantic processing to a greater extent than was the recall of LD students. However, Ceci observed no group differences in automatic semantic processing.

Torgesen, Murphy, and Ivey (1979) studied the influence of an orientating task on memory performance. The subjects were fourth-grade normal achieving and learning disabled boys. The procedures were conducted in two phases. During phase 1 the boys were shown 24 pictures of common objects for a three minute study period. Prior to the study period they were instructed that they would be asked to recall the pictures, and told that they could move them around. The examiners tested for immediate recall, and a 10-minute delayed recall of the picture names. In the second task, the children were simply told to sort the pictures into categories, with no mention of a recall task. Incidental recall of the pictures was then tested, both immediately and after a delay. On the first task (intentional) the disabled readers showed poorer performance and less category clustering at recall. However, on the incidental memory task no differences were found between groups. Torgesen et al, (1979) suggested that these results indicate that disabled readers are less likely to spontaneously use an efficient information processing memory strategy.

The studies cited consistently demonstrate that when children are unaware of the need to remember information, LD and normal achieving students recall similar amounts. However when intentional memory is the focus, when children are made aware of the need to remember, LD children seem to be unable to recall information to the same extent as the normal achieving counterparts. These results are theorized to be the result of a lack of memory enhancing cognitive strategies employed by LD children in comparison to normal learners. The basic assumption here is that with the employment of memory strategies comes increased recall.

<u>Recall of Pictures vs. Words</u>

A controversial issue in the literature on memory research is whether there exists a single semantic memory system with multiple access routes, or a dual coding system with separate routes for verbal and non-verbal information (Ceci 1984).

Paivio (1971) supports the idea that, two types of memory exist, one for pictures and one for words. He theorizes that during retrieval both verbal label codes and visual codes are available. The efficient memorizer establishes inter-connections between coding systems so that the presentation of visual information activates verbal labels and the presentation of a word elicits its corresponding image, ultimately resulting in easier recall. Paivio suggests that creating inter-connections between a picture and its verbal code is a natural process which results in pictures being encoded in a dual fashion more frequently. Before a picture can be named a verbal label must be attached to it.

Nelson (1979) presents an alternate view of the reported picture superiority effect cited in the literature (Paivio, 1971; Horowitz, 1969; Ritchey, 1980).

> The relative ease of remembering pictures might be explained in terms of inherent differences in the distinctiveness of either their visual or their meaning features. The visual representation for a simple picture may be more differentiating than the visual representation associated with its label. Similarly, the meaning representation allied with the picture of an object may be more distinctive than that associated with its label. (p. 58)

Ritchey (1980) carried out a study designed to investigate the effects of organization and elaboration in picture-cued and word-cued memory tasks. His subjects were 2nd, 4th, and 6th grade students. He conceptualized the semantic memory structure as one in which elaboration was considered to vary depending on the nature of the information and the organization imposed upon it. Between-item elaboration referred to an individual linking or associating items in memory, such as dividing items into categories, paired associations, etc. Ritchey (1980) defines within-item elaboration as "the qualitative nature of the processing performed on an individual item" (p. 462)--in other words the meaning that isolated information would imprint on memory. In his study Ritchey (1980) presented children with pictures and words in either a category recall or control situation. In the category-recall situation between-item elaboration was emphasized by instructing the students to group pictures or words (category recall task) after individual presentation. In the control situation the between-item elaboration was minimized by individually presenting the word or picture with no instructions to group or organize them. Ritchey concluded:

> No differences between pictures and words in either recall or clustering were found in the category-recall task. However, when the same items were presented in the control situation the typical picture superiority effect in free recall was found. (p. 460)

The results indicate that when pictures or words were categorized at input, no differences in recall were observed. When they were individually presented with no instructions to group or organize the information, students were able to recall more pictures in comparison to their verbal labels, and this pattern seemed to hold across all age groups tested. It could be suggested that this study lends support to Nelson's (1979) notion that differences in distinctive features (within-item elaboration) account for the picture superiority effect in free recall situations.

Srivastava and Pirohit (1983) designed a study to test normal achieving students' recall of picture stimulus compared to word stimulus recall. They discovered that picture (s) + word triads and picture + picture triads produced significantly better memory performance as compared to word triads in a free recall condition.

The research of picture stimulus and word stimulus has also been employed to investigate encoding differences between normal achieving and learning disabled students. Done and Miles (1978) tested memory for sequences of digits, pictures, and nonsense shapes which were presented tachistoscopically for a period of two seconds. The subjects were 13 year old students who were identified as either normal learners or learning disabled students. The results indicated that the learning disabled readers only had difficulty with the memory task which involved verbal encoding (digits).

Hulme (1981) reported that LD readers were deficient at item memory for letter strings which were presented visually. In a parallel experiment using visual forms rather than letters, Hulme (1981) concluded that there were no differences found between LD readers and normal readers.

Deverbalizing information resulted in similar memory performance in both groups. These results lend support to the contention that LD students have trouble encoding and/or retrieving verbal information.

Swanson (1984) conducted two experiments also designed to investigate the effects of deverbalizing information. In Experiment 1 normal-achieving and learning disabled students viewed nonsense pictures without names, or with either relevent or irrelevent names. The results indicated that both types of names improved the recall of the normal student, while LD readers had better recall for unnamed pictures. In Experiment 2, both groups participated in recall tasks for complex visual forms labelled with: (1) unrelated words; (2) hierarchically related words; or (3) without labels. A task requiring the reproduction of an original form showed an increase in performance of the normal-achieving students due to labelling, while LD readers showed better reproduction for unnamed pictures. Swanson concluded, "The results suggest that LD children's learning difficulties may be due to an inability to activate a semantic representation that interconnects visual and verbal codes" (p. 124).

The research in the present study was designed in part to explore whether normal-achieving students employ memory strategies to a greater extent when compared to a group of potentially learning disabled students. The above literature review strongly suggested that by using all picture stimulated memory tasks, the investigator would eliminate the possible confounding effects that a word-stimulated memory task may create. The research cited indicates that when information is deverbalized, LD students' ability to recall is similar to normal-achieving students. Thus, one could suggest that any memory differences emerging on a deverbalized task could be explained in terms of efficiency and use of memory strategy since verbal encoding problems which many LD students are reported to experience would be controlled.

Studies on Memory Strategies

Torgesen (1980), in a meta-analysis of seventeen studies on memory comparing normal-achieving students with LD students, concluded, "LD children as a group are consistently less planful and less organized in their approach to memory tasks than children who learn normally" (p. 366). Several studies indicate that LD children may fail to utilize memory rehearsal strategies to the same degree as normal-achieving students. An approach often used in the investigation of rehearsal strategies was to observe students for the serial position effect during recall for evidence of 'primacy effects' (memory for the first few items in a list of things to be remembered). The assumption here is that the primacy effect results from the extra rehearsal of the earlier items on the list. Conversely, the recency effect is defined as a good memory for the last few items in a list, and therefore doesn't require the employment of a memory strategy to enhance retention.

Bauer (1977) carried out a study designed to look at the primacy effect for word lengths on recall. The subjects were 24 ten-year-old children, half of whom were identified as having a learning disability. Bauer (1977) tested immediate and delayed recall for word lists, ranging in length from three to twelve words. The delay interval was unfilled for this study. Bauer found that with the three-word list, both groups were equal on immediate recall, but the disabled group performed worse at delayed recall. With longer lists, the disabled group showed a weaker primacy effect, but there was no difference in recency except with delayed recall of the 12-word list. Bauer interpreted these results as indicating a rehearsal deficit in the disabled group. He reasoned that immediate recall of a three-word list requires little rehearsal, whereas the delayed recall of such a list requires active rehearsal. The reduced primacy effect with longer lists is interpreted as demonstrating that the LD students didn't rehearse the words to the same extent as their normal achieving peers. Torgesen (1982) has observed that "one of the most important aspects of this study is that it shows a relationship between a processing activity in short term memory (elaborative encoding) and acquisition, or learning rate"

(p. 127). However, Torgesen cautions the reader that differences in the primacy recall does not necessarily reflect differences in elaborative encoding strategies employed by the students.

Torgesen & Goldman (cited in Lloyd, Hallahan & Kauffman, 1980) investigated the use of verbal rehearsal as a memory strategy in normal and LD readers. Each student was presented with 25 familiar pictures and instructed to remember their serial order. The investigators recorded lip movements as one indicator of the use of verbal rehearsal as a memory strategy. They concluded that normal readers were able to recall more pictures, and engaged in more verbal rehearsal. However, when both groups were instructed to point to and name each picture, the recall differences between the groups was eliminated.

Done & Miles (1978) also investigated rehearsal strategies in LD and normal-achieving readers by designing a study which employed filled and unfilled delays in recall. They presented adolescent readers with sequences of digits in a tachistoscope for two seconds. The subjects were required to place the digits in correct order either after a filled delay, or after an unfilled delay. The researchers suggested that the filled delay would eliminate the use of rehearsal strategies. They concluded that normal readers were superior to the disabled readers in the unfilled situation, but performed similarly on the filled delay task.

The authors suggested that while the filled delay task eliminated the possibility of incorporating rehearsal strategies, the unfilled delay task provided each group with the opportunity to make use of such rehearsal strategies. Done and Miles suggest that the normal group's superior recall performance on the unfilled task indicates that they were better able to make use of memory rehearsal strategies, compared to their LD counterparts.

Torgesen (1977) also investigated the memory strategies employed by fourth grade LD and normal achieving students, using a category recall task and a serial recall task. In the category recall task, the subjects studied 24 pictures for two minutes, during which time they were free to move the pictures around. Each picture belonged to one of several conceptual categories. Recall simply involved having the students name the pictures. In the serial recall task, the subjects were shown a series of pictures which each student viewed individually by pressing the appropriate button. Each student was instructed to study the pictures so that they could recall them in left to right order. Torgesen found that LD readers recalled less on both tasks. He also observed differences in the study behavior of the two groups. In the category recall task, the disabled readers categorized the pictures less while studying, spent less time moving the cards about, and verbalized less. In the serial recall task, Torgesen reported that the disabled readers were less ordered in the pattern of button presses, and named the pictures less.

In an earlier study Parker, Freston, & Drew (1975) reported on LD students inability to take advantage of externally organized material. Parker et al. (1975) compared the recall performance of 30 LD and 30 non-LD ten year old students. The study was designed to investigate the extent to which recall was influenced by the organization of the input stimulus (word lists) and the level of difficulty of the items. The materials used in this study consisted of 12 lists of 5 stimulus words. Four extremely difficult lists, four lists of intermediate difficulty, and four lists of low difficulty were constructed. The same items were used for the organized (conceptual categories such as animals, flowers, foods, etc) and for the unorganized list. Thus for each conceptual category there was a list of high, intermediate or low difficult words. On the unorganized list the items were randomized. The stimulus items in each list were read to the subjects as they looked at them. Parker et al concluded, "for the normal group both material organization and level of difficulty influenced the amount of recall; for the disabled group, only the level of material difficulty influenced recall" (p. 53). With these findings, Parker et al offer the suggestions that, "LD children are unable to take mnemonic advantage of externally organized material to the same extent as their normal counterparts" (p. 53). The LD students seemed unable to take memorial advantage of the organized information, in that their recall on both the organized list and the unorganized list was not significantly different.

Shepherd, Gelzheiser, & Solar (1985) report a somewhat different finding. Their investigation comprised two studies involving 110 LD and 110 non-LD students between the ages of 9 and 15 years. The first study was designed to explore the use of categorical organization during recall. The stimuli used were line drawings of common objects that could be grouped into four categories. The procedure was to present the students with the drawings and observe them for the employment of grouping or categorization of the stimulus during input and recall. The authors conclude, "the proportion of LD and non-LD subjects sorting the pictures into categories to study did not differ, but at recall the non-LD group used more clustering" (p. 556). Their second study used the same subjects in a paired-association recall task designed to investigate differences in the use of elaboration as a memory strategy. Subjects were tested using lists of 25 pairs of concrete nouns. The students were shown cards with the paired words printed on it. They were instructed that later they would be asked to recall the words. When the student viewed all the 25 word pairs, they were shown cards with only the first word printed on it.

Their task was to say the word that was paired with the stimulus word on the first viewing. At the completion of the task, the students were probed to establish what they did to remember the words. Any verbal report that the student had created a visual or verbal relationship between the two words was coded as an elaboration. Shepherd et al concluded "the LD subjects were significantly less likely than were non-LD subjects to report the use of elaboration when learning word pairs...and earned a significantly lower mean recall score" (p. 558). In a discussion on their findings, Shepherd et al pointed out that some LD students did use memory strategies and some non-LD students failed to. For this reason, the authors caution against a categorical statement suggesting that all LD students fail to use learning strategies; rather, these authors present the view that as a group LD students seem to use strategies less often than their normal-achieving peers.

Dallago & Moley (1980) were interested in examining the use of category clustering or grouping as a memory strategy in three different instructional situations. The subjects for this study were 9-to 11-year-old disabled and normal readers. They were randomly divided into three experimental conditions, each consisting of an LD and normal group. The subjects in each condition were tested twice for the recall of pictures belonging to three conceptual categories. The first test involved a base line recall of the pictures without study instructions. On the second testing occasion, the children in each condition were given varying study instructions. The semantic condition involved giving the children the category labels with instructions to sort the pictures into the three categories. In the formal condition the children had to sort the pictures according to color. Finally, in the free sort condition, the children were told to categorize the pictures in any way that would help them. Dallago and Moley report that the disabled students were found to have lower recall scores. However, they reported that the various experimental conditions had equivalent effects on both the LD and normal achieving students. Their results did show that LD readers displayed less category clustering in the free sort condition. This study also indicated that the LD group were able to make use of the conceptual groupings when cued to do so. One might suggest that their inability to take advantage of the conceptual groupings in the free sort condition is not the product of LD students' inability to conceptualize the between item relationships, within each group, since they were able to correctly group items when instructed to do so. Rather, it may be hypothesized that their lack of conceptual grouping on the free sort task may be further proof that LD students do not actively engage in some memory tasks in a manner that makes maximum use of their innate memory abilities.

Wong (1982) directed her attention to the use of retrieval strategies rather than storage strategies. She hypothesized that "LD children would demonstrate substantially less organized strategies and self-checking behaviors in selecting the retrieval cues than gifted and normal-achieving children" (p. 33). Wong's subjects were gifted, normal-achieving, and LD children from grades 5, 6 and 7. Each group of ~~gifted~~, normal-achieving and LD students were subdivided into two groups: experience and non experience. In the experience group the children had a story read to them as they simultaneously read it. Then they were asked to recall it by writing it down. After writing down the story, each child was given a pile of index cards with one "idea unit" typed on each card. The typed idea units were in the same sequential order as the original story. The children were asked to select 12 cards that they would like to have as retrieval cues if they were asked to remember the story. The procedure for the non experience group was identical to the above except that the children were not required to recall the story prior to their selection of the 12 unit cards. Each child from both groups was individually interviewed to have them justify their choice of the unit cards. Wong concluded,

> LD children lacked self-checking skills. Moreover, they were less exhaustive than the others in their selective search of retrieval cues. Unlike the gifted, both normal-achieving and LD children failed to choose retrieval cues of maximum use in aiding recall. (p. 33)

The research cited above indicates that as a group LD students do not take advantage of memory strategies such as verbal rehearsal, association, and elaborative encoding to the same extent as their normal achieving agemates. It also suggests that they don't take advantage of the memory strategy, categorization, even though they seem able to conceptualize the relationships between items within a group. The research also leaves one questioning the LD students level of involvement in tasks requiring the retention of information.

Metamemorial Knowledge and Memory Performance

Hagen (1972) attempted to identify two variables which influence an individual's performance on memory tasks: (1) awareness that memory is possible and desirable; and (2) awareness of oneself as an actor. These variables have come to be known as METAMEMORY, defined by Flavell (1977) as "the individual's knowlege of anything germane to information storage and retrieval" (p.213). Borkowski & Kurtz (1984) simplify this definition of metamemory to "verbalizable knowledge about memory" (p. 198). Cavanaugh & Borkowski (1980) suggested that "knowledge about memory" refers to a person knowing what memory strategy might be needed, an awareness that several strategies can be used in a particular task, and knowing when the same memory strategy can be used in different situations.

In summarizing a discussion put forth by Flavell &

Wellman (1977) on the individual's development of metamemorial skills, Flavell (1978) identifies SENSITIVITY to memory as being one necessary prerequisite for good memory. Flavell's (1978) "sensitivity" refers to an awareness on the part of the individual to understand "what situations call for intentional memory-related behavior, and which situations don't" (p. 214). Flavell also offers his perception of the major variables that influence memory performance: PERSON variable; TASK variable; and STRATEGY variable. The person variable is defined as "performance relevant characteristics of the information processor" (p. 214). Kreutzer, Leonard, and Flavell (1971) provide the reader with a brief descriptive summary of what they perceive the early development of the PERSON variable to entail:

> There is much for the child to discover about those temporary and enduring attributes and states of human beings which are relevant to data retrieval...He will gradually become aware that he can learn and remember things through his own, self-initiated mental activity. (p. 1)

Flavell (1978) defines the TASK variable as "performance-relevant characteristics of the memory task or problem" (p. 214). Kreutzer, Leonard, & Flavell (1975) provide the reader with a rationale for identifying knowledge about the demands of a memory task as one of the major factors which influence memory performance.

> ...he could learn that a retrieval problem is easier if the body of information to be recalled is small, familiar and meaningful, well organized

> and so on. For instance, having only to remember the gist of a long prose passage is a much less-demanding retrieval problem than being asked to retrieve it word for word. (p.2)

Flavell (1978) defines the last variable, the STRATEGY variable as "the potential solution procedures". (p. 214). In discussing the strategy variable Kreutzer et al (1975) state:

> The child has the possibility of acquiring an almost limitless repertoire of deliberate and conscious memory strategies: planful storage strategies that aim at facilitating future retrieval when confronted with intentional recall problems; and intelligent retrieval strategies that aim at facilitating present retrieval, whether the retrieval problem has been expected (intentional) or not (incidental). (p. 2)

Flavell (1977) suggests that as individuals acquire an understanding of how the PERSON, TASK, and STRATEGY variables interact with each other, their ability to adapt to the demands of various memory situations will be enhanced. In discussing the complex interactions of the identified variables, Kreutzer et al (1975) state:

> ...the storage and retrieval he/she should select may jointly depend upon his estimate of his own strengths, weaknesses, and preferences as a learner; upon numerous properties of the information presented; and upon the amount and kind of retrieval demanded by the task. (p. 2)

Thus, a learner's approach to a memory task depends on the previous knowledge he/she has acquired regarding individual memory strengths, types of memory tasks, and the demands of retrieval. Flavell (1977) suggests a bidirectional relationship between knowledge about memory and memory behavior.

Parallels may be drawn with Sternberg's (1979, 1980, 1984) componential conceptualization of the individual as an information processor. In his theoretical model the metacomponents, which control the executive processes, continually expand in knowledge and efficiency via the feedback from both the performance components and the knowledge acquisition components. Perhaps, a similar feedback loop accounts for the hypothesized increase in metamemorial knowledge as the development of the individual unfolds.

While Sternberg (1979, 1980) theorizes that all processing is controlled by the metacomponents, Flavell (1978) identifies two conditions under which metamemorial knowledge is likely to influence memory behavior,

> (1) When it has to do with the relation between one's present memory state and the goal state one wants to achieve; and (2) when the motivational and other resource-allocation factors are favorable for translating mnemonic knowledge into appropriate mnemonic action. (p. 230)

It may be possible for an individual to acquire the metamemorial knowledge, but not take full advantage of this knowledge by failing to make the transition from metamemory knowledge to effective memory behaviors. Again the voluntary activity level of the student is focused on in much the same way as Torgesen's inactive learner.

One frequently stated rationale presented in studies investigating the memory-metamemory connection is presented by Borkowski & Kurtz (1984).

> A child who has an accurate, perceptive understanding of how her mind works should be more persistent, experience greater success via selected strategy use, and correctly reason that good performance is due to controllable factors such as effort and strategy deployment. (p. 337)

The metacognitive approach is not without its controversy, however, Fiebel (1985) pinpoints one area of debate.

> Does metacognition simply involve the processing of a greater number and different types of phenomena--but in a manner that is not different from any other type of cognitive processing--or is there actually a qualitative difference in the way people deal with phenomena and with their knowledge of these phenomena? (p. 248)

This is a complex theoretical issue, the resolution of which will come through more empirical research on the relationship between metacognitive variables and variables defined traditionally as simply cognitive.

The Strategy Use-Metamemory Relationship

Cavanaugh & Borkowski (1980) were interested in investigating whether there exists a developmental relationship between memory and metamemory. Subjects for the study were 178 school children from kindergarten, first grade, third grade and fifth grade. The hypothesis examined in the investigation was stated as: "Individuals possessing well-articulated metamemory may be more likely to demonstrate strategic behavior than persons with less metamemory" (p. 442). Metamemory was assessed using the

Kreutzer et al (1975) test battery. Memory strategies employed by the students were assessed by having each student do three memory tasks. A free sort task allowed children to use any strategy to learn a categorizable list. In a cognitive cueing task, the experimenters provided category pictures as cues for both storage and recall of a categorizable list. In an alphabet search task, the children were given an unanticipated recall test of randomly presented letters. Cavanaugh & Borkowski (1980) suggested that organizational strategies during storage (sorting items into groups) and recall (clustering, organizing memory search) should enhance item retention on all three tasks. They concluded that developmental changes in the strength of the relationship between metamemory and memory were observed, as well as moderate but fairly consistent correlations between verbalizable metamemory and memory performance. In discussing their findings Cavanaugh & Borkowski state:

> These results seem to suggest that what one knows about memory is related not only to how one goes about memorizing but also to how well one performs, and that similar metamemory-memory links are likely to appear in multiple tasks. (p. 451)

However, their study also indicates that a high metamemory score is not a good predictor of memory strategy use on the part of an individual. Verbalizable metamemory is not indicated to be a necessary prerequisite for good memory since some of the subjects scored low on the metamemory battery and high on memory scores, or vice versa. Cavanaugh & Borkowski (1980) state, "a causal hypothesis linking metamemory to memory is not supported by the present findings" (p. 451).

Douglas (1981) compared the performance of LD and normal achieving students using the Kreutzer et al (1975) metamemory battery. He concluded that both groups demonstrated familiarity with external storage strategies, but only the normal-achieving students showed an understanding of the more sophisticated internal strategies such as cumulative rehearsal.

Byrd & Gholson (1985) designed a study to explore the metamemory-memory relationship as one variable of interest (the study also investigated the relationship between metareading and reading skills). The subjects for the study were 40 second-grade and 40 fourth-grade students. Metamemory was assessed using the Kreutzer et al (1975) battery. The memory tasks were those used in the Cavanaugh and Borkowski (1980) study cited earlier: free sort; cognitive cueing; and alphabet search. They concluded:

> Significant but low correlations were revealed between several of the memory and metamemory items. Study behavior during the free-sort task was related to knowledge about memory, and recall and clustering were significantly correlated to metamemory. (p. 434)

Trepanier (cited in Borkowski & Kurtz, 1984) compared LD and normal-achieving students on their knowledge of their memory abilitites, their knowledge of the ease of immediate versus delayed recall, and memory estimation skills. His conclusions suggest that LD children were often inaccurate in judging their own memory skills and the memory skills of their friends. He theorizes that this inaccuracy may be the result of inadequate metamemory development.

Borkowski & Kurtz (1984) designed a study to investigate the relationships of metacognitive knowledge, strategy use, and the effects of training in one or both. Sixty first and third grade children were divided into three treatment groups: strategy instruction; metacognitive training; or both strategy use and metacognitive training. A metamemory-strategy use pretest-post test was employed as a method of comparing metamemorial knowledge and strategy use before and after training. Borkoswki and Kurtz concluded:

> Post-training scores on the memory tasks showed that strategy training was highly successful. Metacognitive training appeared to have no effect on the metamemory or strategy score with one exception: metamemory and strategy use were significantly correlated for children who received metacognitive and strategy training. Apparently, children who were initially high in metamemory skills profited more from the comprehensive training package. (p. 335)

Contrary to what they expected, the children who received both strategy use and metamemory training were not at an advantage in terms of strategy use when compared to students who only received the strategy training. Borkoswki & Kurtz interpret these findings as an indication that "metamorial knowledge takes place over a long period of time, following multiple cognitive experiences with strategies" (p. 350). These conclusions ultimately question the effectiveness of metamemory training. However, Borkoswki and Kurtz emphasize that their results support the notion that a high metamemory score predicted the maintenance and generalization of study strategies.

> Children initially high in metamemory, who received metamemory instruction, generalized the experimenter-trained strategies to transfer tasks consistenly better than children lower in initial levels of metamemorial knowledge. (p.352)

Thus pretest metamemory scores did seem to be an indicator of the student's ability to take advantage of what he/she learned and to apply it to other memory tasks relevent to the memory strategy. Although the metamemorial knowledge-memory strategy use relationship is not a consistent one, there do seem to be advantages of an individual processing verbalizable knowledge about memory.

Summary

The above literature review indicates that LD and NA students perform similarily on memory tasks which involve unintentional memory. However, when subjects are informed about the need to remember, NA students are able to recall more written stimuli (Lloyd et al, 1980, Ceci, 1984), while recalling similar amounts of pictured stimuli (Done & Miles, 1978, Ritchey, 1980). In addition, research also indicates that, compared to NA students, LD students tend to underutilize memory strategies such as rehearsal (Bauer, 1977; Done & Miles, 1978), categorization (Parker et al, 1975; Torgesen, 1977), grouping (Dallago & Moley, 1980), and association (Shepherd et al, 1985). In addition, LD students were reported as lacking self-checking skills and being less exhaustive in their search for retrieval cues (Wong, 1982).

In trying to account for memory differences in children, researchers began to theorize and investigate whether there exists a link between what one knows about memory (metamemory) and one's use of memory enhancing strategies. However, studies investigating this dimension of memory are few. One study (Cavanaugh & Borkowski, 1980) concluded that there is a connection between what one knows about memory and how one goes about memorizing. Yet, they also conclude that verbalizable metamemory is not a prerequisite for good memory. Similarily, recall and clustering were reported to be significantly correlated to metamemory (Byrd & Gholson, 1985). In addition, high metamemory scores predicted the incorporation and generalization of memory strategies that were taught to children (Borkowski & Kurtz, 1984).

The metamemory-memory connection has also been investigated to try and better understand the learning problems of Learning Disabled (LD) students. It has been theorized that perhaps LD students' reported behavior of not incorporating memory strategies to the same extent as their NA peers is the result of a lack of knowledge or awareness about the workings of their memory system. One recent study concluded that LD children are often inaccurate in their estimation of their memory abilities, and those of their peers (Trepanier in Borkowski & Kurtz, 1984) and verbalized less knowledge about memory strategies such as cumulative rehearsal (Douglas, 1981).

The present study was designed to look at all three dimensions of memory together: students' ability to recall 15 pictured objects; strategies they incorporate while studying the pictures; and their verbalizable knowledge about memory functioning. This research investigated these variables using NA students and students diagnosed as potentially learning disabled (PLD). Furthermore this study controled for the possibility that any observed difference in the use of categorization as a strategy was not the result of students' inability to categorize objects/stimuli into groups. All students were presented with a categorization task aimed at establishing whether or not they could conceptualize the relationships between items. As well, this research controled for the possible confounding effects that written stimuli would possibly present to LD students by having 15 pictured objects as the material to be remembered.

Finally, this study addressed the need for a further test of intentional-unintentional memory, using pictured stimuli. First of all, do intentional memory tasks yield greater recall performance than unintentional tasks, using pictured stimuli? Secondly, would normal achieving students perform better than potentially learning disabled students on intentional tasks and not on unintentional tasks?

In summary, this research was designed to investigate whether memory differences exist between PLD and NA students on such dimensions of memory as recall, strategy use, and verbalizable knowledge about memory. The memory performance of both groups was examined in two situations: unintentional memory; and intentional memory. Finally, the design of the study allowed the researcher to compare the groups on two additional variables: (a) their perceived competence; and (b) their perceptions of the task difficulty.

CHAPTER III

METHODOLOGY

Subjects

The subjects in this study were two groups of fourth grade students enrolled in ten schools under the jurisdiction of the Roman Catholic School Board for St. John's during the 1985-86 academic year. One group was made up of 21 Potentially Learning Disabled (PLD) subjects, selected on the basis of an ability-achievement discrepancy formula. The second group included 24 Normal-Achieving (NA) students selected from students having an IQ between 85-115 and functioning academically at or better than grade level. Intellectual ability was determined by the Canadian Cognitive Abilities Test which was administered by the School Board to all grade four classes, while achievement was assessed with the Canadian Test of Basic Skills, also administered to the grade four classes as a group test. Students assessed as having an IQ score between 85-115, and functioning 1 1/2 grade years below their agemates in either reading, math, or both were classified as being potentially learning disabled (PLD) students. The subjects in the NA and PLD groups were matched as closely as possible on IQ, using the average of scores on the Verbal and Nonverbal scales. Although effort was made to match the two groups on sex as well, the screening procedure resulted in the selection of more boys (n=27) than girls (n=18). Mean achievement and intellectual ability scores for the two groups are presented in Table 1. While the two groups differed significantly on both reading and math achievement ($P<.001$), the analysis of variance confirmed the adequacy of the intellectual ability matching.

Throughout the data collection phase of the study neither the researcher nor the research assistant knew which students made up the PLD group. This information was in the possession of the educational psychologist working for the School Board.

Research Design

The design of this study involved an experimental comparison of 24 PLD and 21 NA grade four students on several experimental tasks. The tasks included a group-administered picture recall task (see Appendix C) an individually administered picture recall task, and a metamemory task.

The design encompassed two studies: a main study (Study 1) and a sub-study (Study 2). Study 1 employed a single classification design and had the following two-fold purpose: (1) to examine differences between PLD and NA students on several dependent variables; and (2) to examine the interrelationships among variables both within and across groups. The dependent variables in Study 1 were: recall performance; index of strategy use; study time;

Table 1

Means, Standard Deviations (in brackets) and F-Tests for Achievement (Grade Equivalents) and Intellectual Ability Scores

	NA	PLD	F
Reading Grade Equivalent	4.3	2.7	120.33***
Math Grade Equivalent	4.4	3.3	40.57***
Verbal IQ	100.38 (6.50)	98.04 (5.39)	1.69 NS
Non Verbal IQ	100.23 (8.69)	96.17 (7.96)	2.61 NS

***<.001

NS= Nonsignificant

metamemory index; categorization skills; perceived task difficulty; and perceived relative competence in task performance. All the 24 PLD and 21 NA students were given the same tasks and instructions.

Study 2, the sub-study, employed a 2 (category of student) x 2 (type of task) factorial design to examine differences betwen PLD and NA students on intentional and unintentional memory. The memory task was a group-administered picture recall task. Some of the subjects in each of the two categories of students were specifically instructed to study the pictures for later recall (intentional memory), while others were told only to study all the pictures carefully to identify missing parts but later asked to recall the pictures (unintentional memory). Sample sizes for the various conditions are presented in Table 2.

Instruments

Study 1

Individual Recall Task. The stimulus for the recall task was developed by the researcher by selecting 15 common objects representing second grade level nouns from the Dolch Word List (Dolch, 1955). Single line drawings were found for each object and reproduced on individual cards, with each card having one pictured object on it. The back of each card was numbered to enable the examiner to lay the

Table 2

Sample Sizes: Group by Memory Type

	Intentional (n=19)	Unintentional (n=21)
NA(n=21)	8	13
PLD(n=19)	11	8

cards out in the same sequence for each student.

The 15 pictured objects were from one of three common categories, which provided the opportunity for the efficient memorizer to group the pictures during input. The three categories were as follows:

1) Things you wear: glove, hat, shoes, crown, and socks.
2) Furniture: table, bed, chair, lamp, and desk,
3) Body Parts: hand,nose, foot, eye, and ear.

Metamemory Tasks: The metamemory instrument administered in this investigation was adopted from Borkowski and Kurtz's (1984) modified version of the metamemory battery developed by Kreutzer, Leonard, and Flavell (1971). The battery included verbally presented hypothetical everyday situations aimed at eliciting information on various aspects of children's knowledge of their memory. For example, the Story List situation assesses the child's knowledge of the efficiency of elaboration. Each student was shown eight pictures (a man, bed, tie, shoes, table, hat, and car) and asked if the items would be easier to recall after hearing them named, or after hearing a story that included all eight. The Preparation Object metamemory item is considered to provide an indication of the child's ability to systematically search memory for a lost object. Rote Paraphrase determines if the subject acknowledges the relative ease of gist recall over verbatim recall.

A question asked at the end of the individual memory task which assessed students' knowledge of the efficiency of grouping was also included in computing the metamemory score. The question asked whether it would have been easier to remember the 15 pictured objects if the groups of common objects had been presented together (see Appendix B for Metamemory instrument).

Study 2

Study 2 involved a group task only. The instrument for this group task also consisted of 15 line drawings of common objects selected from the second grade level of the Dolch Word List (see Appendix C). The pictured objects were all of equal size and placed on one page. Four of the pictured objects had missing parts (e.g. the car didn't have a door), a feature which made it possible to present the stimulus to the unintentional groups as a search task. The 15 pictured objects were from one of three common categories;

1) Means of transportation: truck, car, train, bus, and boat.
2) Animals: rabbit, cat, dog, cow, and horse.
3) Things you eat: candy, pie, bread, ham, and apple.

The pictures were located on the page such that: (1) no two objects from one group were adjacent to each other; and (2) the objects were not in well defined columns or rows.

Testing Procedures

Both Study 1 and Study 2 were administered in the school that each student attended. In all, there were 10 city schools in the investigation. A research assistant collected data from four of the schools during the same time period as the writer collected data in the other six schools. The assignments of schools was done in such a way as to ensure that each tester had approximately the same number of PLD and NA students, while at the same time taking into consideration geographic location of the schools. Both the writer of this report and the research assistant underwent approximately 4 hours of training which included practising directions and procedures for the administration of both Study 1 and Study 2.

No student in the investigation was administered both Study 1 (individual), and Study 2 (group) on the same day. In all cases Study 2 was administered first, in an attempt to reduce the possibility that the Unintentional Memory groups of Study 2 would become aware of the fact that the task was actually a memory task.

Study 1

The tasks in Study 1 were administered in a one hour sitting. Each student was seated at a small table or desk directly across from the examiner. Fifteen picture cards were laid out in front of each student. He/she was instructed that his/her task was to try to memorize for later recall as many of the pictured objects as he/she could. Each student was told that he/she could do anything he/she wished to help them remember the pictures. The picture cards were placed in the same order for each student, with no two pictures from one category placed together. Each student was requested to tell the examiner when he/she had finished studying the pictures. A maximum time limit of five minutes was allowed. However, each student was inconspicuously timed, starting when all the cards were laid out and stopping when the student told the examiner that he/she had finished. During the study time the examiner observed and noted any observable strategies such as lip movement, counting, scanning, or any other observable learning strategy. Card manipulation was noted, especially with respect to organization and/or gathering the cards into common groups, or combining cards from the same category. When the student stated that he/she was finished, the cards were collected and he/she was given a pencil and paper and asked to write down as many of the objects as he/she could remember. It was stressed to students that spelling wasn't important, and if he/she wanted to know how to spell a word he/she could ask the examiner. When the student finished writing as many as he/she could remember, the examiner collected the sheet and asked the following questions designed to provide information on how the student went about remembering the pictured objects.

1. How did you learn the list? What did you do to be sure that you would remember the pictures? What else did you do? Anything else?
2. Why did you learn the list in that way?
3. Are there any other ways you could have used to study the pictures?

The pictures were again laid out on the table in the original order. If the student used grouping or categorization during the study period, he/she was asked how many categories he/she had and which pictures were in each category. If the student didn't use grouping or categorization, a check was made to establish if he/she had the ability to categorize (i.e., a categorization concept). The students were asked to arrange the pictures in three groups by putting together all pictures which were similar, or had something in common and to label each group. Each student was then asked whether it would have been easier to memorize the pictures if he/she had been presented with the pictures from each category grouped together. This question was scored as part of the metamemory score since its aim was to establish the students knowledge about memory and conditions that made memory easier.

Immediately following these probes, students were asked questions designed to: (a) have them rank the difficulty level of the individual memory task (see Appendix D); (b) have them rank their own performance in comparison to other classmates who did the same task (see Appendix E); and (c) to determine if they counted the cards while learning them (see Appendix F, question 3).

The final phase of Study 1 consisted of verbally presenting, individually, the condensed version of the Borkowski & Kurtz (1984) version of the metamemory battery (see Appendix B) designed to elicit information on various aspects of the students' verbalizable knowledge about their memory. This phase makes up the major part of the metamemory score in the analysis section.

Study 2

The memory task in Study 2 was administered in a group setting. Each student was given a page with the 15 pictured objects on it. The Intentional memory group was instructed to study the pictures to: (a) find the pictures with missing parts; and (b) study the pictures for later recall. The Unintentional memory group was only instructed to study all the pictures carefully in order to identify those with missing parts. (During the examiner training it was discovered that the picture of a "ham" on the picture sheet was not clearly recognizable. The examiners agreed that following the instructions each examiner would focus the attention of each group on the location of the picture and inform them that it was a ham). When each group finished studying the pictures, the picture sheets were collected and each subject was given a pencil and paper. The examiners asked students to write down as many of the pictured objects as they could remember. It was emphasized that spelling was not important. The recall sheets were collected and the students were dismissed.

Scoring

In all 7 different scores were derived for analysis. While Study 1 involved all 7 scores, Study 2 involved a single score. Relative Difficulty Score (see Appendix D) and Perceived Relative Competence (see Appendix E) were each based on one question requesting subjects, respectively, to rate the difficulty of the task and the way they perceived their competence in relation to their agemates. Study Time (ST) was the amount of time it took each subject to learn the 15 stimuli in the individual memory task. The remaining four scores are described below.

Recall Score (RS)

In both Study 1 and Study 2, the RS was simply calculated by counting the number of pictures that the student was able to correctly remember.

Index of Strategy Use

The Index of Strategy Use (ISU) score was derived from analysis of protocols for each student. Protocols consisted of: (a) the tester's observations during task performance by each student; and (b) students' verbal responses to probes designed to find out how they went about memorizing the 15 pictures (see Appendix G). A list of all strategies emerging from the protocols was drawn up. Five graduate students of Educational Psychology were then asked to rank the strategies from highest to lowest, in terms of efficiency. The resulting ranks were compared to the researcher's own ranking of the various strategies. Minor disagreements, mainly over the more lower-level strategies were resolved through consultation with the author's thesis advisor. Weights were then assigned to each strategy, with the high-level, more efficient strategies attracting greater weights. Two additional points were awarded to students who monitored or checked their performance while doing the individual memory task. The maximum score attainable on the Index of Strategy Use was 16.

To establish reliability, approximately 10% of both the PLD and the NA group were scored by the author and by a second scorer. This process involved randomly selecting verbal protocols and examiner notes for two subjects in each group. Both scorers then independently computed the ISU score. As Table 3 demonstrates, both scorers computed scores which were in perfect agreement.

Index of Categorization Skills (ICS)

The categorization task was administered immediately following the recall task. It involved the examiner laying the cards out a second time and asking the student to sort them into groups of pictures which had something in common.

Table 3

Comparison of Author's Scoring with Independent Scoring of Strategy Use for Randomly Selected Students

Category of Student	Author's Score	Independent Score
PLD	7	7
PLD	10	10
NA	12	12
NA	9	9

Points were awarded relative to the degree of accuracy and logic in grouping the items (see Appendix G). Students who correctly used categorization or grouping as a memory strategy when studying the 15 pictures in the individual memory task were awarded full ICS points. The maximum points attainable was eight.

Metamemory Index (MI)

The MI involved scoring the response that each student made to the four hypothetical situations presented verbally by the examiner (see Appendix B for a detailed account of the situations presented, questions asked and scoring procedures).

Story list. This task presented subjects with the situation that two girls had to try to remember eight pictured objects. One girl only saw the pictures while the other girl saw the pictures and heard a story about all eight items. Each student was asked to decide which situation made it easier to remember, which girl would learn the most, and why. Points were scored if the student stated that the story made it easier (1 point), and the girl that heard the story would remember more (1 point). Points were also awarded if the student was able to verbalize an awareness of the effect of elaboration on retrieval (maximum points = 4).

Preparation object. The examiner presented the hypothetical scenario that he/she was going skating the next morning, and asked the subject what he/she would do to make sure that he/she would not forget his/her skates. The possible answers were grouped into four categories: (1) external cues related to the object (skates); (2) external cues relying on others (others); (3) external cues through the use of another object (e.g. a note); and (4) relying on the internal processes of self. One point was scored for each category used. (If a student had two answers from one category, he/she only received one point).

Retrieval object. The student was asked to assume that he/she lost a jacket and to indicate how he/she would go about finding it. The possibilities were separated into seven categories of answers; (1) likely places he/she may have left it; (2) retrace steps; (3) ordered search; (4) check lost and found; (5) exhaustive search; (6) get others to help search; and (7) check with others to see if they found it. One point was awarded to the student for each category suggested as a retrieval strategy.

Rote paraphrase. This situation presented the student with a fictional character who has to learn a story by listening to it. Each student was asked a series of questions related to the task and awarded points if they: (1) verbalized an understanding of how recalling word for word is more difficult than recalling the gist; (2) demonstrated an understanding of the advantages of the fictional character knowing the task requirements before studying (e.g. gist recall rather than word for word); and (3) why it would be easier. Although it was not included in the MI score, each student was asked to generate strategies that the fictional character might use to help remember the story. Both groups were compared on their ability to generate possible study strategies (see Appendix H).

The final set of points included in the MI score was based on a question asked of each student immediately following the individual memory task. This question required him/her to put the cards into groups or categories of pictures that had something in common. Each student was then asked whether it would have been easier to remember the 15 pictured objects if he/she had been originally presented in the groups or categories. Two points were awarded if the student verbalized that the categories would have made it easier to remember the items. The total possible on the Metamemory Index was 30.

The reliability of the MI scoring system was assessed by looking at the agreement between the author's scoring and an independent scorer. The process involved both scorers independently coding and scoring the verbal protocols and examiner notes of two randomly selected students from each group. As Table 4 demonstrates, close to perfect agreement was obtained.

Table 4

Comparisons of Author's Scoring with Independent Scoring of the Metamemory Index for Randomly Selected Students

Category of Student	Examiner's Score	Independent Score
LD	14	14
LD	16	15
NA	23	23
NA	20	20

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The subjects in the present study were 45 fourth grade students. Twenty-one of the subjects were Normal-Achieving (NA), while twenty-four of the students were classified as Potentially Learning Disabled (PLD). The PLD students were selected using a discrepancy formula. Students who were assessed by the Canadian Cognitive Abilities Test to have an intelligence quotient within the average range, but achieving at least 1 1/2 years behind grade level on the Canadian Test of Basic Skills in reading, math, or both were identified as PLD. The NA group were assessed to have an intelligence quotient within the average range and were achieving at grade level or better, in both reading and math.

As revealed in Table I (Chapter III), while the two groups were comparable in IQ, they differed significantly in reading and math achievement. The main purpose of the study, as specified earlier, was two-fold:

(1) to examine NA-PLD differences on a number of recall, strategy use, and metamemory tasks; and

(2) to examine interrelationships among recall, strategy use, and metamemory both within and across groups. These two main objectives were pursued in Study I, the main study. A subsidiary study (Study 2) addressed

group differences in intentional and unintentional memory using a 2 x 2 design. Results are presented separately for the two studies.

Study 1

This study was designed to investigate the following research questions:

(1) Would one group (NA or PLD) be able to recall more of the 15 pictured objects?

(2) Would there be a between-group difference in students' self reported and observed use of memory strategies while studying the pictures?

(3) Would there be group differences in students' verbalizable knowledge about memory functioning?

(4) Would there be group differences in study time?

(5) Would there be group differences in students' perceptions of task difficulty?

(6) Would there be group differences in students' perceptions of their ability to perform the task, relative to their classmates?

(7) Would there be a between group difference in students' categorization skills?

A univariate one-way ANOVA were performed on each of the seven variables corresponding to the above questions. Table 5 provides a summary of the means, standard deviations (SD) and F-values for both groups on all variables

Table 5

Means, Standard Deviations, and F-Values for all Variables

	PLD		NA		
Variable	Mean	SD	Mean	SD	F
Memory Recall	9.5	2.1	10.8	2.4	3.8
Strategy Index	3.4	1.8	4.8	2.0	5.5*
Metamemory Index	17.9	4.5	22.0	3.4	11.1**
Memory Time (seconds)	107.9	54.5	147.2	61.6	4.9*
Task Difficulty	2.8	.6	2.9	.6	.4
Relative Competence	1.7	.6	1.9	.5	2.1
Categorization Skills	4.5	1.3	5.0	1.5	1.9

* $p < .05$

** $p < .01$

investigated in Study 1. Findings in relation to each of the seven variables are presented in the sections which follow.

Recall Performance

As Table 5 shows, NA students recalled slightly more pictures (mean = 10.8) than PLD students (mean = 9.5). However, this difference was not statistically significant. This finding of no significant group difference in recall ability is somewhat surprising, given the body of literature suggesting that NA students are able to recall more items on intentional memory tasks (Bauer, 1977; Torgesen, 1977; Done & Miles, 1978; Dallago & Moley, 1980; Shepherd et al 1985).

However, this result may be explained in relation to the picture superiority effect reported in several empirical studies. It appears that while LD children show poorer performance on verbal tasks, they tend to recall as many pictures or visual forms as their normal achieving peers (Done & Miles, 1978; Hulme, 1981; Ritchey, 1980; Srivastava & Pirohit, 1983; Swanson, 1984).

In a developmental study employing 2nd, 4th, and 6th grade students, Ritchey found that when students were specifically instructed to categorize word and picture stimuli during input, no differences in recall were observed between pictures and words. However, in the absence of specific instructions to categorize, students across the three age levels recalled more pictures than words. Using normal achieving students, Srivastava and Pirohit (1983) also demonstrated that picture stimuli produced better recall than word stimuli. Done and Miles (1978) compared 13-year-old normal achieving and LD students on memory for sequences of digits, pictures, and nonsense shapes. The LD students showed poorer performance only on the task involving verbal encoding (i.e., the digit sequence).

Hulme (1981) has demonstrated that normal-achieving and LD students show comparable memory performance following deverbalization of the stimulus. In an initial study using letter strings as the stimulus, LD readers showed poorer recall performance. When visual forms rather than letters were employed in a parallel study, no differences were observed between the groups of students. Finally, a similar but more complex study by Swanson (1984) showed that while labelling enhanced the normal-achieving students' memory for pictures, LD students performed better on unnamed pictures.

Two related findings have emerged from the body of research on memory for pictures and verbal labels. First, for both normal-achieving and LD children, pictures produce better memory performance. Second, LD children appear to be inferior to normal-achieving students only on verbal tasks. Paivio (1971) attributes this tendency to the fact that pictures are encoded into memory as visual forms with verbal labels attached. This dual coding results in enhanced recall. Nelson (1979), in explaining the picture superiority effect, suggests that a picture may be more differentiating and thus more meaningful than its corresponding verbal label, consequently making pictures easier to remember.

Given the foregoing discussion, an important factor that may have accounted for the absence of a significant between-group difference in recall performance may have been the difficulty level of the task. As will be discussed later, both groups assessed the task as being easy. In fact the average rating of difficulty level from both groups was virtually the same (NA = 2.9; PLD = 2.8). Given the similarity in ratings and previous evidence that LD students generally do not show inferior performance on picture recall tasks, the present finding is not too surprising. It is conceivable that increasing the difficulty level of the task (by using either a longer list or less familiar pictures) might result in better differentiation of the two groups.

Study Time

Interestingly, there was a significant difference ($p<.05$) in the amount of time taken by each group to study the 15 pictures. The PLD group studied the pictures for an average of 107.9 seconds, while the NA group had a mean study time of 147.1 seconds, approximately 40 seconds longer.

These data suggest that as a group NA students paid more attention to the task or spent more time to ensure the careful processing of the information. This finding is consistent with the often reported relationship between impulsivity and low achievement in learning disabled students. One would have expected that the longer processing time taken by the NA students would have resulted in signifantly better recall performance, but such was not the case.

Having found a significant between-group difference in study time, a two-way ANOVA was performed to examine potential sex differences. The results showed an interaction between group and sex, with no sex main effect (Table 6). While NA boys studied the task longer than PLD boys, NA and PLD girls did not differ significantly (see Figure 1). It appears from these data that whatever relationsip exists between low achievement or learning disability and impulsivity is more true of boys than it is of girls.

Strategy Use

Results of the one-way ANOVA showed that the NA group scored significantly higher than the PLD group on the index of strategy use ($F=5.45$; $p<.05$). A 2 (group) x 2 (sex) ANOVA revealed no significant interaction effects.

Two points are worth noting. First, although the two groups of students did not differ significantly in recall performance, NA students showed superiority over PLD students in their choice of efficient strategies. The

Table 6

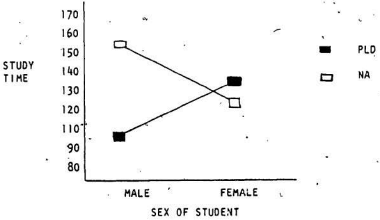
Results of Two-Way Analysis of Variance for Study Time: Group (PLD vs NA) by Sex (M vs. FM)

Source of Variation	Sum of Squares	D.F.	F-Value
Group ID Main Effect	16364.0	1	5.2*
Sex Main Effect	863.1	1	.3
Group x Sex Interaction	13116.8	1	4.1*

* $p < .05$

Figure 1

Group by Sex Interaction on Study Time



correlational analysis (reported later) nevertheless showed a clear relationship between strategy efficiency and recall performance. Second, although NA students were superior to PLD students in strategic behavior, both groups were very low on the strategy index. The mean strategy score for the superior group was 4.8; the maximum score possible was 16. It appears from this data, then, that as a group these grade 4 students tended to use lower level or less efficient strategies. This finding is consistent with the general picture that emerges from developmental studies, namely that younger children (ages 11 and below) employ less efficient strategies than older children or adults.

A descriptive analysis of specific strategies employed by students in the two groups follows. In all, 14 strategies were extracted from students' verbal reports and observer notes on students' overt behaviors during study time. Table 7 presents the 14 strategies and their definitions. Table 8 presents a summary of numbers and percentages of students employing each strategy in the two groups. These strategies are rank-ordered from most to least efficient, based on ratings by five graduate students of educational psychology.

The most commonly employed strategy (used by 47% of all subjects) was unorganized verbal rehearsal. As defined in Table 7, the unorganized verbal rehearsal memory strategy simply involves the repeated rehearsal of all 15 pictures

Table 7

Definitions of Strategies Employed

Strategy	Definition
Categorization	Grouping items together which have some common characteristic(s).
Association	Creating links between two items or between one item and some aspect of knowledge already known.
Elaboration	Mentally adding to given information so as to relate items to be remembered.
Imagery	Forming mental images of items to be remembered.
Chaining & Rehearsal	Repeated rehearsal involving always starting at the first and adding more items to be learned during each successive rehearsal.
Chunking & Rehearsal	Breaking a list into sequented chunks or segments and rehearsing items within chunks at a time.
Inaccurate Categorization	Inaccurately grouping items together which have common characteristics, or some degree of accurate and inaccurate categorization.
Alphabetical Order	Placing the verbal labels of the 15 pictures in alphabetical order.
Unorganized Rehearsal	Repeated rehearsal of all 15 items together.

Spelling Labels	Spelling out loud the verbal labels of each picture.
Ordered Scan	One viewing of the pictures in the order they were presented.
1. Verbalization	Saying out loud and in order the verbal labels of each picture.
2. No Verbalization	Viewing quietly (lip movement) each picture in order.
Random Scan	One viewing of the pictures in random order.
Shapes	Encoding pictures on the basis of shape or shapes in common.

Table 8

Ranking of Efficiency and Frequency of Use for Memory Strategies Employed During Study Time

Strategy	Ranking	Students Using Strategy PLD	Students Using Strategy NA	% of Respondents within Categories PLD	% of Respondents within Categories NA
Categorization	1	1	3	4.2	14.3
Association	2	3	0	12.5	0.0
Elaboration	3	0	1	0.0	4.8
Imagery	4	0	0	0.0	0.0
Chunking & Rehearsing	5	1	2	4.2	9.5
Chaining & Rehearsing	6	0	0	0.0	0.0
Inaccurate Categorization	7	0	1	0.0	4.8
Alphabetical Order	8	0	0	0.0	0.0
Unorganized Rehearsal	9	9	12	37.5	57.1
Spelling Labels	10	1	0	4.2	0.0
Ordered Scan					
1. Verbalization	11	1	0	4.2	0.0
2. No Verbalization	12	5	2	20.8	9.5
Random Scan	13	2	0	8.3	0.0
Shapes	14	1	0	4.2	0.0
Totals		24	21	100%	100 %

together, and therefore neither decreases the demands placed on short-term memory nor increases the organization of the material to be memorized. Only 4 of the 24 PLD group and 4 of the 21 NA group (18% of the total number of subjects) used memory strategies that were ranked as being the 4 best strategies for this task. Surprisingly only 1 PLD and 3 NA students (9%) used the categorization strategy, ranked as the best memory strategy for this particular task.

It appears evident from these results that neither group was able to utilize the more efficient memory strategies while studying the pictures. This is evidenced by the finding that 47% of the students simply rehearsed the 15 pictures, while another 26.5% employed strategies ranked to be even less efficient than the unorganized verbal rehearsal strategy. Approximately 73% of the students in this investigation used memory strategies ranked ninth or lower.

The finding that NA students used significantly more efficient strategies but recalled relatively no more pictures than the PLD students is perhaps further evidence of the picture superiority effect referred to earlier. It appears, as some research shows (e.g., Done & Miles, 1978; Ritchey, 1980), that pictures are relatively easier to memorize and hence may require less strategic effort.

Categorization Skills

As mentioned earlier, only 9% of the students in this investigation used the categorization strategy while studying the pictures. This is especially relevant given the finding in this study that all students were able to successfully complete the categorization task administered after the main memory task. The ANOVA results revealed no group differences in categorization skills. While all students displayed the ability to group together objects that had something in common (e.g. eye, nose), only 4 of the 45 students used categorization as a memory strategy. This finding provides conclusive evidence that students' failure to utilize categorization as a memory strategy was not the result of limitations in their ability to mentally create conceptual categories. The finding is especially important in that it supports Torgesen's contention that many students do not use their intact intellectual abilities to their full extent (Torgesen, 1977).

Metamemory

The NA group scored significantly higher (mean = 22.00; SD = 3.4) than the PLD group (mean = 17.95; SD = 4.1; $p<.04$). The maximum score possible for this index was 30. A 2 (group) x 2 (sex) ANOVA showed no significant interaction effects (Table 9). Thus on the whole, NA students exhibited superior verbalizable knowledge and awareness about memory functioning and strategies. A descriptive analysis of students' responses on the various metamemory subtests follows.

Table 9

Results of Two-Way Analysis of Variance for the Metamemory Index Score: Group (PLD vs. NA) by Sex (Male vs. Female)

Source of Variation	Sum of Squares	D.F.	F. Value
Group Main Effect	183.8	1	10.7*
Sex Main Effect	2.8	1	0.2
Group x Sex Interaction	7.8	1	0.5

* $p < .05$

The subtest which discriminated between the two groups of students more clearly was Preparation Object. The two other subtests--Rote Paraphrase and Story List--did not reveal any clear differentiations between NA and PLD students.

In the preparation object subtest, the students were asked what they would do to help them remember to bring their skates to school the next morning. On average the NA group was able to generate more cues they could use to help them remember (i.e., write a note, move skates, ask for reminder, use of a cognitive memory strategy).

In the rote paraphrase subtest 13 PLD (54%) and 11 NA (53%) said they would simply listen to the entire story to learn it. Five PLD (21%) and 3 NA (14%) said they would listen and rehearse the entire story. Only 3 PLD (13%) and 4 NA (19%) said they would chunk the story into parts and learn it in sequence. The data indicated that the two groups were not very different in their awareness of effective memory strategies for this particular study task.

Both groups demonstrated an awareness of the effect of meaning or elaboration on retrieval, as indicated by their performance on the story list subtest. Both groups displayed the understanding that hearing a story which connected 15 pictures would make the later recall of the pictures easier. While both groups verbalized an understanding of the effects of elaboration on retrieval, only one student used it as a memory strategy while studying the 15 pictures on the individual memory task. Although most students understood the advantages of the elaboration strategy, they failed to use it to increase memory efficiency.

In the same vein, although most students correctly indicated -- following a probe -- that presenting the 15 pictures of the recall task in categories would have made for easier encoding and recall, only 4 of the 45 students in this study (9%) used categorization as a strategy. Both of these findings (i.e., the findings regarding elaboration and categorization) are consistent with evidence from previous research suggesting discrepancies between children's responses to metacognitive questions and their actual behaviours. In one study, Brown and her associates (cited in Brown, 1978) reported that the majority of 4-year-olds, first-graders, and third-graders predicted correctly that given a list of 12 words to learn, categorization and rehearsal would result in better performance than the strategies of labelling and looking. However, as much as 78% of 4-year-olds, 64% of first-graders and 23% of third-graders making this correct prediction actually failed to use the superior strategies.

The results of the present study differ, however, in one important respect, as shown later in the presentation of the correlational data. Despite the discrepancies noted above, the overall index of strategy use correlated significantly with the composite metamemory index.

Task Difficulty

The two groups of students did not differ in their rating of how difficult it was to remember the 15 pictured objects. Both groups assessed the task as being an easy one. Perhaps this finding in part accounts for the finding that although the NA students studied longer, used more efficient strategies, and verbalized more knowledge about memory, they did not recall significantly more pictures. The ease of the task may have neutralized the benefits that a longer study time and a more efficient strategy use would accentuate.

Relative Competence

The two groups did not differ in the way they perceived their competence on this task relative to their classmates. Both groups indicated that they would be able to remember the same amount of information as their peers.

Relationships Among Variables of Study 1

Intercorrelations among the four major variables in Study 1 (recall performance, strategy index, metamemory index, and study time) were calculated separately for the two groups, using the Pearson product-moment correlation coefficient. Tables 10 and 11 report the correlations matrices for the PLD and NA groups, respectively.

As can be seen from Tables 10 and 11, the NA and PLD

Table 10

Intercorrelations Among Recall, Strategy Index, Metamemory Index, and Study Time in the PLD group (n = 24)

Variables	Recall	Strategy Index	Metamemory Index	Study Time
Recall	-	.49**	.22	.54**
Strategy Index		-	.57**	.28
Metamemory Index				.03
Study Time				-

** $p < .01$

Table 11

Intercorrelations Among Recall, Strategy Index, Metamemory Index, and Study Time in the NA Group (n = 21)

Variables	Recall	Strategy Index	Metamemory Index	Study Time
Recall	-	.52**	.66**	.35
Strategy Index		-	.59**	.33
Metamemory Index			-	.39*
Study Time				-

* $p < .05$
** $p < .01$

groups displayed two common correlation patterns (i.e., recall with strategy use; strategy use with metamemory). Regardless of group ID, those students who used the more efficient memory strategies tended to be able to recall more pictures. As well, those students from both groups who verbalized more knowledge and awareness of memory functioning tended to utilize the more efficient memory strategies.

In addition to the common correlations patterns, each group displayed correlation patterns that were unique. The PLD group results indicate a relationship between recall and study time. Those PLD students who studied longer tended to be able to recall more of the 15 pictures. This relationship is not surprising given the quick approach that some PLD students displayed, especially the PLD boys as mentioned earlier.

The NA group also displayed some unique correlation patterns. Those NA students who were able to recall more pictures also had a tendency to score higher on the metamemory index score. In addition, those NA students who scored higher on metamemory also had a tendency to study the task longer.

The correlational results obtained in this study are supportive of findings reported in several developmental studies. Among both NA and PLD students in the present study, strategy use correlated significantly with knowledge and awareness about memory processes. Thus, regardless of academic achievement, students articulating greater knowledge of memory processes were more likely to demonstrate greater efficiency in strategy use. In a developmental study of first-, third-, and fifth-grade children, Cavanaugh & Borkowski (1980) found moderate but fairly consistent correlations between verbalizable metamemory and memory performance. In a second developmental study involving second- and fourth-grade students, Byrd & Gholson (1985) reported significant -- albeit low -- correlations between memory and metamemory items.

It is significant to note that there is one important commonality between the present study and the Cavanaugh & Borkowski (1980) and Byrd & Gholson (1985) studies. All three studies employed an adaptation of the Kreutzer et al (1975) battery to measure metamemory. The consistent results across the three studies provide convincing confirmation of the theoretically hypothesized relationship between strategic memory performance and verbalizable knowledge about memory processes. However, none of these studies has addressed the issue of causality. The theoretical utility of the concept of metamemory will be enhanced significantly as causal relations between knowledge and strategic performance are empirically validated.

Summary of Study 1

The NA students on average recalled more pictures (mean = 10.8) than the PLD students (mean = 9.5) although this difference was not statistically significant. The NA group studied the pictures significantly longer than the PLD group. Furthermore, the NA students as a group tended to use more efficient memory strategies. However, neither group consistently utilized those memory strategies ranked as the top three for this particular task. Both groups demonstrated positive correlations between strategy index scores and recall performance, as well as between strategy index scores and metamemory index scores.

These results suggest the following: (1) normal achievers are superior to potentially learning disabled students both in terms of efficient strategy utilization and metamemorial competence; (2) generally, however, the strategies employed by grade four students are low in efficiency; (3) strategic behavior is related significantly to recall performance; and (4) metamemorial knowledge is related significantly to strategic behavior.

Study 2

This substudy was designed to investigate the following research questions:

(1) Will intentional memory be superior to incidental memory, in terms of recall performance?

(2) Can the often-reported finding that normal-achieving students outperform learning disabled students on intentional memory tasks but not on incidental (or unintentional) tasks be replicated?

In connection with the first research question, it was hypothesized that students instructed specifically to study for later recall would manifest better recall performance than students who were not instructed to study for later recall (although on the basis of research comparing NA and LD students, the effect of specific instruction would be less marked for LD students). That is, a statistically significant main effect for memory type (intentional vs unintentional) was anticipated.

With regard to the second research question, it was hypothesized that -- although intentional memory would generally be superior -- NA students would show superior performance than PLD students on the intentional task, while not differing significantly from PLD students on the unintentional task. Thus, a statistically significant group x memory type interaction effect was expected.

Table 12 summarizes the mean recall scores for PLD and NA students under both the intentional and unintentional conditions, while Table 13 displays the results of the two-way ANOVA performed on the data. As Table 13 reveals, significant main effects for memory type and group were found. These results confirmed the first hypothesis and are

Table 12

Group Means for Unintentional and Intentional Memory Conditions

GROUP Memory Type	PLD	NA
Unintentional	7.9	9.3
(n = 26)	(n = 13)	(n = 13)
Intentional	10.8	12.3
	(n = 11)	(n = 8)

Table 13

Results of Two-Way Analysis of Variance: Group (PLD vs. NA) by Memory Type (Unintentional vs. Intentional)

Source of Variation	Sum of Squares	D.F.	F. Value
Memory Type Main Effect	101.0	1	26.7***
Group Main Effect	26.4	1	7.0*
Memory Type x Group Interaction	.1	1	.03 NS

* $p < .05$
*** $p < .001$
NS = Nonsignificant

consistent with the theoretical formulation, that recall performance tends to be better under intentional conditions than under incidental conditions (Craik & Tulving, 1975). One reason suggested for the superiority of intentional memory is that it leads the learner to "devote more time and attention to processing the material" (Glass, Holyoak, & Santa, 1979; p. 142). A second explanation is that encoding strategies that are specifically designed to enhance recall performance tend to be used mainly under conditions that call for deliberate attempts to learn (Glass et al., 1979).

The second hypothesis tested in this study was not supported. There was no significant interaction between memory type and group classification (Table 13). In fact, under both conditions, NA students showed a similar degree of superiority in performance over PLD students. These results contradict earlier findings reported by Ceci (1984), Tarver et al. (1976), and Torgesen et al. (1979), and will be discussed in relation to one of the primary assumptions underlying the design of the present study -- namely that performance on an unintentional memory task is supposedly based on the nonstrategic processing of information, whereas performance on an intentional task is based on strategic processing of information.

Under the foregoing assumption, confirmation of the second hypothesis would have supported the theoretical viewpoint that strategic behavior is an important variable that differentiates normal achievers from students with learning difficulties. The present findings do not necessarily challenge this theoretical position. However, a potential explanation exists for the difference between the present results and findings reported on previous studies.

This explanation has to do with the nature of the instructions given to subjects in the unintentional condition. The subjects in this condition were told to search for stimulus items with missing parts (there were 4 such items among the 15 pictures). It appears that the nature of the task called for a systematic search and organized strategic behaviour. Students who were systematic and organized in their search behaviours would have to process the items at a "deeper level" than less organized and less systematic students. Seen in this light, the unintentional task in this study was (rather inadvertently) also a test of strategic processing.

In a sense, this study has tested information processing differences between normal-achieving and potentially learning disabled students under an individual task situation, as well as under a group performance situation. In the individual task situation normal-achievers showed superiority over potentially learning disabled children, although this superiority was not statistically significant. The normal-achievers were, however, significantly more strategic than their PLD comparison. Taken together, the results from the two substudies provide some support for the theoretical formulation that strategic behaviour is an important variable distinguishing normal-achievers from children with learning difficulties.

Summary of Study 2

The present study found empirical support for the theoretical formulation that intentional memory tasks produce better recall performance than unintentional tasks. However, the study failed to replicate the finding of differential performance by NA and PLD on intentional and unintentional tasks. The failure to replicate was attributed to problems in the design of this substudy --specifically to problems in the nature of the instructions given to students in the unintentional condition.

CHAPTER V

SUMMARY AND CONCLUSIONS

The subjects in this investigation were 21 normal-achieving (NA) and 24 potentially learning disabled (PLD) fourth grade students. Two studies were included in the design. In Study 1, a memory task requiring students to memorize 15 pictured objects was administered individually. The study had a two-fold purpose. First, it was designed to investigate whether differences exist between PLD and NA students on: (a) their ability to recall pictured objects; (b) their verbalizable knowledge about their memory functioning; (c) their observed and self-reported use of memory strategies; (d) their perception of task difficulty; (e) their ability to categorize; (f) their perception of their ability to remember in comparison to their classmates; and (g) the amount of time taken to study the task. Second, it sought to examine the nature of the relationships that may existed amoung recall performance, strategy use, and metamemory.

Study 2 involved randomly assigning students in each group to either of two group administered memory conditions: (a) an intentional memory task condition in which students were required to try and memorize 15 pictured objects or (b) an unintentional memory task condition in which the students were required to search for missing parts of 15 pictured objects and later asked to recall as many of the objects as they could remember. The purpose of Study 2 was to compare the recall performance of the PLD and NA groups on both unintentional and intentional memory tasks. While strategic behavior can be observed in intentional memory tasks, unintentional memory tasks emphasize what some researchers (e.g. Tarver, Hallahan, Kaufman, & Ball, 1976; Lloyd, Hallahan, & Kauffman, 1980; Ceci, 1984) refer to as automatic processing. Thus, if PLD students were found to be deficient at intentional memory but unimpaired at unintentional memory, this would provide support for the hypothesis that LD children's difficulties are related more to conscious, purposeful information processing than to automatic encoding of information.

In summarizing and drawing conclusions and implications from the study, the main findings will be examined under the following four major themes: (1) stategy use, (2) metamemory, (3) study time, and (4) intentional versus unintentional memory. Each will be examined seperately.

Strategy Use

The main findings regarding students' use of strategies may be summarized as follows:

1. NA students demonstrated greater efficiency in strategy use.
2. As a group, all subjects used low-efficiency strategies.

3. Amoung both groups of subjects, strategy efficiency significantly correlated with recall performance.

The evidence resulting from this investigation suggests that compared to their PLD agemates, NA students as a group, tended to use the more efficient memory enhancing strategies while studying. This finding is significant because it sheds some light on the learning differences between the two groups of children. Efficient strategy use benefits the learner by reducing the demands placed on the limited holding capacity of the individual's memory system. Strategies work to increase the meaning and organization of incoming information, thereby making it more accessible for recall. If one accepts the notion that learning and memory are inseparable, then more efficient strategy use has implications for learning differences. That is, if efficient strategy use enhances memory--and memory is essential for learning to take place--then it seems reasonable to assume that efficient strategy use should enhance learning. Accepting this argument, the differences found between the two groups on the efficiency with which they process information suggests that poor achievement among the PLD group may stem, at least in part, from inefficient use of strategies.

Research by Flavell et al (1970), Torgesen, Murphy & Ivey (1979) and others have concluded that training/coaching in strategy use can close the gap between NA and LD students. Findings such as these have provided a catalyst for developing programs aimed at enhancing learning and thinking strategies for both LD (Deshler, Warner, Schumaker & Avery, 1983; Wong, 1985) and normal achieving students (Mulcahy, Marfo & Peat, 1985). However, such programs are in the infancy stages, and still have to address the problem that instructed strategy techniques do not seem to generalize readily across various memory situations.

In analyzing the various strategies used by all subjects in this study, it was observed that, as a group, all students used low-efficiency strategies. Perhaps this pattern is suggesting that developmentally these students are too young to understand and use the more efficient memory strategies such as categorization, association, elaboration, and images.

The issue remains, can educators play a role in enhancing the development of efficient strategic behavior in students--both learning disabled and normal achieving? The challenge for reseachers in education is to further investigate whether students can be taught to actively and spontaneously generate, utilize, and generalize appropriate learning strategies. The benefits of efficient strategy use is confirmed in this study by the positive correlation found between strategy use and recall for both groups of students; that is, those students who used the more efficient strategies tended to recall more items. The implication here is that with improved strategy efficiency comes improved performance.

Metamemory

The findings regarding students' verbalizable knowledge about their own memory capabilities or processes may be summarized as follows:

1. The NA students showed superior metamemory.
2. Metamemory was significantly correlated with strategy efficiency in both groups.

The task of trying to empiricalize the amount of knowledge one has about memory functioning is not an easy one. For the purposes of this research, verbalizable knowledge was the focus. What the results indicated is that, in hypothetical verbally presented memory situations, NA students verbalized more awareness about strategies or behaviors that would enhance recall.

One rationale for investigating the metamemory variable was to examine whether there is a relationship between what one knows about memory functioning and memory behavior. Perhaps this relationship is best illustrated by the significant correlations--for both groups--between the variables metamemory and strategy use. That is, individuals exhibiting greater verbalizable knowledge about memory were more likely to demonstrate more efficient strategy use than those with less knowledge.

This finding suggests that any efforts made on the part of educators to improve strategic efficiency in students should include information aimed at increasing metamemorial awareness and knowledge. For example, training on the use of the strategy categorization should include information aimed at increasing a student's awareness of such variables as: (a) why it works; (b) the natural limitations of memory; (c) various situations where the strategy could and could not be used; and (d) demonstrations, and repeated practice on its uses. By so doing, the student not only becomes aware of the strategy as a memory tool but also increases his/her knowledge about memory functioning. This can be viewed as instructionally taking advantage of the metamemory-strategy use relationship suggested in this and other research.

What was interesting to observe in this study was the finding that while most students verbalized an understanding of the specific strategies elaboration and categorization, very few students used these strategies while studying. This is what Flavell et al (1970) referred to as a "production deficiency"; children may have the capacity to use the strategy but may not do so spontaneously. Perhaps this tendency is suggestive of the possibility that knowledge and awareness about specific memory strategies precedes the actual application of those same strategies.

While Flavell (1978) does not speculate on the origins of strategic behavior in students, he does present a bidirectional hypothesis which provides a theoretical link between metamemory and strategic behavior. Briefly summarized, as students increase his/her knowledge about areas of memory related to knowledge of personal attributes, strategies, and memory demands (metamemory), he/she adapt his/her approach to memory tasks to incorporate this knowledge (strategies). As he/she adapt their strategies, they receive feedback on his/her performance, ultimately enhancing his/her knowledge about memory functioning. While only speculative, perhaps this theorized feedback loop accounts for the present study's finding to the effect that NA children were more efficient in their use of strategies and more knowledgeable about the workings of the memory system than PLD students.

It could be argued that if this feedback loop exists then changes in metacognitive awareness should result from strategy training. Future research could explore this hypothesized feedback loop by approaching the metamemory/strategy use equation from a different angle; namely, whether instruction aimed at expanding a child's metacognitive awareness will lead to more rapid acquisition of new strategies, or to more effective generalization of old strategies.

Results of this investigation indicate that only in the NA group were metamemory and study time significantly correlated. Also, only in the NA group was metamemory significantly correlated to recall performance. It appears that knowledge about memory functioning did not alter the speed with which the PLD group studied the task, or their ability to recall the 15 pictured objects. It could be theorized that this finding lends support to the notion that LD students' memory abilities develop more slowly than NA students; PLD students who verbalized greater knowledge about memory functioning did not seem to benefit from this knowledge to the same extent as the NA students.

Study Time

The following findings were obtained, relative to study time.

1. NA students studied the task for significantly longer than the PLD students.
2. PLD girls were not as hasty as PLD boys in studying the task.
3. In the PLD group recall performance significantly correlated with study time.

If the PLD boys' approach to studying this task is characteristic of their approach to other tasks in school, then it is not surprising that they are experiencing academic problems. This finding poses one important question: Are there common characteristics of the PLD group which are highlighted by the quick study time? Some possible explanations could be attention problems, impulsivity, or perhaps a poor understanding of the parameters of the task demands.

While the author can only speculate on the quick study time of the PLD group, the behavior is clearly established; the PLD group, especially PLD boys, spent significantly less time processing the information. The significance of this finding, lies in the fact that these PLD students who did study the task longer were able to recall more items. Consequently, a link is created between time spent processing information and performance for the PLD students. As educators, it is important to recognize the fact that some of the classroom performance problems of LD students could be the result of impulsive responding or to the tendency to spend inadequate amounts of time on information processing.

Intentional versus Unintentional Memory

The intentional memory task produced better recall performance than the unintentional memory task. This finding is a logical one, and supports the findings of previous studies (Tarver etal, 1976; Ceci, 1984; Torgesen et al, 1979). The central issue here is the importance of the conscious role of the learner in learning situations. As such, variation in intentional learning may be attributed to variations in the planful sustained activity of the learner and variations in the efficiency with which they utilize their intact intellectual abilities (Torgesen & Licht, 1983).

As mentioned in the previous chapter, a significant limitation in the design of the unintentional memory task made it difficult to adequately test the hypothesis pertaining to NA-PLD differences on unintentional memory tasks. While the task was designed to provide an indication of the nonstrategic processing of information, the instruction to study the items in order to identify those with missing parts actually called for a systematic search and organized strategic behavior on the part of the student. Consequently, comparisons between groups on their ability to automatically encode information was not meaningful. Future research on unintentional memory should consider the possible confounding factors that may be present. Any measure of unintentional memory must not require any type conscious processing on the part of the subject.

REFERENCES

Aristotle (1964). On memory and recollection (W.S. Hett, Trans.). Cambridge, Ma.: Harvard University Press. (Original work published 350 B.C.).

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

Bauer, R.H. (1977). Memory processes in children with learning disabilities: Evidence for deficient rehearsal. Journal of Experimental Child Psychology, 24, 415-430.

Bauer, R.H. (1982). Information processing as a way of understanding and diagnosing learning disabilities. Topics in Learning and Learning Disabilities, 2, 33-45.

Boring, E.G. (1950). A history of experimental psychology. New York: Appleton - Century - Crofts.

Borkowski, J.G., & Kurtz, B.E. (1984). Metacognition and special children, in B. Gholson and T.L. Rosenthal (Eds.) Application of cognitive development theory. Orlando, Florida: Academic Press.

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

Byrd, D.M., & Gholson, B. (1985). Reading memory and metacognition. Journal of Educational Psychology, 24, 428-436.

Cavanaugh, J.C., & Borkowshi, J.G. (1980). Searching for metamemory-memory connections: A developmental study. Developmental Psychology, 5, 441-453.

Ceci, S.J. (1984). A developmental study of learning disabilities and memory. Journal of Experimental Child Psychology, 38, 352-371.

Ceci, S.J., Lea, S.E., & Ringstrom, M.D. (1980). Coding characteristics of normal and learning disabled 10 year-olds. Journal of Experimental Psychology: Human Learning and Memory, 6, 785-797.

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

Craik, F.I.M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology: General, 104, 268-294.

Dallago, M.L., & Moley, B.E. (1980). Free recall in boys of normal and poor reading levels as a function of task manipulations. Journal of Experimental Child Psychology, 30, 62-78.

Deshler, D.D., Warner, M.M., Schumaker, J.B., & Avery, G.R. (1983). Learning strategies intervention model: Key components and current status. In J.D. McKinney & L. Feagans (Eds.) Current topics in learning disabilities, Vol. 1. Norwood, N.J.: Ablex.

DeRuiter, J.A., & Wansart, W. L. (1982). Psychology of Learning Disabilities. Aspen Pub., Rockville, Maryland.

Dolch, E. (1955). Methods in reading. Champaign, Illinois: Garrard.

Done, D.J., & Miles, T.R. (1978). Learning, memory and dyslexia. In M.M. Gruneberg, P.E.Morris, & R.N. Sykes (Eds.). Practical Aspects of Memory. London: Academic Press.

Douglas, L.C. (1981). Metamemory in learning disabled children: A clue to memory deficiencies. Paper presented at the annual meeting of the Society for Research in Child Development, Boston.

Feibel, W. (1985). On applying metacognition to metacognition about metacognition: A redundant reaction. A paper presented to the University of California, Santa Cruz.

Flavell, J.H. (1971). First discussant's comments: What is memory development the development of? Human Development, 14, 272-278.

Flavell, J.H. (1977). Cognitive development. Englewood Cliffs, New Jersey: Prentice Hall.

Flavell, J.H. (1978). Metacognitive development. In C.J. Brained and J.M. Scandura (Eds.). Structural process models of complex human behaviors. Alphen aan den Ryn, Netherlands: Sythoff & Noordhoff Internal Publishers.

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

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

Glass, A.L., Holyoak, K.J., & Santa, J.L. (1979). Cognition. Reading, MA: Addison-Wesley.

Hagen, J.W. (1971). Some thoughts on how children learn to remember. Human Development, 14, 262-271.

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

Hett, W.S. (1964). Memory. New York: Dover.

Horowitz, A.B. (1969). Effects of stimulus presentation modes on children's recall and clustering. Psychonomic Science, 14, 297-298.

Hulme, C. (1981). Reading Retardation and Multi-Sensory Teaching, London: Routledge and Kegan Press.

Kolligan, J., & Sternberg, R.J. (1987). Intelligence information processing and specific learning disabilities: A triarchic synthesis. Journal of Learning Disabilities, 20, 8-17.

Kreutzer, M.A., Leonard C., Flavell, & J.H. (1975). An interview study of children's knowledge about memory. Monographys of the Society for Research in Child Development, 40, 1-60.

Leahey, T.H., & Harris, R.J. (1985). Human learning. Englewood Cliffs, New Jersey: Prentice-Hall.

Lerner, J. (1985). Learning disabilities: Theories, diagnosis and teaching strategies (4th Ed.). Boston: Houghton-Miffin.

Lloyd, J., Hallahan D.P., & Kauffman J.M. (1980). Learning disabilities: A review of selected topics. In L. Mann & D.A. Sabatino (Eds.) The Fourth Review of Special Education. New York: Gnine and Stratton.

Miller, G.A. (1956) The Magical number, seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Mulcahy, R., Marfo, K., & Peat, D. (1985), A Strategies Program for Effective Learning and Thinking (SPELT): A teachers' manual. Edmonton, Alberta: University of Alberta Cognitive Education Project.

Nelson, D.L. (1979). Remembering pictures and words: Appearance significance, and name. In L.S. Cevinak & F.M. Craik (Eds.), Levels of processing in human memory. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Paivio, A. (1971). Imagery and verbal processes. New York: Holt, Rinehart & Winton.

Parker, T.B., Freston, C.W., & Drew, C.D. (1975). Comparison of verbal performance of normal and learning disabilities as a function of input organization. Journal of Learning Disabilities, 8, 53-59.

Ritchey, G.H. (1980). Picture superiority in free recall: The effects of organization and elaboration. Journal of Experimental Child Psychology, 29, 460-474.

Sahakian, W.S. (1975). History and systems of psychology. New York: John Wiley & Sons.

Shepherd, M.J., Gelzheiser, L.M., & Solar, R.A. (1985). How good is the evidence for a production deficiency amoung learning disabled students? Journal of Educational Psychology, 77, 553-561.

Srivastava, A.K., & Pirohit, A.K. (1983). Short term recognition memory for pictures and words: A dual coding interpretation. Psycholigal: An International Journal of Psychology in the Orient, 4, 241-245.

Sternberg, R.J. (1979). The nature of mental abilities. American Psychologist, 34, 214-230.

Sternberg, R. J. (1980). Sketch of a componential subtheory of human intelligence. Behavioral and Brain Sciences, 3, 573-584.

Sternberg, R.J. (1984). Mechanisms of cognitive development: A componential approach. In R.J. Sternberg (Ed.) Mechanisms of cognitive development. New York: W.H. Freeman and Company.

Swanson, H.L. (1984). Semantic and visual codes in learning disabled readers. Journal of Experimental Child Psychology, 37, 124-140.

Swanson, H.L. (1985). Assessing learning disabled children's intellectual performance. Advances in Learning and Behavioral Disabilities, 4, 225-272.

Swanson, H.L. (1987). Information processing theory and learning disabilities: An overview. Journal of Learning Disabilities, 20, 3-7.

Tarver, S.C., Hallahan, D.P., Kaufman, J.M., & Ball, D.W. (1976). Verbal rehersal and selective attention in children with learning disabilities. Child Development, 48, 141-160.

Torgesen, J.K. (1977). The role of non-specific factors in the task performance of learning disabled children: a theoretical assessment. Journal of Learning Disabilities, 10, 27-34.

Torgesen, J.K. (1980). The use of efficient task strategies by learning disabled children: Conceptual and educational implications. Journal of Learning Disabilities, 13, 364-371.

Torgesen, J.K. (1982). The study of short term memory in learning disabled children. Advances in Learning and Behavioral Disabilities, 1, 117-149.

Torgesen, J.K., & Goldman, T. (1977). Rehearsal and short term memory in reading disabled children. Child Development, 48, 141-160.

Torgesen, J., Murphy, H., & Ivey, G. (1979). The effects of an orienting task on the memory performance of reading disabled children. Journal of Learning Disabilities, 12, 396-401.

Torgesen, J.K., & Licht, B.G. (1983). The learning disabled child as an inactive learner: Retrospect and prospects. J.D. McKinney, & L. Feagan (Eds.) Current Topics in Learning Disabilitites. Norwood, New Jersey: Ablex Publishing Corporation.

Wittrock, M.C. (1981). Learning and memory. In F.M. Farley and N.J. Gordon (Eds.) Psychology and Education: The state of the union. Berkeley, California: McCutchan.

Wong, B. (1979). The role of theory in learning disability research. Journal of Learning Disabilities, 12, 15-24.

Wong, B. (1982). Strategic behaviors in selecting retrieval cues in gifted normal-achieving and learning disabled children. Journal of Learning Disabilities, 15, 33-37.

Wong, B. (1985). Potential means of enhancing content skills acquisition in learning disabled adolescents. Focus on Exceptional Children, 17, 1-8.

APPENDIX A

Instructions and Record Sheet for Intentional Memory
(Study 1)

NAME: ______________________ Sex: ______________________

SCHOOL: ______________________ DATE: ______________________

I.D.: ______________________

I want you to learn these pictures. You can do anything you wish to help you remember the pictures. Later I'm going to ask you to remember as many as you can. Spelling is not important.

APPENDIX B

Instructions, Probes, and Scoring for Metamemory Index Score

1. Story List

MATERIALS: Pictures of a bed, tie, shoes, table, dog, hat, car.

The other day I showed these pictures to two girls your age. I asked one girl to learn them so that she could tell me what they were later when she couldn't see them any more. And I showed the same pictures to another girl, but also told her a story about the pictures (E puts down each picture as its depicted object was mentioned).

> A man gets out of BED, and gets dressed, putting on his best TIE and SHOES. Then he sits down at the TABLE for breakfast. After breakfast he takes his DOG for a walk. Then he puts on his HAT and gets into his CAR and drives to work.

I told the girl who heard the story that she was supposed to learn the pictures so she could tell me what they were later when she couldn't see the pictures. Do you think the story made it easier or harder for the girl to remember the pictures? Which girl do you think learned the most? Why?

2. Preparation: Object

Suppose you were going ice skating with your friend after school tomorrow and you wanted to be sure to bring your skates. How could you be really certain that you didn't forget to bring your skates along to school in the morning? Can you think of anything else? How many ways can you think of? (If the subject doesn't skate, E poses an equivalent problem involving a different object, e.g. a ball).

3. Retrieval: Object

Suppose you lost your jacket while you were at school. How would you go about finding it? Anything else you could do? Think of all possible ways.

4. Rote - Paraphrase

The other day I played a record of a story for a girl. I asked her to listen carefully to the record as many times as she wanted, so she could tell me the story later. Before she began to listen to the record she asked me one question: "Am I supposed to remember the story word for word, just like on the record, or can I tell you in my own words?"

a. Why do you think she asked this question?

b. Would knowing the answer to the question help her know how to study the story?

c. If I told her to learn it word for word, what do you suppose she did?

d. Would it be easier to learn it word for word, or in her own words?

e. Why?

Scoring of Metamemory Index (MI)

1. ____ a. Easier = 1 point
No difference, harder, other = 0

____ b. Girl who was told the story = 1 point
Other response = 0

____ c. Clear awareness of the effect of meaning and/or elaboration on retrieval = 4 points
Some awareness = 2 points
No awareness = 0

2. a,b,c, 1 POINT PER CATEGORY SUGGESTED

( ) External cues related to the skates

( ) External cues relying on others

( ) External cues through the use of other objects (e.g. note)

( ) Internal cues, relying on the internal processes of self.

______ TOTAL

3. a,b,c, 1 POINT PER CATEGORY

( ) Check with others to see if they found it or know its whereabouts (e.g. announcement)

( ) Check lost and found

( ) Request search assistance

( ) Check the likely places

( ) Retrace steps

( ) Exhaustive search

( ) Other ____________________

______ TOTAL

______ 4a. Clear awareness of the effect of how recalling word for word is more difficult than recalling the gist = 4 points

Some awareness = 2 points

Response reflecting the need for a clarification of the task demand = 1 point

______ 4b. Yes = 2 points

Sort of = 1 point

No = Ø

______ 4d. Easier to learn in own words = 1 point

Any other response = Ø

______ 4e. Awareness of why gist recall would be easier than word-for-word recall = 4 points

Some awareness = 2

No Awareness = Ø.

______ Score from Question 5c - Intentional Task

Would the pictures be easier to remember
if I gave them to you in this order (grouped)?

Yes= 2 points

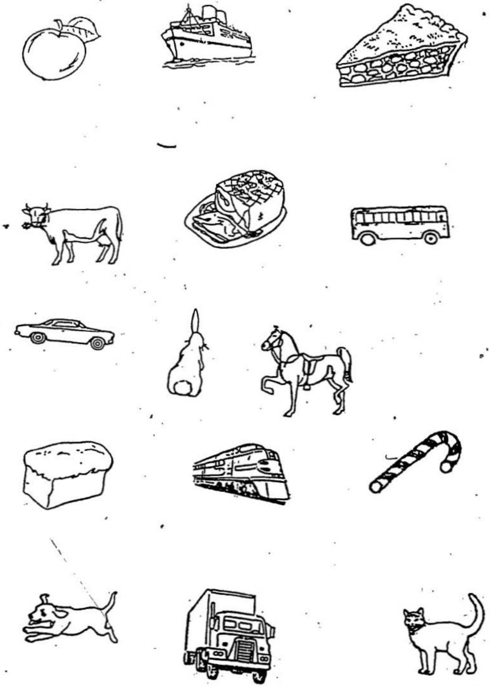
Some conditional response = 1 point

No = 0

____/30 TOTAL METAMEMORY INDEX (MI)

APPENDIX C

Stimulus Used for Unintentional Memory



APPENDIX D

ID#: ____________________ School: ____________________

Coding of the Difficulty Level of The Intentional Memory Task

How easy or difficult did you find this exercise?

_______ a. [ ] Very Easy (4)

b. [ ] Easy (3)

c. [ ] Difficult (2)

d. [ ] Very Difficult (1)

APPENDIX E

ID#: ____________________ School: ____________________

Coding of the Relative Competence on

the Intentional Memory Task

If your classmates had to remember these pictures would they....

________ a. [ ] Remember more than you just did.

b. [ ] Remember the same amount.

c. [ ] Remember less than you just did.

APPENDIX F

Index of Strategy Use Probes and Scoring

ID#: ______________________ School: ______________

Question 1. (Administered immediately following the intentional memory task)

How did you learn the pictures? What did you do to be sure that you will remember them? Anything else? (The examiner recorded any observed behaviors such as manipulating the cards.)

Question 2.

Why did you learn the list in that way?

Question 3.

Are there any other ways you could have used to study the pictures?

Scoring

Question 1

Strategy Used. Efficiency Ranking and Corresponding Scores.

A. (10 Points)

_______ 1. [ ] Categorization or grouping (Accurate [see Section C for inaccurate grouping]).

B. (8 Points)

_______ 2. [ ] Association by meaning

_______ 3. [ ] Elaboration and imagery.

_______ 4. [ ] Imagery

C. (6 Points)

_______ 5. [ ] Chunking

_______ 6. [ ] Chaining

_______ 7. [ ] Inaccurate categorization

_______ 8. [ ] Rearranging pictures in alphabetical order of labels.

D. (4 Points)

_______ 9. [ ] Rehearsal

_______ 10. [ ] Spelling out of picture labels

_______ 11. [ ] Ordered scanning with verbalization.

E. (2 Points)

_______ 12. [ ] Ordered scanning without verbalization

_______ 13. [ ] Random scanning

Question 2

_______ [ ] Clear awareness of the relationship between good strategy and efficient recall; or clear demonstration of how the strategy used makes for good easy recall...(3 points).

[ ] Some awareness....(2 points)

[ ] Evaluative responses such as: 'makes it easier', 'it is better', etc.... (1 point)

[ ] Reponses such as "I always do it like that", "My teacher taught me", "I don't know".... (Ø points).

Question 3.

_______ [ ] One or more reasonable strategies (1 point)

[ ] Response such as "no", "maybe", or "yes" with no elaboration...(Ø points)

_______ 2 BONUS points for students who monitored or checked their performance (i.e. counting the number of pictures to be remembered).

_______/16 Index of Strategy Use (ISU)

APPENDIX G

Index of Categorization Skills Scoring

ID#: ____________________ School: ____________________

Question 4. (Administered to those students who used the categorization strategy while studying the 15 pictures).

a. How many categories did you have?

b. Which pictures were in each group?

Scoring. Correct categorization = 3 points

Incorrect categorization = 2 points

No categorization = 0 points

Question 5. (Administered to those students who were not observed using categorization. [Give full credit for question 5a if student received maximum points for Question 4 above]).

a. I want you to look at all the pictures carefully. (The examiner lays out the pictures in the original order of presentation). See if you can arrange the pictures in three groups by putting together all the pictures which are similar, pictures which have something in common.

b. Now give each group a title.

Scoring

5a. Correct categorization = 2 points

Incorrect categorization = 1 point

5b. All labels describe categories	=	3 points
Two labels describing	=	2 points
One label	=	1 point

INDEX of CATEGORIZATION SKILLS (ICS) ____/8____

APPENDIX H

Generated Strategies for Studying Recorded Story
in "Rote Paraphrase" Situation in Metamemory Index

4c. Check with an X each strategy used by student.

[ ] Listen (e.g. play or listen to entire story).

[ ] Copy (write down)

[ ] Chunk story into parts and learn sequentially

[ ] Chunk story into parts and learn in chains

[ ] Study - vague statement referring to study/learn

[ ] Visual Imagery

[ ] Elaborate story by associating parts with previous knowledge

[ ] Listen and copy

[ ] Listen and Rehearse

[ ] Copy and Rehearse

[ ] Other ____________________