A COMPARATIVE STUDY OF INFORMATION PROCESSING CAPACITY AND COGNITIVE STYLE IN LEARNING DISABLED AND NORMALLY ACHIEVING BOYS: A NEO-PIAGETIAN APPROACH

by

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INTRODUCTION

The current Federal definition used to describe children with learning disabilities is:

> Specific learning disability means a disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, or mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage (Federal Register, Vol. 42, no. 250, Thursday, December 29, 1977).

One of the assumptions underlying this and other definitions of learning disabilities is that the learning disabled child has certain basic competencies or integrities.. It is generally accepted that his intellectual capabilities, sensory processes, and emotional resources are within normal variation (McCarthy, 1975). The exploration of psychological process and individual difference variables which may interfere with the manifestation of this assumed learning potential during the educational process is currently being stressed in the related literature (Senf, 1972; Owen, Braggio & Ellen, 1976; Margolis, 1977; Torgensen, 1977, 1980; Maier, 1980; and Wong, 1980).

These studies often apply constructs from information processing models including encoding mechanisms, intra and inter modality integration, memory structures and rehearsal strategies, selective attention, and motivational variables. Few information processing models, however, include criteria for changes in the different aspects of information processing which occur or emerge as the child develops (Ensinger & Sullivan, 1974). If the competence/performance discrepancy associated with learning disabled children is to be investigated and explained, the identification of a theory which includes testable constructs related to learning potential and performance variables within a cognitive developmental framework would provide a foundation.

Neo-Piagetian Theory

A theory which appears to include the necessary parameters for studying the competence/performance discrepancy of learning disabled children has been developed by Pascual-Leone (1970). His model is an extension of Piaget's theory of intellectual development and is referred to as Neo-Piagetian theory. By studying Piaget's formal, structural model of how the child acquires knowledge and interacts with his environment from the perspective of information processing theory, Pascual-Leone has developed a functional performance model of cognitive development. This model attempts to describe the devices or mechanisms available to children which allow them to generate the sequence of competencies defined by Piaget (Pascual-Leone, 1970; Case, 1972a; and Case, 1972b).

Particularly pertinent to the study of learning disabled children are the Neo-Piagetian constructs which include an estimate of cognitive competence, a performance strategy which may be inefficient if applied during the solution of certain tasks, and a system of analyzing task requirements from the child's point of view. The estimate of cognitive competence is called M-space or M-capacity. It is a measure of the information processing capacity of the child at each stage of development. The variable associated with performance is identified as the cognitive style field independence-dependence. By analyzing cognitive tasks associated with each substage of cognitive development, Pascual-Leone (1970) has found that the number of schemes necessary to solve classical Piagetian tasks is related to the M-capacity typical of children at each substage.

Neo-Piagetian Construct of M-capacity

The Piagetian concept upon which M-space is based is termed "field of equilibrium" (Pascual-Leone, 1970). According to Piaget and Inhelder (1956), the force which directs development is the dynamic interaction between the child's cognitive structures and environmental data. Throughout development the child is continually modifying and constructing schemes which can generally be defined as organized behavioral patterns of internal representations of rules and items of information (Case, 1974a). "They (schemes) constitute the stuff out of which the child's knowledge is made..." (Langer, 1969,

p. 98). The child's capacity to coordinate and combine schemes increases with age. Piaget refers to the mental space in which this integration of data takes place as a "field of equilibrium" (Piaget and Inhelder, 1956). Pascual-Leone (1970) conceptualizes this Piagetian cognitive developmental variable as the quantitative construct called "the central processor M." Parallel and/or sequential activation of schemes which are already in the child's response repertoire are executed within the limitation of the child's M-capacity. M-space is the set measure of the maximum number of schemes or "discrete chunks" of information that the child can attend to, integrate, or coordinate at any one time during problem solving or during the transformation of environmental data (Case, 1972a).

Competence versus Performance

A factor which determines whether the child will apply his available M-space during his performance on a task is conceptualized as the cognitive style field-independence-dependence and corresponds to an individual difference or performance strategy (Pascual-Leone, 1970). Children who are field independent tend to utilize their modal (maximum) M-space and are not swayed by distracting perceptual cues; children who are field dependent attend to salient, but often misleading tasks cues and therefore may exhibit performance deficits despite adequate information processing capacity (Case, 1975).

Neo-Piagetian theory, therefore, offers a possible vehicle for testing the competence/performance discrepancy associated with learning disabled children. Current theory in the field of learning disabilities suggests that learning disabled children should demonstrate normal information processing capacity (Senf, 1972; Ross, 1976). Several empirical studies suggest that some learning disabled children may have a limited capacity for processing information (Aten & Davis, 1968; Bartel, Grill, and Bartel, 1973; Ring, 1976; Spring, 1976, and Badian, 1977). If limited information processing capacity is redefined as a lag in the growth of M-space, there could be evidence that some learning disabled children are not as competent as their normally achieving peers, in the Neo-Piagetian sense.

Other studies suggest that an ineffective learning strategy, rather than capacity deficit, depresses the learning disabled child's performance on academic and research tasks (Keogh and Donlon, 1972; Guyer and Friedman, 1975; Torgensen, 1977). Neo-Piagetian theory has incorporated the cognitive style field independence as a factor which may influence an individual's efficient application of M-capacity on certain tasks. If learning disabled children are significantly more field dependent than their normally achieving peers, a performance rather than competence difference would be suggested.

Purpose of the Study

The primary purpose of this study was to investigate the applicability of Neo-Piagetian theory in describing the competence/

performance discrepancy associated with learning disabled children. Three aspects of cognitive functioning were examined: M-capacity, level of field independence, and level of operative thinking. The following questions were asked in order to identify if there are differences between learning disabled and normally achieving children in these areas of cognitive functioning:

(1) Does performance on measures of M-capacity differentiate learning disabled children from normally achieving students, or are learning disabled children as competent as their normally achieving peers?

(2) Are learning disabled children more field dependent than their normally achieving peers and therefore more inefficient processors of their available M-space?

(3) Are there differences between learning disabled children and normally achieving children in the attainment of certain operative structures which can be demonstrated during performance on Piagetian tasks? Can these differences, if identified, be attributed to competence and/or performance factors?

Significance of the Study

One desired result of research related to children with learning disabilities is more effective educational intervention. The various approaches to academic remediation in the field of learning disabilities are a source of controversy and debate among professionals, particularly concerning two main approaches to task analysis: modality processing and skills sequence (Lerner, 1976).

The focus of the modality processing or ability training approach is the specification of individual patterns of perceptual and psycholinguisitic functioning (Haring & Bateman, 1977). A primary implication is that discrete psychological processes (visual sequential memory or auditory discrimination, for example) can be assessed and trained separately, and furthermore, that such training is relevant to the acquisition of certain academic skills. Examples of remedial programs based upon this approach are the Frostig Visual Perception Training Program (1964), Bush and Giles (1969) prescriptions based upon the Illinois Test of Psycholinguistic Abilities, and the MWM Program for Developing Language Abilities (1973). Reviews of related research reveal tenuous relationships between improvement in the correlated disability and improvement in the presenting academic difficulty (Bateman, 1967; Englemann, 1967; Newcomer and Hamill, 1975). The effectiveness of process-oriented training programs may be dependent upon the age of the child and his corresponding ability to compensate for perceptual deficits with the development of conceptually based learner strategies (Bibace and Hancock, 1969; Vellutino, et.al., 1977).

The skills sequence approach emphasizes identification of component skills the learner needs to master in order to achieve the desired terminal behavior (Ysseldyke and Salvia, 1974). While the modality processing approach stresses the discovery of inter and intra individual differences along psychological process dimensions based upon test constructs, the skills sequence approach does so along continua of objectives. Distar programs for reading, arithmetic, and language (Englemann, 1969) and other criteria referenced curriculum programs are examples of the skills sequence approach.

Lerner (1976) has suggested that these two approaches to task analysis need not be "dichotomous;" teaching expertise should include skill in analyzing hierarchies of competencies and task modifications based upon the individual child's profile of modality strengths and weaknesses. Information-processing theories have enriched the field of task analysis by directing attention to the interaction between the demands of specific tasks and the capabilities of the human system as processors of environmental data. In addition, child developmentalists are currently examining this interaction, and its interface with the child's level of cognitive development (Case, 1975). The importance of this type of approach for teaching the learning disabled child is recognized by McCarthy (1975):

> The challenge to the teacher of learning disabled children involves not only a precise match between the cognitive style of the learner and the cognitive demands of the task, but also an awareness of the critical periods in the development of each process (p. 307).

Including a developmental index of the child's current functioning and a means of looking at tasks from his point of view, rather than adult established apriori skills continua may lead to more accurate predictions about the effects of instruction.

Neo-Piagetian theory is a comprehensive model which does address the child's level of cognitive development, his individual mode of approaching certain tasks, and a means of task analysis. Although this theory has been empirically tested with "normal children" (Pascual-Leone and Smith, 1969; Pascual-Leone, 1970; Case, 1972a; Case, 1972b; Case, 1974b; Case, 1975), it has not been applied to the study of children with specific learning disabilities. It is suggested that such an investigation may contribute significantly to our understanding of the characteristics exhibited by learning disabled children.

Definitions

Definitions of some of the terms used throughout this study are provided in order to assure that the reader and the author share understanding of several important concepts:

> Cognitive Styles. Cognitive styles "can most directly be defined as individual variation in modes of perceiving, remembering, and thinking, or as distinctive ways of apprehending, storing, transforming, and utilizing information....Abilities concern level of skill - the more or less of performance - whereas cognitive styles give greater weight to the manner and form of cognition" (Kogan, 1971, p. 244).
>
> Cognitive Task. A cognitive task refers to a task which demands the simultaneous or sequential activation of non-field facilitated schemes for solution; mental effort or central computing space must be applied during task solution.
>
> Development. Development is a universal processor for all thinking and action. The child's ability to learn is dependent upon his general level of development, i.e. his current system of cognitive structures. A developmental change is a structural one, rather than an increase in information or stimulus response units.

Field-Independence-Dependence. This cognitive style refers to individual variation in the degree that component parts of a stimulus configuration are experienced as discrete, and reflects individual differences in the ability to overcome the influence of embeddedness (Witkin, et.al., 1962).

Learning. Learning refers to an increase in the child's repertoire of schemes.

M-space. M-space "is defined as the set measure of the field of concentration; its magnitude is the maximum number of activated schemes which can be coordinated at any one time" (Case, 1972b, p. 287). It is a quantitative index of the child's developmental level and an estimate of cognitive competence. Other terms used interchangeable with M-space are M-capacity, information-processing capacity, working memory, and central computing space.

Scheme. A scheme is an organized behavioral pattern which involves physical or psychological activity and refers to the basic cognitive structure underlying an individual's overt action.

Executive Scheme. An executive scheme is an internal representation of a procedure or plan to apply when confronted with a specific task. A particular executive scheme may determine what other schemes are activated during task solution.

Figurative Schemes. Figurative schemes are internal representations of items of information with which a subject is familiar, or of perceptual configurations which he can recognize.

Operative Schemes. Operative schemes are internal representations of functions which can be applied to one set of figurative schemes in order to generate a new set.

Chapter 2

REVIEW OF LITERATURE

The Neo-Piagetian model of cognitive development incorporates concepts from Piagetian theory, cognitive psychology, child development theory, and learning theory. The first section of this chapter provides information important to understanding the central Neo-Piagetian construct called M-space. The two primary relationships discussed are the distinction between competence and performance, and the difference between the Piagetian and psychometric approach to the measurement of intelligence. An indepth review of the theoretical and empirical bases related to the concept of M-space and the growth of M-capacity follows. Included are supportive documentation from cognitive psychology and child development studies. Validation studies of the Neo-Piagetian model and a discussion of the factors which affect an individual's performance on cognitive tasks according to Neo-Piagetian theory are presented. The chapter concludes with a discussion of the related theory and research in the field of learning disabilities.

Distinction Between Competence and Performance

The distinction between competence and performance is a central theme in this study which applies a Neo-Piagetian model of cognitive development. Chomsky (1966) contends that performance can only be studied seriously on the basis of an explicit theory of competence that underlies it. Based upon such a distinction, Flavell and Wohlwill (1969) formulated a general competence/performance model for explaining response variability across and within age groups on cognitive tasks. The structural or competency aspects of this model are derived from Piaget's theory of cognitive growth which focuses on the emergence of universal competencies occuring throughout development in an invariant sequence. The functional or performance aspects are based upon information processing theory which attempts to explain how this knowledge is actually stored, accessed, and used by a human subject. In effect, this model presents a procedure for estimating a child's performance on Piagetian tasks at given points during cognitive development by specifying the organismic and task variables which may interact with level of competence in determining a child's performance.

Flavell and Wohlwill's model extends Piaget's competency model of intellectual development by incorporating situational and individual difference variables which may not only affect the child's transition from one stage to another, but a child's performance on a specific task. One difficulty in applying this competence/performance model is calculating the values of the parameters specified. The means for estimating the probability that an operation is part of a child's cognitive structures, and predicting the effect that organismic and task characteristics have on a particular child's performance are not clearly delineated. Overcoming this problem is especially important for investigating the discrepancies manifested by learning disabled children between assumed competence and actual performance on academic tasks. What organismic characteristics can be specified in this population of children which interact with task attributes to impede learning? What alternative measure of cognitive competence is available in order to estimate the learning disabled child's developmental level? Pascual-Leone's (1970) Neo-Piagetian theory of cognitive development generates some testable solutions to these questions.

Conceptualizations of Intelligence

Important to understanding Pascual-Leone's theory and the measure of competence incorporated is a grasp of Piaget's conceptualization of the construct intelligence and how it diverges from the psychometric approach to mental growth. Both Piagetian and psychometric viewpoints recognize the importance of maturation and the primary characteristic of intelligent behavior as rationality. The psychometric approach, however, stresses quantitative changes in rational behavior, inter-individual differences based upon intelligence as a normally distributed variable, and intellectual growth as a statistical concept reflecting correlations of test scores obtained at different ages (Wechsler, 1976).

The Piagetian view emphasizes the qualitative changes manifested by individuals as they mature cognitively. Mental growth is described in terms of the similarities demonstrated by children at each new stage of intellectual functioning (Langer, 1969). The stress is on those non-random intra-individual changes which occur throughout development in an invariant sequence. Reasoning ability is defined by the specific mental operations which permit the child to transform information. The structure of the child's thought at any point in development consists of the operative schemes that he applies during his interactions with the environment. The dynamic encounters between the child's cognitive structures and his environment constitute the major force for development.

This force, or instrinsic motivation, is labeled equilibration. It is the regulatory process which controls assimilation and accomodation, the invariant modes of knowing. Assimilation refers to a transformation of information so that it conforms to the child's existing cognitive structures. Accomodation refers to an alteration of cognitive structures which occurs when new information cannot be assimilated. "Mental growth can thus be seen as a progressive series of attempted assimilations, necessary accomodations, and new equilibrated assimilations at a higher level" (Elkind, 1974, p. 8).

The function of intelligence is the production of novel assertions by a continuous transformation and coordination of environmental data. Piaget has stated that this integration of information takes place within a "field of equilibrium," or an "attention span" which expands as the child matures (Piaget, 1964). Pascual-Leone (1970) has conceptualized this Piagetian cognitive-developmental variable as a quantitative construct called the central processor M, or the set measure of the field of equilibrium. It is his contention that the central processor M corresponds to the functional aspect of cognitive competence. His theory is an attempt to describe how a finite automation (the child) can generate the competencies delineated by Piaget.

Neo-Piagetian Construct Called M-Space

Pascual-Leone (1970) suggests that cognitive growth may be explained by means of a "hidden parameter" called M-space or finite central computing space which increases in a linear manner during development. M-space is the set measure of the maximum number of schemes or "discrete 'chunks' of information" that the human subject can attend to, or coordinate at any one time. It can be interpreted as a quantitative index of a child's developmental stage. The structural or qualitative characteristics of each successive stage of development are "a function of 'central computing space' available at the stage" (Case, 1972a, p. 287). Pascual-Leone (1970) contends that the child's M-space or information processing capacity is the quantifiable aspect of the developmental concept of intelligence. Intellectual growth (in the Neo-Piagetian sense) therefore, is commensurate with growth in M-space. From the psychometric viewpoint, M-space resembles a measure of competence or intellectual capacity similar to the "g" factor in Spearman's two factor theory of intelligence; "g" refers to a global or general mental ability factor which theoretically underlies problem solving performance or reasoning power (Spearman, 1927). M-space also resembles an "analage function," a construct from Cattell's theory of intelligence (Cattell, 1963). Fluid intelligence refers to the broad factor of cognitive potential which represents analage functions common to all humans. Such functions eventually interact with cultural demands, resulting in crystallized intelligence. Analage functions refer to basic capacities in perception, retention, and expression which govern intellectual performance. Analage functioning is closely associated with central neural organization and not significantly affected by learning. It "operates to some extent in all intellectual performance and thus produces variance in all ability measurements" (Horn, 1968, p. 82). Piagetian tasks constitute good measure of "g" (Vernon, 1965) and analage functioning (Horn, 1968). One analage function included in most intelligence tests which superficially resembles M-space is "span of apprehension." Horn (1968) defines span of apprehension "as the number of distinct elements which a person can maintain in immediate awareness." It "is an elementary capacity and yet one which determines, in part the complexity with which one can successfully cope in an intellectual task"(p. 82). M-space, however, is not to be equated with rote learning ability as measured by some memory span tests. M-space is more specifically related to "working memory" which reflects the information processing theorists' emphasis that the learner is an active organizer of environmental data, rather than a passive receiver of information (Chi, 1976). Indeed, the Neo-Piagetian position maintains that the limits of the child's M-space represent a developmental constraint upon him as an active learner (Case, 1975).

Theoretical Support for the Construct M-space

Psycholinguistic and information processing theory have both posited constructs explicity corresponding to Pascual-Leone's central processor M. Such hypothetical constructs attempt to explain how the human organism is able to transform, coordinate, and integrate (or program) increasingly more complex information as a language user and problem solver.

Reitman (1965) discusses a hypothetical organ called the "comprehension operator" or integrator mechanism for building novel schemata (organized behavioral responses), concepts, percepts, and internal sentences:

> Both in its use and construction of cognitive elements the comprehension operator may be a major source of what usually are thought of as limitations of immediate memory. Such limitations may instead be viewed as particular properties of specific information-processing organs, as restrictions upon the number of separate elements such a comprehension organ may hold when constructing a new element (p. 262).

Miller and Chomsky (1963) in developing a model of the language user, "a limited automaton who can generate and comprehend an infinite number of structurally variant sentences **discuss a** device called M. It is a finite transducer containing a certain amount of computing space "which may be utilized in various different ways, and it must be equipped to perform logical operations of various sorts" (p. 466). According to these authors, M incorporates competence "whether or not it is realized in performance... since only (it) can explain the transfer of learning that we know occurs when memory aids are in fact made available" (p. 467). Although a scale which predicts the manner in which M increases is not specified, that such a scale may exist can be inferred from the following statement (at least in describing the development of competence in applying the rules of generative grammar during speaking and listening):

> As the amount of computing space available to the device M increases, M will understand more deeply embedded structures in the manner of G (p. 469) (G represents the rules of transformational grammar).

A defining parameter of the device M therefore, is its finitenes, bounded memory, or limited capacity.

That such a device or processor is operating during short-term memory activities involving the transormation of incoming data or activation of cognitive schemes is suggested in the work of several information processing theorists (Norman, 1970; Reitman, 1971; and Bjork, 1974). The trend is away from examining memory as a "passive storehouse of information" (Reitman, 1971), to investigating those control processes which the human organism demonstrates in overcoming the limited span of the working or immediate memory (for example, chunking). Rather than describing long-term and short-term memories as isolated organizations, there is a stress on building models of human memory based upon the dynamic and interactive processes of memory structures. Reitman (1971) describes "working memory" as:

> ...a store so called because it contains not only the new items but also other relevant information from the long-term memory. When all input items have been processed through the system or the current task is interrupted, a reorganizing process goes to work disassembling the working memory in order to save the significant parts for permanent storage in the long-term memory (p. 119).

Bjork (1974) proposes that governing such control processes (for example, mneomonic activities) is a "central processor" which is viewed as a conscious mechanism that directs attention, storage, rehearsal, and retrieval. Since the capacity of the working memory (or central computing space) is finite, limits are placed on the ability of the human subject in searching out and evaluating information in the attentional field (Norman, 1970; Lindsey and Norman, 1972), and in activating cognitive schemes (Case, 1975). It is assumed that the maximum number of chunks of information which can be coordinated at any one time, by the cognitively mature subject is seven (Miller, 1956; Gregg, 1972). It is also assumed that the central processor is the only device available to the human subject for coordinating schemes in his repertoire, and the sole cognitive mechanism for processing information which requires mental effort (Pascual-Leone and Smith, 1969).

Growth in M-space: A Developmental Phenomenon

Neo-Piagetian theory maintains that M-capacity increases in an all or none fashion until a plateau is attained during adolescence. Several studies from the field of child development tend to support this growth in M-space or information processing capacity. In a study by Potter (1966) which examined recognition of ambiguous pictures by children from preschool age through college age, the author concludes: ". . . if a single principle concerning the growth of perceptual recognition with age emerges from this study it is that the 'span of integration' increases" (p. 132). This phenomenon refers to the gradual expansion of a capacity to differentiate and coordinate more than one aspect of a stimulus configuration simultaneously or sequentially, and an increasing ability to entertain successively integrated hypotheses for task solution. Potter suggests that the growth of the span of integration allows the child to make use of more information in a complex stimulus or complicated task.

Olsen (1966) investigated the problem-solving capabilities of children ages three through nine years. The experimental task demanded that the child discover which of two or three patterns was reproduced on a board that consisted of bulbs which could be lit by pressing a key. The child's task was to execute a plan which would give him enough information to deduce which pattern was replicated on the board. The author identified three solution strategies: Search, Successive Pattern, and Information Selection. Movement from the first strategy to the last was seen to be a function of the number of task properties which the child could deal with simultaneously. The Search strategy, typically demonstrated by three and four year olds, was characterized by the manipulation of only one aspect of the task. They found which bulbs lit up, irrespective of the pattern configuration to be tested. During Successive Pattern Matching, characteristics of the five and six year olds, another aspect of the task was coordinated, as illustrated by testing each pattern in its entirety on the bulb board. The Information Selection procedure, utilized by seven to nine year olds, indicated an "internalization of the task requirements." These children were able to coordinate several features of the task at one time, and mentally retain information which led to eliminating alternatives. Olsen (1966) stated that "the mind appears automatically to break the information into 'chunks' sized appropriately to its level of development", and that the movement from Search strategy to Information Selection "involves being able to deal not with one image at a time, but rather with the properties of features of several images simultaneously" (p. 152). In discussing the inability of the five year old to apply the Information Selection strategy, Olsen suggested that "the structure for combining information sequentially is either not yet developed or it is simply not well enough managed" (p. 150).

Friedrich (1974) administered several dichotic listening tasks to normal children between the ages of seven and seventeen years. Although younger subjects did indicate efficient processing strategies in their repertoire, their performance was consistently less accurate than the adolescent group. The author concluded that the employment of optimal processing strategies for encoding, storing, and retrieving information was dependent on the child's capacity: "The child's relative lower accuracy or recall, even with optimal strategies, may be due to a restricted storage limit for relevant information" (p. 563).

Neo-Piagetian Developmental M-space Scale

By examining the informational complexity of tasks (specifically Piagetian) from the child's point of view, i.e. determining the amount of mental effort which the child needs to expend in order to coordinate the separate schemes required for task solution, Pascual-Leone (1970) has derived a developmental scale which describes the observed increase in children's information processing capacity, or M-space. In order to understand this scale of M-space values, definitions of basic terms need to be discussed.

Scheme Concepts

The concept of scheme is central to Piagetian theory, modern information processing theory, and the Neo-Piagetian theory. "Schemes are defined as subjective units of thought, that is, as the mental blueprints which represent experience and which are responsible for producing behavior" (Case, 1974b, p. 545). Schemes may be classified into three types: executive, figurative, and operative. Executive schemes correspond to "plans" (Miller, Galanter, and Pribram, 1960), or strategies/tactics for processing and ordering a sequence of operations in order to achieve a particular objective.

Case (1974b) also refers to executive schemes as "internal representations of procedures" (task instructions) which determine which figurative and operative schemes the child will activate in a specific situation. Figurative schemes correspond to "chunks of information, images of recognizable perceptual information" (Gregg, 1972), or the "cognitive demons" (pattern recognition devices) of Selfreidge's Pandemonium model (Lindsey and Norman, 1972). The response generation of figurative schemes is a constructive-active process. The child acts upon a weighted set of feature or cue tokens, rather than simply reacting to stimulus input; he recodes information according to his cognitive structures (assimilation) and conceptions. Operative schemes are "the internal representation of functions (rules) which can be applied to one set of figurative schemes in order to generate a new set" (Case, 1974b, p. 545).

Linear Scale of M-space Values

The growth of M-space is assumed to change in a linear manner with increasing age, according to the following scale (Pascual-Leone, 1970):

Age	Developmental Substage	M-space
3-4	Early Preoperations	e + 1
5-6	Late Preoperations	e + 2
7-8	Early Concrete Operations	e + 3
9-10	Middle Concrete Operations	e + 4
11-12	Late Concrete - Early Formal Operations	e + 5
13-14	Middle Formal Operations	e + 6
15-16	Late Formal Operations	e + 7

The constant "e" refers to the mental effort required to activate an overlearned executive scheme (Case, 1974a). "The numeral refers to the maximum additional number of figurative and operative schemes which can be activated under the direction of this executive, without direct support from the immediate perceptual input" (Case, 1974a). There is a correlation between the M value associated with each substage of cognitive development and the number of schemes which are activated during solution on tasks characteristic of each substage. An example analyzing the concrete operational task, conservation of equivalence within the domain of substance follows:

> During a conservation of equivalence task the child is presented with two clay balls; after agreeing that they are equal in amount, one of the balls is transformed by rolling it into a sausage shape. The child is asked if the balls still have the same amount of clay in them.
>
> In solving this task the child appears to activate the following schemes:
>
> E : an executive scheme representing the instructions, 'Do the balls still have the same amount of clay in them?' and directing an appropriate perceptual scan of the ball as it is transformed;
>
> F1: a figurative scheme representing the fact that 'if nothing has been added to or taken away from the ball which was transformed';
>
> F2: a figurative scheme representing the rule that 'if nothing is added or taken away, then the amount remains the same';
>
> F3: a figurative scheme representing the information that 'the balls originally were equal in amount'.

> If children do not coordinate the above schemes, they usually fail the task, apparently because they activate:
> F : a figurative scheme representing the rule that 'things which look bigger contain more'.
> The age at which this task is first passed is 7-8 years. The M-space associated with this age is e + 3 (Case, 1972a, p. 340).

Validation Studies of Neo-Piagetian Theory

Several studies have attempted to validate Neo-Piagetian theory which maintains that central computing space increases with age according to the developmental scale of M-values derived by Pascual-Leone (1970), and that the power of the central processor M accounts for differences in performance across age groups during linguistic and logical functioning.

Pascual-Leone and Smith (1969) predicted the ability of children ages five through ten to produce novel linguistic assertions after scheme analyzing four conditions of linguistic responding. The experimental tasks consisted of (1) a decoding verbal condition, during which the child was required to state which of two visual stimuli the experimenter was thinking of on the basis of a descriptive verbal cue; (2) a decoding gesture condition, during which the child was required to state which visual stimulus the experimenter was thinking of on the basis of a gesture or movement he made associated with one of two objects presented; (3) an encoding verbal condition, which demanded that the child think of one of two objects and select a word to serve as a discriminating cue for the experimentor; and (4) an encoding gestural condition which required that the child make a movement discriminating which stimulus he was thinking of. Significant results supported the hypotheses that all age groups were successful on the decoding task, irrespective of mode of representation; but, the encoding tasks were not completely solved until seven to eight years of age, and not completely mastered until nine to ten years of age. The encoding tasks placed a heavier demand on M-capacity, because the number of schemes to be coordinated was greater than for the decoding conditions. According to the authors, these findings suggested that the child's linguistic performance was contingent upon his logical competence and not vice versa as other investigators in cognitive development indicated (Bruner, Olver, and Greenfield, 1966).

In Pascual-Leone's (1970) definitive study, children's performance on a Compound Visual Stimulus Task was accurately predicted from the number of mediated responses elicited to complex visual configurations. Only normal field independent subjects, ages five through eleven, were included. The experimental task involved teaching the child a different response to each of several visual cues. After responses were learned, compound stimuli were presented to be decoded. For example, a child was taught to clap his hands when he saw the color red. After he learned one response for each stimulus, compound stimuli were presented and compound responses were required. The task was presented as a "spy game." M-capacity was determined by the number of correct responses the subject emitted. The schemes corresponding to the task instructions and perceptual scanning of the stimuli were overlearned during training, and were continuously centrated by the central processor M; these schemes constituted the constant "e" in the M-space formula, e + k. The "k" (in this case) refered to the number of mediated responses the child emitted. Predicted values of M-space for each age level, according to the established developmental scale, were upheld.

Case (1974a) succeeded in cross-validating the M-space scale on a Digit Placement Task. During this task, the child was required to indicate the correct position of a number with respect to a previously presented ordinal series of numbers. In this case, "k" was equal to the maximum number of digits in the series in which the final number exposed was correctly placed. For example, if after exposing each of the following digits for one and a half seconds each - 3, 8, and 12 - the child correctly placed (by means of a token) the numeral 6 within the series, his estimated M-space would be e + 4 (characteristic of nine to ten year olds). The distribution of M-space scores for the age groups studied, six through ten year olds, was equivalent to Pascual-Leone's findings. In this same study, Case mentioned that the Backward Digit Span Task yields "identical norms" and may therefore make a good measure of M-space (p. 301).

In another study conducted by Case (1974b), the effects of instructing subjects on a cognitive task, the Bending Rods Task, were predicted based upon subjects' estimated M-capacity, their cognitive style, and the demands of the task. The task was analyzed to require an M-space of e + 3 for solution. After assurance that each subject had the appropriate schemes in his repertoire, Case predicted: (1) the successful performance of eight year old, field-independent subjects, (2) the failure of the six year old, field-independent subjects, and (3) the intermediate performance of the field-dependent eight year olds. He reiterated that M-capacity functions as a developmental constraint upon generating complex responses, even when the child's repertoire includes the necessary schemes for task solution.

Neo-Piagetian theory, therefore, specifies the factors which affect response variability on cognitive tasks across and within age groups. These factors relate to the repertoire of schemes available to the child, his maximum M-capacity, and his tendency to utilize his modal M-space. An understanding of these factors is integral to the present study and an indepth explanation follows.

Factors Affecting Response Variability on Cognitive Tasks

The first factor which affects a child's performance on certain cognitive tasks is the actual repertoire of schemes which he brings to a task. The child's experiences in interacting with his particular environment may determine the content and complexity of his repertoire. The acquisition of new schemes, or a change in the repertoire may occur in the following ways: (1) old schemes can be modified by differentiation; new components (feature extractions) are incorporated into the existing repertoire and become releasing responses for the activation of operative schemes; (2) combinations of figurative schemes which consolidate several schemes in the child's current repertoire result in a new "higher-order unit," in other words, the schemes have been chunked and are released as one functional representation; (3) by applying an operative scheme to a set of figurative schemes, a novel response may be generated; and (4) this entire process is recursive, therefore, superordinate schemes (operative) which act as affecting responses become "compound superstructures" analogous to a complex computer program which consists of several subroutines (Pascual-Leone, 1970; Case, 1972a, 1974b). These are the steps in the learning process according to Neo-Piagetian theory.

The second factor affecting response variability is the child's maximum M-capacity, the number of schemes in his repertoire that he can activate and coordinate at any one time. Activation of a scheme (unless field facilitated) requires the application of mental effort, or the executive service of the central processor M. This factor represents a developmental constraint on the child's ability to perform on certain tasks (Case, 1975). If a child is confronted with task demands which exceed his current M-capacity, irrespective of his cognitive style characteristics, Neo-Piagetian theory would predict that he would not be successful. Differences in M-space across age groups are assumed to be due to biological factors which are reflected in measures of intelligence that are "content-free" (Case, 1974a, 1974b). Empirical distributions of M-space scores within age groups show that approximately 75 percent of the children have M-spaces equal to e + k. The "k" refers to the maximum numbers schemes in addition to the executive scheme ("e"), typically coordinated by individuals at each substage of cognitive development. Some children may function with an M-space equal to e + k - 1, and others with an M-space equal to e + k + 1 (Case, 1972b).

Some children are low M-processors. They approach complex tasks which demand differentiation of the stimulus field, or a breaking down of the task into its component parts, in a simple or global manner (Case, 1974a). Another aspect of low M-processors' performance is the inability to overcome a particular style of responding which gives undue weight to salient, but misleading, cues when the relevant cues for task solution are "embedded." Inappropriate or inefficient executive schemes (plans for problem solving) may be triggered by responding to such cues. Pascual-Leone (1970) proposes that this third factor corresponds to the cognitive style construct, field-independence-dependence.

As defined by Witkin, et.al. (1962), this dimension refers to individual variation in the degree that component parts of a stimulus configuration are experienced as discrete, and reflects differences in ability to overcome the influence of embeddedness. The field independent individual is able to select relevant stimuli that are embedded in a larger context and resist the interfering effect of contextual stimuli. The field dependent individual tends to be dominated by the overall organization of the stimulus field and is relatively unable to experience parts of a field as discrete.

Two primary indices of this dimension are the Rod and Frame Test, and the Children's Embedded Figures Test (Karp and Konstadt, 1963). The first device measures the individual's ability to adjust a movable rod within a luminous frame, which remains tilted, to a true vertical position (Witkin, Goodenough, and Karp, 1967). The Children's Embedded Figures Test requires the individual to locate a simple figure which is embedded within a larger visual stimulus configuration. During normal development, children progressively become more field-independent with significant changes in perceptual organization abilities being noted especially between the ages of five and eight (Kogan, 1971). At first the child's search routines are stimulus bound and susceptible to the perceptual salience of task cues. Later, with the development of more mature operative structures, the child is able to subordinate salient but irrelevant task aspects to the logical or conceptual requirements inherent in the task demands. According to Pascual-Leone's theory (1970), this movement to a more field independent style is contingent upon growth in the M-space available to the child.

Pascual-Leone's theory sheds new light on how a field dependent style influences performance. If a child typically applies minimum M-space during performance on a complex task because his field-dependent cognitive style is incongruent with task demands, he may generate a developmentally lower response. Field dependent children consistently performed poorer than their field independent counterparts on the Compound Visual Stimulus Task (Pascual Leone and Smith, 1969) and certain Piagetian tasks (Case, 1974b). This distinction between the child's structural (maximum) M-space and functional M-space (that which he actually uses) is related to a competence/performance distinction. High M-processors habitually use their maximum M-capacity, while lower M-processors typically approach a complex task "with a set of operations involving the least possible mental effort" (Case, 1974a).

Related Theory and Research in the Field of Learning Disabilities

In the past decade, there has been increasing support from theorists and researchers to re-examine learning disabilities in terms of the psychological processes which underlie cognitive and perceptual development (Senf, 1972; Keogh, 1973; McCarthy, 1975; Gallagher, 1975; Strother, 1975; Ross, 1976; and Torgensen, 1979). Generally accepted is the need for a comprehensive theory relating deficits in psychological processes to specific performance deficiencies (Senf, 1978 and Wong, 1979). The application of information processing constructs in addressing this need appears to be a promising direction (Senf, 1972; McCarthy, 1975; Torgensen, 1977, 1980).

Senf (1972) has postulated a complex, comprehensive theory which incorporates information processing constructs, i.e., capacity thresholds, attention, stimulus parameters, rehearsal strategies, etc., in order to explain the performance deficits associated with learning disabilities. Senf (1972) maintains that learning disabled children probably have normal or adequate information processing capacity:

> Because the information processing capacity is limited, the organism must select which information it will process (attend to). Though an obvious notion, the assumption that the processing system has limited capacity has very important ramifications for the distribution of this limited capacity. Improper management of an adequate amount of information processing capacity can result in failure on certain tasks just as severe as that caused by limited capacity itself. The paradox of learning disabilities may find some resolution in this notion, though not mentally retarded, presumably a condition represented by limited capacity, the learning disabled child has adequate resources, i.e., processing capacity, but seems unable to achieve the desired complex behaviors, as for example, reading (p. 310).

Some research studies exploring the memory spans of learning disabled children indicated, however, that they may manifest restricted information processing capacities. Ring (1976) found that the performance of learning disabled children was significantly poorer than that of normal children on several auditory memory span tasks, although the "learning disabled children did profit from input organization." In a study comparing normal and dyslexic boys on digit naming and digit span tasks, the author concluded that in addition to a slower encoding speed, the "impaired memory span of the dyslexic children" contributed significantly to the variation in performance between the two groups (Spring, 1976). Badian (1977) investigated the relationship between short-term auditory memory and auditory-visual integration in a comparative study between children who were adequate readers and those who were reading disabled. The author found that the retarded readers did poorly on all tests requiring auditory memory and that this inferior performance seemed due to a short term memory span deficit.

Ross (1976) contends that failure on memory tests may also reflect "an inability or failure to attend" and furthermore that a "dilemma (is) created when one tries to draw inferences about covert processes (i.e., memory) when only input and output can be observed" (p. 67). Torgensen (1980) hypothesizes that some of the research results concerning the limited short-term memory spans of learning disabled children may be related to findings that some learning disabled children do not employ efficient strategies on tasks measuring memory span (for example, rehearsal strategies), rather than confirming structural or capacity deficits. These statements suggest that differences in ability to attend and ability to apply appropriate task strategies may be confounding variables in studies examining the memory spans of learning disabled children.

Ross' (1976) theory of the relationship between selective attention and specific learning disabilities emphasizes the developmental changes that emerge as the child becomes a more efficient processor of information. He reviews the findings of many research studies in the field of learning disabilities and reaches the conclusion that "learning disabilities may thus be viewed as the result of delayed development in the capacity to employ and sustain attention." In defining selective attention, although probably a broader term than field independence, certain components are quite comparable: both involve the ability to inhibit attention to irrelevant stimulus dimensions, both are tangential to the transition from a perceptually based approach to the application of cognitive or conceptually based strategies, and both factors improve with age until a plateau is reached at adolescence.

There is support that some learning disabled children are overly field dependent and approach learning situations with inefficient task strategies. According to Senf (1972), one factor which may account for "improper management" of the learning disabled child's information processing capacity is a task approach characterized by a field dependent cognitive style. There appears, therefore, some overlap between Senf's Information-Integration theory and Pascual-Leone's Neo-Piagetian theory.

In a study by Maier (1980), the author hypothesized that learning disabled children would manifest a lag in cognitive functioning on verbal recall tasks which required the subjects to formulate generalization responses and draw inferences. Although this hypothesis was supported, an instructional technique which enhanced the learning disabled children's ability to focus on the relevant material needed for solutions significantly increased this recall of higher order responses. A conclusion drawn from this study was that learning disabled children did not independently or spontaneously apply the cognitive operations which they later demonstrated in the "focused information" situation. It appeared that the learning disabled subjects had difficulty shifting from one area of attention to another and that the intervention technique "forced the child to refocus attention on both the task and on the content" (p. 146).

Keogh and Donlon (1972) found that boys with moderate to severe learning disabilities were markedly more field dependent than their normally achieving peers on a portable Rod and Frame instrument. Guyer and Friedman (1975) also reported significant differences between groups of normal and learning disabled children on the same measure of field-independence. These authors stated that "it is evident that learning disabled children are much more likely to approach school with a field sensitive orientation" and that developmental lags in certain areas of cognitive functioning, which may result in a less mature cognitive style, "should be detectible as a deficit where task requirements and cognitive style are incompatible." Some learning disabled children, therefore, may be relying on immature or inappropriate strategies when solving analytic tasks, in complex stimulus situations, and on tasks which demand attention to instructions rather than more salient but misleading cues of the stimulus arrays. Since most school tasks come within the category of analytic or complex, these children would be at a disadvantage.

Case (1974b) suggests that children who manifest a field dependent orientation beyond normal variation may require more M-space than field independent children to solve the same task. In acquiring appropriate executive schemes, initially incapatible with their cognitive style, a greater demand is placed upon their information processing capacity: "...one M-space may have to be devoted to concentrating the newly acquired executive scheme, and the M-demand of the task" may therefore be $e + k + 1$ for the child. Without specific interventions which address the child's incompatible learning style "catching up" with their peers may occur at a later age when their M-space increases. Such children may require specific instructional techniques which direct their attention to relevant task cues. There is some evidence, therefore, that some learning disabled children may be overly field dependent and therefore low M-processors. Their demonstrated discrepancy between assumed competence (M-capacity) and performance on cognitive tasks may be a function of the lack of synchronous development between perceptual and cognitive systems.

Few studies have investigated the performance of learning disabled children on cognitive tasks, namely Piagetian tasks. Klees and LeBrun (1972) administered a measure of perceptual organization ability and several Piagetian tasks to dyslexic boys. They found that the severe learning disabled boys demonstrated both quantitative and qualitative differences in cognitive processing abilities. Meltzer (1976) administered conservation, seriation, and classification tasks to groups of learning disabled and normally achieving boys and found no significant differences in their level of attainment of operative thinking. Anderson, et.al. (1980) conducted a comparative examination of learning disabled and normally achieving boys performance on a visual integration task and a hierarchical classification task. They found that the learning disabled boys were delayed by about two years when compared with the performance of the normally achieving controls in their ability to demonstrate part/whole perception and hierarchical classification.

Because the surface responses of children attempting to solve cognitive tasks may be similar whether they are operating with inadequate M-capacity for the task, or whether they are inefficiently processing their modal M-space due to a field dependent cognitive style, it is important to determine which constraint upon learning or performance is present. According to theoretical assumptions, learning disabled children should have adequate information processing capacity (Senf, 1972; Ross, 1976). This characteristic, however, has not been consistently demonstrated by learning disabled subjects in research studies. Differences in the tasks used to measure information processing capacity may account for the discrepancy between current theory and empirical findings. Some of the tasks used may have assessed rote memory, rather than working memory or M-capacity. In this study, the tasks utilized to measure M-space are assumed to accurately estimate a child's information processing capacity because a transformation of stimuli is required in order to achieve the correct responses.

In summary, the learning disabled child's lack of success on certain cognitive tasks, despite adequate information processing capacity, may be indicative of an individual learning style which is not compatible with task requirements. Failure on cognitive tasks may be related to deficits in performance, rather than ability or competence deficits. Given a task structured to conform with the learning disabled child's unique, but inefficient task approach, his underlying cognitive competence should be demonstrated.

Chapter 3

METHODOLOGY

This chapter presents the research design and hypotheses, subject selection procedures, and descriptions of the experimental tasks. The research activities were designed to test the applicability of the Neo-Piagetian model in describing the competence/performance discrepancy associated with children who demonstrate specific learning disabilities. The primary focus of this research was an examination of the cognitive functioning in learning disabled and normally achieving children. The aspects of cognitive functioning which were investigated were M-capacity, degree of field independence, and level of operative thinking.

Hypotheses and Design

Several research hypotheses were formulated using constructs from Neo-Piagetian theory. The hypotheses were stated as follows:

(1) there is no difference in the M-capacities of learning disabled and normally achieving children;

(2) there is a difference between learning disabled and normally achieving children on tasks measuring level of field independence; and

(3) there will be a difference between learning disabled and normally achieving children on tasks measuring level of operative thinking if the learning disabled children demonstrate differences in M-capacity and/or level of field independence.

A matched-samples design was applied in this comparative study in order to control variance due to individual differences which may be correlated with the dependent variables, i.e., M-capacity, field independence, and level of operative thinking. In addition, assurance of group equivalence on variables such as IQ and age, particularly, may be crucial to the interpretation of significant differences.

Subject Selection Procedures

The subjects for this study were drawn from ten elementary schools in a Southwest Virginia County. The author personally visited each school and discussed the nature and scope of the project with the building principal. Parent permission letters (see Appendix A) were distributed to learning disabled (LD) and normally achieving (NA) children according to the following specified criteria.

Criteria for Selecting Potential LD and NA Subjects

The criteria for selecting potential subjects for the LD sample were:

(1) students were male, enrolled in the third or fourth grade, and between the ages of 8.5 and 10.0 years;

(2) students have been classified as learning disabled by an eligibility committee and were receiving the services of a learning disabilities teacher.

The criteria for selecting potential subjects for the NA sample were:

(1) students were male, enrolled in the third or fourth grade, and between the ages of 8.5 and 10.0 years;

(2) no student had ever been referred for special education;

(3) no student was receiving Title I reading and/or math services; and

(4) no student had repeated a grade.

Only boys were included in this study because there are four to six as many boys as girls identified as learning disabled (Lerner, 1976).

Of the 150 parent permission forms distributed to the ten elementary schools, 86 permissions were obtained. These represented 56 normally achieving boys and 30 learning disabled boys. To each potential subject the author administered the Slosson Intelligence Test (SIT) and the Wide Range Achievement Test (WRAT) for matching purposes and further assurance of correctly delineating the two samples. These instruments were individually administered in one session that lasted about 45 minutes.

The Slosson Intelligence Test (SIT) (Slosson, 1971) is an individually administered test of mental ability. It is primarily used as a screening instrument. The test takes between ten and thirty minutes to administer. Published validity studies report correlations between the SIT ratio IQ score and the Wechsler Intelligence Scale for Children scores from .54 to .93, and between the SIT and the Stanford-Binet between .76 and .90. A retest reliability coefficient of .97 was obtained on a heterogeneous sample of 139 subjects after a period of two months. The SIT is a widely used device for screening children with learning disabilities and yields a quick estimate of mental ability (Salvia and Ysseldyke, 1978).

The Wide Range Achievement Test (WRAT) (Jastak and Jastak, 1965), is an individually administered test used to assess performance in the basic school subjects of reading (oral reading of single words), spelling, and math computation. Each of the subtests is divided into two levels: Level I for children ages 5.0 to 11.11 years and Level II for individuals 12.0 through adulthood. The test takes between 20 and 40 minutes to administer. Three kinds of scores are obtained: grade equivalents, percentiles, and standard scores. Concurrent validity estimates between the WRAT and the Stanford Achievement Test range from .80 to .91. Split-half reliability estimates range from .92 to .98 for the reading and spelling subtests and from .85 to .92 for the arithmetic subtest.

Criteria for LD and NA Subjects

The following criteria were applied in selecting LD subjects from the 30 boys previously identified:

(1) a learning disabled subject must have obtained an intelligence quotient of at least 90 on the SIT;

(2) a learning disabled subject's performance on the WRAT must indicate a discrepancy of at least ten points between the SIT intelligence quotient and the derived standard score on one or more of the WRAT subtests.

Subjects to be included in the normally achieving sample were further defined as follows:

(1) a normally achieving subject must obtain an intelligence quotient of at least 90 on the SIT;

(2) a normally achieving subject's performance on the WRAT must indicate an achievement level commensurate with or above his SIT intelligence quotient.

Of the 30 possible LD subjects, five were excluded at this stage of selection because their derived standard scores on the WRAT subtests did not show a ten point discrepancy when compared to their SIT intelligence quotient, or they obtained an intelligence quotient below 90. Of the 56 potential NA subjects, seven were eliminated from the research study because they did not achieve a SIT intelligence quotient of at least 90 and/or a discrepancy greater than ten points was obtained between their standard scores on one or more of the WRAT subtests and the SIT intelligence quotient. From this pool of 49 NA subjects, 25 boys were selected as best matching the 25 LD subjects on the following variables: age, grade level, and SIT intelligence quotient.

Experimental Tasks

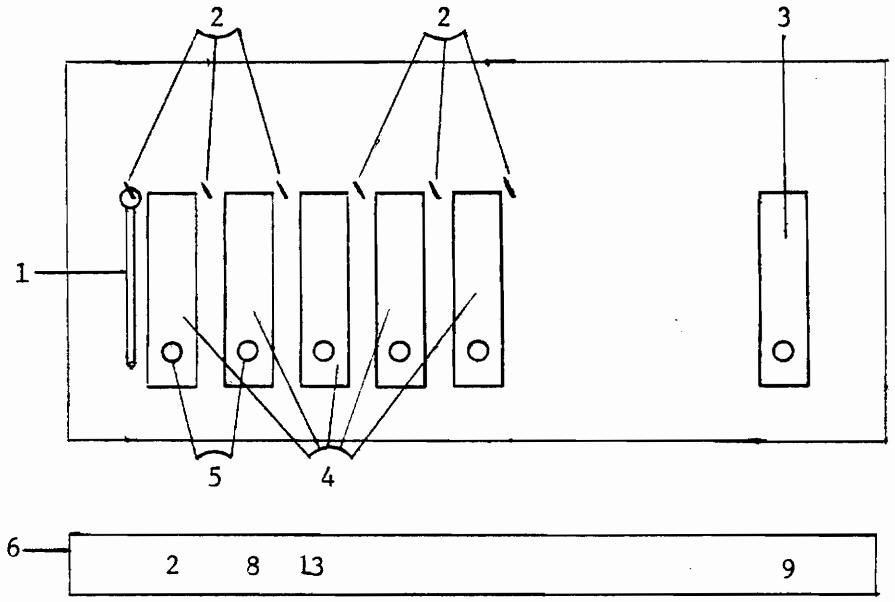
Two tasks were administered to all subjects in order to determine M-capacity: the Digit Placement Task and the Backward Digit portion of the Wechsler Intelligence Scale for Children - Revised (WISC-R), Digit Span Subtest. Two tasks were administered in order to assess each subject's level of field-independence: the Children's Embedded

Figures Test and the Wechsler Intelligence Scale for Children - Revised (WISC-R), Block Design Subtest. Seven Piagetian tasks were administered to each subject to determine level of operative thinking. Each of these experimental tasks are described briefly in the following sections.

Digit Placement Task

The Digit Placement Task requires the child to place a digit, by means of a token, in correct ordinal position with respect to other digits which increase numerically from left to right. A diagram of the task apparatus is shown in Figure 1 on page 47. For example, the digits 2, 8, and 13 may be exposed to the child for one and one-half seconds each. The child repeats each digit as it appears in the visual array. A final digit, 9, is shown immediately thereafter and the child is asked to place the 9 in the correct position by means of a movable wooden rod. In this example, accurate placement of the last digit is characteristic of an e + 4 M-space. In an example with three digits, correct placement of the final digit would be indicative of an e + 3 M-space. The constant "e" refers to the mental effort required to activate an overlearned executive scheme. The numeral refers to the number of figurative and operative schemes activated.

All subjects were provided with a pre-training session to insure that their scheme repertoire included the necessary schemes for task solution and that they would activate the appropriate, overlearned



1. Token

2. Hooks on which token may be placed

3. Door concealing final numeral

4. Doors concealing ascending numerals

5. Door handles

6. Example of numeral card

Figure 1. Digit Placement Task Apparatus

executive scheme (corresponding to the task procedures). The pretraining consisted of the following activities:

(1) each subject was shown a card with 25 written numerals, ranging from 1 - 60, and asked to name the numerals;

(2) each subject was given cards with samples of numerals, ranging from 1 - 60, and asked to arrange the cards in correct numerical sequence;

(3) each subject was shown the task apparatus with all numerals visible, and asked to demonstrate understanding of the task instructions by placing the last numeral card in the correct sequence;

(4) each subject was shown the tasks apparatus and taught how to use the place marker; the subject was asked to demonstrate understanding of the use of the token on two practice trials.

All subjects met the above pre-training requirements, demonstrating that the numerals 1 - 60 were in their scheme repertoire and that they understood the task procedures.

The Digit Placement Task was administered in two sessions. Five items at each level, from e + 2 through e + 6, were presented to each subject during each session. The numerals used for each session by item are provided in Appendix B on page 98. The Digit Placement Task has been cross-validated with Pascual-Leone's Complex Stimulus Visual Information Task, and yields comparable M-space estimates (Case, 1972a). A test-retest reliability coefficient of .58, $p < .01$, was obtained when children, ages seven to eight years, were administered that task over a two day period (Case and Globerson, 1974).

Backward Digit Span Task

The Backward Digit Span portion of the WISC-R Digit Span Subtest was also administered to each subject as a criterion measure of M-space. The task consists of eight series with two trials each. The test begins with the task of repeating two numbers backward and increases to a maximum of eight numbers. According to Case (1972a) the child's M-capacity would be equal to the maximum number of digits repeated backwards successfully. Significant correlation coefficients have been obtained between an experimental form of the Backward Digit Span Task and the Digit Placement Task (.51, $p < .01$), and between the Backward Digit Span Task and the Complex Stimulus Visual Information Task (.43, $p < .01$). Because the Backward Digit Span Task is much quicker to administer and does not require the extensive training procedures necessary for the other two tasks, validation of this test as an estimate of modal M-space would be helpful.

The Children's Embedded Figures Test

The Children's Embedded Figures Test (Karp & Konstadt, 1963) is a widely used research instrument for assessment of the cognitive style field-independence. It is appropriate for children ages 5 - 12 years. The test consists of a series of 25 items which require the subject to locate a simple form embedded in a stimulus configuration. The score obtained is the number of correct responses. The training and testing procedures described in the manual were followed. Validity coefficients reported in the Manual for the Children' Embedded Figures Test using the Embedded Figures Test with children ages 9 - 12 years, ranged from .70 to .86. Internal consistency reliability estimates reported ranged from .83 to .90. The mean score reported in the manual for the 20 nine to ten years olds in the standardization study was 16.6.

WISC-R Block Design Subtest

The WISC-R Block Design Subtest was also administered to each subject to determine level of field-independence. This test consists of 11 timed items; the child is required to reproduce patterns shown on cards with a set of design cubes. The subjects' raw scores were converted to scaled scores using the tables in the WISC-R Manual. This task has been utilized as a measure of field-independence in several Neo-Piagetian studies (Case, 1972b, 1974a, 1974b; Case and Globerson, 1974). A correlation coefficient of .41 (p. < .01) was reported between the Children's Embedded Figures and the Block Design Subtest (Case and Globerson, 1974).

Piagetian Tasks

Seven Piagetian tasks were administered to all subjects in order to estimate level of operative thinking. These tasks were adapted from classical Piagetian tasks which have been widely used in research studies. A description of each tasks follows:

(1) Conservation of Identify, Discontinuous Quantity. Each subject was presented with a cylinder of rice. The rice was poured from the cylinder into a dish by the author, as the subject watched. The subject was asked if there was the same amount of rice in the dish as there had been in the cylinder, or if there was more or less rice in the dish.

(2) Conservation of Equivalence, Discontinuous Quantity. Each subject was presented with two empty containers of equal capacity. The examiner poured equal amounts of rice into the containers, while the subject watched. The subject could adjust the amounts of rice to his satisfaction if he felt that there was a discrepancy between the amounts of rice in the containers. The author poured the rice from one of the containers into a flat dish. The subject was asked to compare the amount of rice in the dish with the amount of rice in the other container.

(3) Simple Classification. The author presented each subject with four black, round buttons and four yellow, square buttons. The buttons could therefore be grouped according to shape or color. The subject was first asked to point to something black, something yellow, a round object, and a square object. The author asked the subject to put the objects that were alike in some way in one group, and the objects that were alike in another way in a separate group. The child was asked the basis for his grouping. The examiner then scrambled the buttons, and asked the subject to group the buttons in a different way. Ability to demonstrate grouping the buttons by color and shape and a verbal justification for the grouping were required for correct solution.

(4) Seriation of Length. The subject was presented with six wooden rods, ranging in length from 8 cm to 20 cm. The subject was asked to place the rods in a row showing progression from shortest to longest. The child was then given a rod 15 cm in length and asked to place this rod where it belonged in the row the subject had just made. The subject was required to verbalize why he had placed the 15 cm rod where he did in the row.

(5) Class Inclusion. The subject was shown six animal figurines, representing four dogs and two rabbits. The examiner asked the subject to name the objects and elicited the class name animals, if the subject did not spontaneously name the class. The child was then asked, "Are there more dogs or more animals?" The child was asked to explain his response.

(6) Conservation of Time. The subject was presented with two, 3 inch dolls. The examiner told the subject that the dolls were going for a walk. The subject was instructed to tell the examiner when to start and stop the dolls as she moved them across the table from a designated starting place. The examiner followed the subject's directions and paced the dolls with equal size steps. The dolls, therefore, covered equal distances. The examiner then asked the subject if the dolls started and stopped at the same time. The subject was then told that the dolls were going on another walk and asked the child to again tell the examiner when to go and when to stop the dolls' movement. This time the examiner moved the dolls in such a way that one doll took larger hops and therefore, stopped farther ahead of the other doll. The child was asked if the dolls started and stopped at the same time. A justification response was required. A correct answer would be that the dolls started and stopped moving at the same time, but one of the dolls took bigger hops and therefore, landed farther ahead.

(7) Hierarchical Classification. Each subject was presented with twelve plastic flowers randomly placed on the table. The flowers included four red roses, one yellow rose, one white rose, one orange rose, one blue rose, one daisy, one tulip, one carnation, and one iris. The subject was asked to sort the flowers into three groups. If the child demonstrated the correct groupings (all red roses, other color roses, other flowers), he was asked the following questions and justification responses were requested for each question:

> Is the group made of all the red roses, bigger or smaller than a group made of all the roses?
>
> Are there more roses or more flowers?
>
> If I take away all the roses, will there be any flowers left?
>
> If I take away all of the flowers, will there be any roses left?

Performance on each Piagetian task was scored either 1 or 0, adhering to an all correct standard for the verbal and motor responses associated with each task. Each subject received an orientation session in order to ensure that he understood the following terms: more, less, same; recognition of the objects used was also verified prior to administering the classification tasks.

The Neo-Piagetian model provides a framework for task analyzing the Piagetian tasks. These analyses attempt to specify the figurative and operative schemes applied during solution. An example of an apriori analysis was presented and discussed on page 26 of this study. Based upon Piagetian stage theory and experimental testing of the Neo-Piagetian model, minimum M-space values may be assumed as necessary for task solution. Table 1 provides a summary description of the seven Piagetian tasks administered to each subject and the associated M-space values. According to Neo-Piagetian theory, four prerequisites are identified in order for an individual child to succeed on a Piagetian task: sufficient M-space, a repertoire which includes the required figurative and operative schemes, a tendency to utilize available M-space, and a resistance to misleading perceptual cues. The last two standards are conceptualized as the cognitive style field independence (Case, 1972a).

Table 1

Summary Descriptions of Piagetian Tasks

and Associated M-Space Values

Task	Description	M-Value
Conservation of Identity Discontinuous Quantity	Comparison of quantities of rice in cylinder and flat dish	e + 2
Simple Classification	Grouping buttons by color and shape	e + 2
Conservation of Equivalence Discontinuous Quantity	Comparison of quantities of rice in short wide containers and tall narrow container	e + 3
Seriation	Serial ordering of wooden rods, ranging in length from 8 cm to 20 cm, and correct placement of rod 15 cm in length	e + 3
Class Inclusion	Comparison of a class of animal figurines with subclasses of rabbit and dog figurines	e + 3
Conservation of Time	Comparison of movement in time of two objects from standard starting point. Deduction that size of movement unit does not affect starting with finish time.	e + 4
Hierarchial Classification	Multiple comparisons of subclasses of category flower.	e + 4

Chapter 4

RESULTS

A matched-pairs design was used to study whether differences could be identified in cognitive functioning between learning disabled and normally achieving boys. Three aspects of cognitive functioning were investigated using a Neo-Piagetian model of cognitive development: M-capacity, level of field-independence, and level of operative thinking. Twenty-five learning disabled (LD) and twenty-five normally achieving (NA) boys were matched on the following variables: age, Slosson Intelligence Test (SIT) quotient, and grade level. The Wide Range Achievement Test (WRAT) was administered to each subject to verify that achievement levels were commensurate with ability in the case of the NA subjects, or showed a discrepancy when compared to the SIT intelligence quotient in the case of the LD subjects.

Description of the Learning Disabled and Normally Achieving Samples

Table 2 displays a comparison of the LD and NA subjects on the variables used for matching purposes. The mean SIT intelligence quotient for the LD sample was 115, with a range of 95-138; the corresponding mean for the NA group was 113, with a range of 91-128. The mean age of both samples was 9.3 years. The average grade placements for the LD and NA samples were 3.3 and 3.2, respectively. The

Table 2

Characteristics of LD and NA Subjects on the following variables:
Age, Grade, SIT Intelligence Quotient, and WRAT Subtests Standard Scores

Pair	Age		Grade		IQ		Reading Rec.		Spelling		Math	
	LD	NA	LD	NA	LD	NA	LD	NA	LD	NA	LD	NA
1	9.0	9.2	3	3	120	124	95	129	91	116	101	116
2	9.0	9.1	3	3	95	93	79	93	78	96	92	92
3	8.8	8.8	3	3	108	107	88	114	85	112	84	112
4	9.0	9.2	3	3	106	104	90	120	91	114	91	109
5	9.0	9.0	3	3	117	115	99	122	92	112	90	109
6	9.0	9.2	3	3	102	106	77	109	78	106	79	101
7	9.7	9.6	4	4	106	111	79	133	79	107	93	103
8	9.8	9.5	4	4	130	129	93	134	87	127	105	121
9	8.6	8.7	3	3	119	112	97	106	93	104	96	113
10	9.0	8.9	3	3	138	128	124	128	94	120	110	118
11	9.6	9.4	4	3	114	112	93	110	85	109	93	109
12	9.7	9.8	4	4	127	125	114	123	100	119	99	121
13	9.6	9.3	3	3	114	113	92	116	93	106	91	106
14	9.5	9.5	4	3	115	114	99	119	91	146	87	110
15	9.9	10.0	4	4	102	91	77	98	75	91	96	93
16	9.2	9.0	3	3	131	128	112	140	92	119	101	120
17	9.4	9.3	3	3	107	105	95	109	90	95	99	101
18	10.0	9.5	4	4	112	115	80	126	81	109	90	111
19	9.8	9.8	4	3	127	120	105	131	75	114	83	117
20	9.3	9.4	3	3	105	108	89	103	89	103	94	99
21	9.2	9.3	3	3	122	119	105	124	86	114	90	111
22	9.3	9.1	3	3	106	105	85	110	80	112	91	99
23	9.3	9.1	3	3	120	119	101	118	85	117	103	120
24	9.2	9.2	3	3	118	116	94	119	87	114	110	123
25	8.7	8.7	3	3	106	107	113	137	94	122	94	111
$\overline{X}$	9.3	9.3	3.3	3.2	115	113	95	119	87	112	94	110
SD	.39	.77	.48	.41	10.63	9.91	12.42	12.16	6.65	11.10	7.75	8.52

LD boys' WRAT standard scores indicated an average discrepancy of ten points in Reading, 28 points in Spelling, and 11 points in Math when compared to their average SIT intelligence quotients. The NA boys' WRAT standard scores were overall commensurate with or slightly above expectation based upon their corresponding mean SIT intelligence quotient.

The experimental tasks were individually administered to all subjects in two 45 minute sessions. Session I consisted of the following tasks:

(1) pre-training for the Digit Placement Task
(2) Digit Placement Task I
(3) the WISC-R Backward Digit Span
(4) the WISC-R Block Design Subtest
(5) questions related to understanding the terms used in the Piagetian tasks

Session II consisted of the following tasks:

(1) Digit Placement Task II
(2) the WISC-R Backward Digit Span
(3) the Children's Embedded Figures Test
(4) the seven Piagetian tasks

Scalogram Analyses of Criterion Measures of M-space

Before examining group mean differences on the criterion measures of M-space, subject responses on the Digit Placement Tasks and the Backward Digit Span tasks were analyzed using the SPSS Subprogram Guttman Scale. According to Neo-Piagetian theory, growth in M-space should correspond to an undimensional and cumulative scale (Pascual-Leone, 1970). A Guttman Scale determines if the component items of a test measure movement towards a single underlying hierarchy. Success on more difficult items should be shown to be a function of success on the easier items. Further interpretation of M-space scores obtained in this study depended on whether they did represent conformity to a Guttman Scale.

Guttman Scale statistics were computed for each session of the Digit Placement Task and each administration of the Backward Digit Span Task by sample. Each Digit Placement Task session consisted of five series of five items. The cut-off point specified for the Guttman Analysis was four out of five correct responses per series. The Backward Digit Span task consisted of eight series of two items; the cut-off point for the Guttman Analysis was established at one out of two correct responses per series. M-space estimates were generated on the basis of these criteria. For example, in order for a subject to be assigned an M-space of e + 4, he must have been successful on four out of five trials at levels e + 2, e + 3, and e + 4 on the Digit Placement Task. In order to obtain an M-space level of e + 4 on the Backward Digit Span task, a subject must have been successful on one out of two trials at levels e + 2, e + 3, and e + 4.

The results of the scalogram analyses indicate that both tasks do form valid Guttman Scales. The Coefficient of Reproducibility, which ranges from 0 to 1, was computed to be 1.00 for each sample on each M-space task. This means that there were no instances where a subject failed an easier series of items while passing a more difficult series on either the Digit Placement Task or the Backward Digit Span task, given the cut-off points specified. The Coefficient of Scalability, which also ranges from 0 to 1 was computed to be 1.00 for each sample for each task. A Coefficient of Scalability above .6 indicates a unidimensional and cumulative scale. The author was satisfied, on the basis of these results, that the criterion measures of M-capacity adequately conformed to Guttman Scale requirements. The reported statistics, however, may be spuriously high because of the cut-off points specified for each task. Had a more stringent standard been stipulated (five out of five correct responses per series on the Digit Placement Task, for example), some errors, or instances where an easier series of items was failed while a more difficult series was passed, would have been reflected in the analyses. Less than perfect coefficients would, therefore, have been obtained.

In addition to the scalogram analysis, reliability estimates were computed for each task by group. A parallel-form reliability coefficient of .50 ($p < .002$) was obtained over the two sessions of the Digit Placement Task for the LD sample; a reliability coefficient of .62 ($p < .001$) was obtained for the NA sample on the parallel forms of the Digit Placement Task. The difference between the coefficients for the two groups was not significant ($p > .05$). Test-retest reliability coefficients of .56 ($p < .002$) and .52 ($p < .004$) were obtained for the LD and NA samples respectively over the repeated administration of the Backward Digit Span Task. The difference between the reliability coefficients was not significant ($p > .05$). The correlation (Pearson r) between the criterion measures of M-space was computed to be .45 ($<$ .05) for the LD group and .35 ($p < .05$) for the NA sample.

Group Performance on Criterion Measures of M-space

The first research hypothesis stated that no difference would be found between the LD and NA samples on the measures of M-space. M-space according to Neo-Piagetian theory is a measure of information processing capacity (Pascual-Leone, 1970). Current theory in the field of learning disabilities holds that the information processing capacity of children with specific learning disabilities is adequate (Senf, 1972 and Ross, 1976). According to Ross (1976), attentional factors interfere with the manifestation of the learning disabled child's working memory capacity.

Because it was the intent of the author of this study to demonstrate that the M-capacities of the LD and NA groups were comparable, a more lenient alpha level was adopted as the decision point in rejecting the null hypotheses. It was determined that this approach to hypothesis testing would reduce the possibility of failing to reject the null hypotheses when in fact fairly large differences may exist between the samples on the measures of M-space. A null hypothesis was formulated to test the results of the samples' performance on each instrument.

Hypothesis IA: The group means on the Digit Placement Task will not be different.

$$H_0: \quad \mu_{LD} = \mu_{NA}$$

$$H_1: \quad \mu_{LD} \neq \mu_{NA}$$

Result: Reject the null hypothesis with alpha set at .10. The probability of committing a Type I error associated with the outcome of H_0 is .061 using the Wilcoxon statistic for matched pairs.

Hypothesis IB: The groups means on the Backward Digit Span Task will not be different.

$$H_0: \quad \mu_{LD} = \mu_{NA}$$

$$H_1: \quad \mu_{LD} \neq \mu_{NA}$$

Result: Reject the null hypothesis with alpha set at .10. The probability of committing a Type I error associated with the outcome of H_0 is .003 using the Wilcoxon statistic for matched pairs.

Table 3 displays a comparison of the actual scores obtained on both tasks by group, and the results of the statistical analyses using the Wilcoxon statistic. The mean Digit Placement Task score of the LD sample was 20.02 with a range of 16-24.5; the corresponding mean of the NA sample was 21.24, with a range of 17.5-25. The average Backward Digit Span score of the LD group was 4.06, with a range of 2-6, the mean Backward Digit Span score of the NA group was 5.08 with a range of 3-7.5. The scores used in the statistical analyses reflect the number of correct responses each subject obtained, averaged over both sessions of each task.

The averaged modal M-space estimates achieved by each subject over the two sessions of both tasks are displayed in Table 4. These estimates were generated by the Guttman Scale procedures previously described on page 58. The M-space estimates correspond to the M-capacity values associated with each Piagetian substage

Table 3

Average M-space Scores Obtained on the Digit Placement Task and the Backward Digit Span Task by LD and NA Subjects and the Results of Statistical Analysis Using the Wilcoxon Statistic for Matched Pairs

	Digit Placement Task		Backward Digit Span Task	
Pair	LD	NA	LD	NA
1	18	23.5	4	6
2	16.5	23	3	5
3	19	23	3.5	4.5
4	22	22.5	3.5	3
5	19.5	23	2	6
6	16	19	3.5	4.5
7	20	25	5.5	7
8	19.5	22.5	3.5	4
9	20	22.5	3.5	5
10	21	20.5	2.5	5
11	21.5	21.5	6	7.5
12	25	17.5	6	5
13	22.5	19.5	4.5	4.5
14	19	19.5	4	6
15	20	23	5.5	6
16	17	20	3.5	3.5
17	19.5	18	3	4
18	22	19.5	3	4
19	18.5	21	5.5	4.5
20	18	24	4	6.5
21	22	21	5	4
22	20	23	4	7
23	23	21	5	4
24	19	20	4	5.5
25	22	18	4	5
$\bar{X}$	20.02	21.24	4.06	5.08
SD	2.15	2.04	1.07	1.12

Wilcoxon Signed Ranks Statistic for Matched Pairs:

Ties = 1
- Rank Mean = 10.56
+ Rank Mean = 13.47
z = -1.871
p = .061

Ties = 2
- Rank Mean = - 8.00
+ Rank Mean = + 13.11
z = - 2.98
p = .003

Table 4

Average M-space Estimates for LD and NA Subjects
Measured by the Digit Placement Task and the
Backward Digit Span Task and Percent of LD and NA
Subjects Obtaining Different M-space Levels by Task

	Digit Placement Task		Backward Digit Span Task	
Pair	LD	NA	LD	NA
1	4	5	3	4
2	3	5	2.5	4
3	4.5	4.5	3	3.5
4	4.5	4.5	3	3
5	4	4.5	2	4.5
6	3	4.5	2.5	3.5
7	4	5	3.5	5
8	4	4.5	3	3
9	4	5	3	3.5
10	4	4	2.5	4
11	4	4.5	4	5
12	5	4.5	4.5	3.5
13	4.5	4.5	3.5	3.5
14	4	4	3	4
15	4	5	4.5	4
16	4	4.5	3	3
17	4	4	4	4
18	5	4	3	3
19	4	4	4.5	3.5
20	4.5	5	3	5
21	5	4.5	4	3
22	4	5	3	4.5
23	4	4.5	3	3
24	4	4	3	4
25	4.5	4	3	4
$\overline{X}$	4.18	4.50	3.28	3.80

M-space Level				
e + 2	----	----	16%	----
e + 3	8%	----	60%	21%
*e + 4	80%	72%	24%	67%
e + 5	12%	28%	----	12%

*e + k for 9-10 year olds

according to Neo-Piagetian theory. Also shown in Table 4 are the percentages of subjects by group obtaining different M-space levels. In assigning subjects to a particular M-space level, the averaged estimates were rounded to the next lower whole integer.

Although the group means for each measure of M-capacity appear similar, a review of the M-space scores and estimates shows that more LD boys obtained lower values than their NA matched partners. The data and the results of the statistical analysis indicate that the M-capacities of the LD and NA groups are not comparable. There is more evidence in favor of significant differences than evidence which would suggest equivalence between the samples on the M-capacity variable. **The LD boys, on the average, manifested more limited or restricted M-capacities than their NA peers.**

Group Performance on Measures of Field Independence

The second research hypothesis stated that there would be a difference between the LD and NA samples on the measures of field-independence-dependence. Neo-Piagetian theory maintains that a child's functional M-space may differ from his modal or available M-space on any one task due to constraints imposed by his individual way of responding. Pascual-Leone (1970) has implicated the individual difference variable, field-independence, to efficiency in applying modal M-space. Field-independent children tend to be high M processors, while field dependent children tend to be low M processors. Research studies examining the perceptual strategies characteristic of LD children have suggested that this group of learners may be more field dependent than their NA peers (Keogh and Donlon, 1972; Guyer and Friedman, 1975; Tarver, et.al., 1977). Stated in the null, the hypotheses associated with the variable field independence were as follows:

Hypothesis IIA: The group means on the Children's Embedded Figures Test will not be different.

H_0: $\mu_{LD} = \mu_{NA}$

H_1: $\mu_{LD} \neq \mu_{NA}$

Result: Reject the null hypothesis with alpha set at .05. The probability of committing a Type I error associated with the outcome of H_0 is .001 using the Wilcoxon statistic for matched pairs.

Hypothesis IIB: The group means on the WISC-R Block Design Subtest will not be different.

H_0: $\mu_{LD} = \mu_{NA}$

H_1: $\mu_{LD} \neq \mu_{NA}$

Result: Reject the null hypothesis with alpha set at .05. The probability of committing a Type I error associated with the outcome of H_0 is .005 using the Wilcoxon statistic for matched pairs.

Table 5 displays the means ranges and standard deviations associated with the CEFT and the WISC-R Block Design Subtest for both samples, and the results of the Wilcoxon Signed Ranks Tests. The mean score of the LD group on the CEFT was 14.36; the corresponding mean of the NA sample was 18.28. The mean scaled score of the LD group on the Block Design Test was 9.12; the average score of the NA group on this task was 11.80. A median score for each instrument was also computed. The median score for the CEFT was computed to be 16.65; the median score for the Block Design test was computed to be 10.5. Seventeen of the 25 LD subjects scored below the median on the CEFT, only seven of the 25 NA subjects scored below the median on this measure of field independence. On the Block Design Test, 15 of the LD boys obtained scores below the median score of 10.5, while nine of the NA boys obtained a score below the median. This results indicated that the LD boys as a group demonstrated a more field dependent cognitive style than their NA counterparts; the majority of the LD boys obtained scores significantly below their matched partners.

Group Performance on the Piagetian Tasks

The third research hypothesis stated that if there were differences between the LD and NA groups on criterion measures of M-capacity and/or on the measures of field independence, then a difference should be found between the samples in level of operative thinking which was assessed by performance on Piagetian Tasks. Because significant mean differences were found to exist between the LD and NA samples on the Digit Placement Task, the Backward Digit Span Tasks, the CEFT and the WISC-R Block Design Subtest, significant differences were anticipated between the groups on the Piagetian Tasks.

Table 5

Ranges, Means, and Standard Deviations of Scores on CEFT and Block Design Test by Groups And Wilcoxon Signed Ranks Test Results for Matched Pairs

		CEFT	Block Design
Learning Disabled	Range	6 - 22	5 - 16
	M	14.36	9.12
	SD	3.98	3.24
Normally Achieving	Range	13 - 23	8 - 17
	M	18.28	11.80
	SD	2.97	2.70
Ties		4	4
- Rank Mean		7.17	8.63
+ Rank Mean		11.64	11.56
z		-3.367	-2.815
2-tailed p		.001	.005

Stated in the null, the third hypothesis was tested as follows.

Hypothesis III: The group means on the set of Piagetian Tasks will not be different.

$H_0: \mu_{LD} = \mu_{NA}$

$H_1: \mu_{LD} \neq \mu_{NA}$

Result: Reject the null hypothesis with alpha set at .05. The level of significance associated with the outcome of the null hypothesis was .006 using the Wilcoxon statistic for matched pairs.

Table 6 displays the mean scores and associated standard deviations obtained on the set of Piagetian tasks by group and the results of the analysis using the Wilcoxon statistic. The LD sample had a mean number correct of 4.44 out of seven tasks; the corresponding mean correct for the NA group was 5.52. This result indicated that the LD group did not demonstrate a level of operative thinking which was comparable to the NA group.

Secondary Analyses

In order to look more closely at the relationship between classification as an LD or NA subject and level of operative thinking, analyses of group performance on several of the Piagetian Tasks were conducted applying the chi-square statistic. The relationship between group membership and performance on the measures of M-capacity and the

Table 6

Means and Standard Deviations of
Number Correct on Piagetian Tasks by Sample
and Wilcoxon Signed Ranks Test Results

		Seven Piagetian Tasks
Learning Disabled	Mean	4.44
	SD	1.16
Normally Achieving	Mean	5.52
	SD	1.09
	Ties	7
	- Rank Mean	7.5
	+ Rank Mean	9.9
	z	-2.744
	2 tailed p	.006

measures of field independence was investigated by examining the coefficients of correlation between the measures for each sample.

Relationship Between Group Membership and Performance on Piagetian Tasks

Table 7 shows the number of LD and NA subjects passing and failing each Piagetian task. The tasks were grouped according to the number of schemes which must be coordinated for solution. The chi-square statistic was computed for group comparison on tasks which might yield meaningful relationships. All subjects had perfect performance on the Conservation of Identity task (e + 2) and the Seriation task (e + 3), and only one more subject in the LD group than in the NA group failed the Simple Classification task (e + 2). The equivalence of the LD and NA groups on these tasks is obvious. A significant relationship, however, was found using the chi-square statistic between group membership and performance on the four remaining tasks: Conservation of Equivalence (e + 3), Class Inclusion (e + 3), Conservation of Time (e + 4), and Hierarchical Classification (e + 4).

Of the tasks administered at the e + 3 level, one primary difference between the Seriation of Length task that all LD subjects passed, and the two tasks which significantly more LD than NA boys failed was the misleading cue inherent in both the Conservation task and the Class Inclusion task. It therefore appeared that although the majority of the LD subjects had available at least an M-space

Table 7

Performance of LD and NA Subjects on the Seven Piagetian Tasks

Group	Late Pre-operations e + 2				Early Concrete Operations e + 3						Middle Concrete Operations e + 4			
	Cons. Iden.		Sim. Class.		Conc. Equiv.		Seriation		Class Inc.		Cons. Time		Hier. Class.	
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
LD	25	0	23	2	19	6	25	0	11	14	2	23	5	20
NA	25	0	24	1	25	0	25	0	18	7	8	17	13	12
x^2					6.82**				4.02*		4.50*		5.56**	

* $p \leq .05$
** $p \leq .01$

of e + 3 (84% using the more conservative estimate of the Backward Digit Span measure), they were still unable to apply their modal M-capacity effectively on some e + 3 tasks. Case and Globerson (1974) suggested that field dependent children manifested developmental lags on certain Piagetian tasks, despite adequate M-capacity because they were field dependent. Additional M-space may be required for field dependent subjects to resist the perceptual pull of certain stimulus situations. The LD group's perfect performance on the Conservation of Identify task which included a misleading cue, but only required the coordination of e + 2 schemes, seemed to support the foregoing statement. Correlation coefficients computed between the measures of field dependence and total number correct on Piagetian tasks also indicated that in the LD group these scores were significantly related, but in the NA group the correlation coefficients were not significantly different from zero at the .05 level. In the LD sample, the correlation coefficient between the CEFT scores and the Piagetian tasks was .37, $p < .05$; the correlation coefficient between the Block Desing Subtest and the Piagetian tasks was .35, $p < .05$. (See Appendix C. The correlation matrix of subject descriptor variables and all experimental tasks is reported for each group.)

Effect of Field Dependence on Modal M-space

It was assumed in this study that all subjects would demonstrate their modal or maximum M-space when measured by the Digit Placement Task and the Backward Digit Span Task. The LD subjects' M-capacities were found, however, to be somewhat less than the M-capacities of their NA partners. In addition, the LD group also obtained lower mean scores on the CEFT and the Block Design Subtest than the NA group. In order to determine if a significant relationship existed between the measures of field independence and M-space, a correlation coefficient matrix was computed and analyzed. Table 8 displays the correlation coefficients among these variables by sample.

In both groups there was a modest, but significant correlation ($p < .05$), between the Digit Placement Task and the Backward Digit Span Task. The relationship between these two measures of M-space and the two measures of field-dependence, the CEFT and the Block Design Test, were markedly different for the two groups. In the NA group the intercorrelations did not differ significantly from zero. However, within LD group the correlations between the criterion measures of M-space and the CEFT scores were positive and significant and although the correlations between the measures of M-space and the Block Design Test were not significantly different from zero at the .05 level, they were positive and approaching the critical value. These findings suggest a lack of independence between M-capacity and field dependence in the LD group.

Table 8

Correlation Coefficients (Pearson r) among Digit Placement Task Scores, Backward Digit Span Scores, CEFT Scores, and Block Design Subtest Scores

	Digit Placement Task	Backward Digit Span	CEFT	Block Design Subtest
Digit Placement Task	----	.45 [.35]	.36 [.07]	.33 [-.28]
Backward Digit Span	----	----	.54 [-.06]	.30 [-.10]
CEFT	----	----	----	.60 [.50]
Block Design Subtest	----	----	----	----

Coefficients associated with NA group are in brackets.
Values at or above .35, $p \leq .05$
Values at or above .60, $p \leq .001$

Chapter 5

DISCUSSION AND CONCLUSION

The purpose of this study was to investigate and compare the following cognitive developmental variables in samples of LD and NA boys: information processing capacity, level of field independence, and level of operative thinking. The main findings were:

(1) the LD boys demonstrated more restricted information processing capacities than their NA matched partners;

(2) the LD group obtained a significantly lower mean score on measures of field independence than the NA group;

(3) the LD group showed a significant delay in operative thinking.

Comparison of the M-capacities of LD and NA Samples

According to Senf (1972), the information processing capacity of LD children should be within normal limits when compared to NA children. This supposition, however, has not been empirically demonstrated. As Torgensen (1977) explains differences between LD and NA children can be demonstrated on many variables due to "non-specific" or performance factors, despite equivalence in underlying competence. It may be difficult for the LD child to reveal his levels of competence because of meta variables like selective attention deficits, inefficient processing of information, and reduced involvement in the learning situation. Torgensen, therefore, refers to some LD children as "inactive learners" (1977).

Contrary to expected, the learning disabled (LD) boys did not demonstrate a level of cognitive competence or M-capacities comparable to their normally achieving (NA) matched partners. According to theoretical distributions of M-space estimates, about 75% of the children at a particular sub-stage of cognitive development should manifest an M-capacity of e + k. Because M-capacity is affected by a general intelligence factor, and the average SIT intelligence quotient of the LD and NA groups was about one standard deviation above the mean for this instrument, we could anticipate more subjects at an M-space level of e + k + 1, than normally expected. Using the M-space estimates generated by subjects' performance on the Digit Placement Task, 80% of the LD boys obtained an M-space of e + 4, typical of nine to ten year olds; 12% obtained an M-space of e + 5, typical of eleven to twelve year olds. In comparison, 72% of the NA boys obtained an M-space of e + 4, but 28% had estimates of e + 5. Therefore, using this measure of M-capacity, the LD boys obtained M-capacity estimates which conform to theoretical and empirical distributions of M-space values for their age group; however, when compared to their NA counterparts they demonstrated lower estimates. The difference between the groups was even more pronounced when M-space estimates generated by the Backward Digit Span scores were examined.

In the LD sample, only 24% of the boys obtained an M-space of e + 4 when using their scores on the Backward Digit Span task, and no LD boys obtained an M-capacity of e + 5. Using this measure of M-capacity, therefore, 76% of the LD sample demonstrated a level of cognitive competence comparable to children ages seven to eight years of age and younger. In the NA sample, 67% obtained an M-capacity of e + 4, and 12% obtained an M-capacity of e + 5. On the basis of these results, the Backward Digit Span task was more difficult for both samples, but especially for the LD boys.

It had been assumed that the two criterion measures of M-capacity would yield comparable estimates of M-space for each subject. The results indicated that this did not hold true. Several tentative reasons are suggested for the differences in results. The Digit Placement Task demanded the active participation of the subject: visually tracking the numerals, naming the numerals, and moving the token. This task was also perceived by the subjects as a "game," as judged by their spontaneous comments. A training session also preceded the administration of the Digit Placement Task in order to assure the subjects' understanding of the task instructions and to verify that their repertoires included the necessary schemes. The Backward Digit Span task on the other hand demanded that the subject withold overt activity until the examiner stated the numerals to be repeated by the subject. No pre-training was given for this task, except the trials stipulated in the standardized instructions. There could have been some difference related to administration of these tasks which depressed the LD subjects' scores.

Another reason for the difference in performance on the two M-space measures may be related to the capacity channel involved: the Digit Placement Task utilized visual stimuli, while the Backward Digit Span task is an auditory processing task.

Torgensen (1980) reported a study which compared the short term memory spans of LD children with auditory sequential memory problems, LD children with other processing deficits, and NA children. The latter two groups performed significantly better on a digit recall task than the group with difficulties related to processing auditory stimuli. However, all the LD subjects experienced performance decrements when the rate of stimuli presentation was slowed which allowed for spontaneous use of rehearsal strategies. Other researchers have found that a shift may occur in the relative importance of deficits in visual versus auditory information processing for academic tasks (Hallahan and Cruickshank, 1973). These authors stated that "as they grow older, therefore, poor readers faced with tasks of increasing complexity apparently do least well on items for which they must deal with auditory stimuli" (p. 171). Spring (1976) found a group of dyslexic children deficient on an auditory digit span task and suggested repeating the study using a visual presentation. He also conjectured that encoding skills related to auditory and visual stimuli may only be moderately correlated. As Lerner (1976) stressed, the precise nature of the relationship between auditory and visual processing deficits at various stages of development needs further investigation. The present study tended to confirm, however, that there was a difference between the LD boys' ability to process visual versus auditory stimuli during a working memory task.

Structural Versus Functional M-capacity: Effect of Field Dependence

According to Neo-Piagetian theory, children may not demonstrate their maximum available M-capacity on certain cognitive tasks because they are typically low M-processors or field dependent. As a group, the LD boys scored significantly lower than the NA group on the two measures of field dependence, the Block Design test and the Children's Embedded Figures Test. It was assumed, however, that the estimates of M-capacity obtained would reflect subjects' modal or maximum M-space. In Case's validation study which used the Digit Placement Task as the criterion measure of M-capacity, no significant relationship was found between this measure and the WISC-R Block Design Subtest, the measure of field independence (1972a). Case concluded that the Digit Placement Task did not contain any misleading cues and that it yielded modal estimates of M-capacity.

In the present study, no significant relationship was found between the measures of M-capacity and the measures of field dependence in the NA sample. However, the zero-order correlation coefficients in the LD sample between the two criterion measures of M-space and the CEFT scores were significant ($p < .05$). The correlation coefficients between these measures of M-capacity and the Block Design Test were positive and approaching the critical value. These results suggested a lack of independence between these constructs in the LD group. One conclusion, based on the differing relationship between M-capacity and field dependence in the LD group, would be that the LD subjects did not demonstrate their maximum or modal M-spaces due to a field dependent cognitive style.

Differences in Levels of Operative Thinking: The Effect of Inefficient Processing of M-capacity

In this study, the LD boys failed to solve as many Piagetian tasks as the NA boys. The seven cognitive tasks administered required the coordination of $e + 2$ through $e + 4$ schemes. According to Neo-Piagetian theory, children ages nine to ten years old, at the middle concrete operations substage of cognitive development, should be able to solve all these tasks, unless they are overly field dependent, have not assimilated the necessary figurative schemes, or do not have an available M-capacity of $e + 4$.

The majority of the LD boys obtained an M-space estimate of at least $e + 3$ (100% as measured by the Digit Placement Task and 84% as measured by the Backward Digit Span Task), and the majority of the LD subjects were also found to be more field dependent than the NA subjects. Based upon Neo-Piagetian theory, one would anticipate that the LD boys would therefore manifest a lag in operative thinking, particularly on tasks which include misleading cues.

Of the seven Piagetian tasks administered to all subjects, five require the subject to overcome how the stimuli and transformation presented "look" in order to generate the correct logical solution: Conservation of Identity, Conservation of Equivalence, Class Inclusion, Conservation of Time, and Hierarchical Classification. The Seriation task and the Simple Classification task may be said to include schemes which are field facilitated. All subjects had perfect performance on the Conservation of Identity and the Seriation tasks; the differences in performance were not significant for the Simple Classification task. Although the Conservation of Identity task does require disembedding, it only demands the coordination of e + 2 schemes.

The delay in operative thinking demonstrated by the LD boys was particularly significant on those tasks which most children should be able to solve by seven to eight years of age, and demand the coordination of e + 3 schemes. Nineteen of the LD boys failed the Conservation of Equivalence task and 14 of the LD subjects failed the Class Inclusion task; all the NA boys passed the Conservation tasks at this level and only seven NA subjects failed the Class Inclusion task. Both these tasks require the child to overcome the saliency of a misleading cue in order to apply a logical operation. Case (1974a) has indicated that for children who are overly field dependent, a task which includes misleading cues may require the application of more M-space than typically associated with that task. Therefore, a field dependent child may solve certain cognitive tasks at a later age when his M-capacity has increased to at least one unit beyond that needed to normally solve the task. The performance of the LD boys tended to confirm this statement, because all the LD subjects were able to solve the Seriation task, an e + 3 task which does not include an embeddedness factor.

In a recent study conducted by Anderson, et.al., (1980), LD and NA boys were administered a visual-integration task and a hierarchical classification task. The LD boys manifested a two to four year delay in demonstrating the operative structures needed to solve the classification task and also had significant difficulty on the visual-integration task . The authors suggested that some of the learning problems that LD children have may be related to cognitive immaturity and an inability to utilize "cognitive operations routinely used by their peers" (1980), p. 37). These authors also conjectured that LD children may only show a delay in operative thinking on tasks which demand overcoming the dominant or salient features of the stimulus configuration. The present study tended to support this hypothesis, however, the LD boys seemed to be at a further disadvantage because of a more restricted information processing capacity than their NA counterparts. The delay in operative thinking manifested by the LD boys may not only have been due to inefficient processing of available M-capacity, but also to having less available M-space. They manifested both quantitative and qualitative lags in their attainment of operative structures.

Conclusions and Implications for Further Research

It was hoped that this study would confirm that LD boys were as competent, in the Neo-Piagetian sense, as their NA peers, i.e., that they had comparable information processing capacity. The results, however, showed that the LD boys as a group manifested M-capacities that were more limited than their NA matched partners. Whether this restricted information processing capacity is a true ability deficit, or an artifact of approaching many cognitive tasks with a field dependent style is still an empirical question, and poses somewhat of a dilemma for the researcher. The results of this study suggest that the LD boys were not able to reveal their maximum level of competence on the tasks administered and could be classified as low M-processors.

The LD boys were more field dependent that their NA counterparts. This demonstrated lag in the ability to overcome the salience of certain stimuli was particularly noticeable when the LD boys tried to solve Piagetian tasks with misleading cues. The LD sample showed both a quantitative and qualitative delay in cognitive development. On the Piagetian tasks, many LD boys performed like children who are at a pre-operational substage or five to six years of age. Only on one concrete operational task, Seriation of Length which is field facilitated, did the LD boys perform comparably with the NA boys.

The implications for further research center upon further operationalizing our definitions of learning disabilities. As

Senf (1977) suggests, subject characteristics along psychological process variables as opposed to educational categories need to be specified in order to make generalizations about research results and identify sub-groups within the learning disabled population. This study indicates that one important classification dimension may be the cognitive style field dependence for the learning disabled child.

If some learning disabled boys are not able to apply their available information processing capacity, even though it may be more limited than their normally achieving peers, because of a field dependent approach, interventions need to be developed to facilitate learning. According to Neo-Piagetian theory, growth in M-capacity is a developmental variable and would not be susceptible to incremental changes due to teaching. Furthermore, individual placement on the continuum of field-independence-dependence is also a fairly stable cognitive trait. It would appear necessary, therefore, to investigate how cognitive tasks may be structured or adapted in order to address these learner characteristics. Several research studies have already succeeded in minimizing performance differences between LD and NA children by adapting tasks so that inefficient task strategies often employed by LD children were identified and corrected (Maier, 1980; Wong, 1980). Torgensen (1979) also advocates a "task-centered approach":

> It (the task-centered approach) should also help to focus interest on efforts to determine which kinds of processing deficiencies can be affected by direct instruction and practice, and which kinds, because they result from structural impairment and cannot be trained, might require the restructuring of academic activities to avoid the area of deficiency (p. 520).

In summary, a definition of one sub-group of learning disabled children is offered, based upon the results of this Neo-Piagetian investigation:

Some children with specific learning disabilities manifest a restricted information processing capacity which may limit their ability to coordinate, integrate, and attend to information needed to solve cognitive tasks. In addition, they are more field dependent than their normally achieving peers. This characteristic may be manifested on tasks which require the child to overcome the saliency of misleading cues in order to apply a more logical strategy. This subgroup of learning disabled children demonstrates both quantitative and qualitative lags in cognitive development. Gearing the demands of cognitive tasks to match their unique learning style and inefficient processing of information is needed, so that their underlying competencies can be demonstrated.

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APPENDICES

APPENDIX A

Dear Parents:

I am a graduate student at Virginia Tech. I am completing my doctoral degree in Educational Supervision with an emphasis on children with learning disabilities. The purpose of my dissertation research is to investigate the differences and similarities between normally achieving students and learning disabled students in the areas of cognitive development and learning styles. I hope that one outcome of this research will be more effective instructional techniques for children experiencing difficulty with school tasks.

In order to gather the appropriate data for this study, groups of learning disabled (those already in an LD program) and normally achieving boys are needed. The total time necessary to administer the tasks to those children who participate in the study will be about 2 1/2 hours. The research project will be spread over a period of 12 weeks, and no individual child session will last more than 45 minutes. Every effort will be made, through cooperation with your child's teacher, to insure minimal loss of any instructional time.

I will be administering a short, standardized test which gives an estimate of the child's intellectual capacity, a measure of current school achievement, two tests which identify the child's learning style, two tests which give an estimate of the child's information-processing capacity, and brief tasks which determine the child's level of cognitive development. It is anticipated that the experimental situation will be a pleasurable and learning experience for your child.

I have obtained permission from the administrative staff of Roanoke County/Salem City Schools to conduct my dissertation research, provided I receive written parent permission. All results of the study concerning individual children will be confidential; only the compiled data will be reported. I welcome any question you may have regarding this study. Attached is a parent permission form; please fill it out, and have your child return it to his teacher. Thank you for your interest and support. If you have any questions or concerns, please feel free to contact me at the location below.

Sincerely yours,

Terry Grimes
College of Education
VPI&SU
War Memorial Gym
Blacksburg, VA 24061
(703) 961-5429

PARENT PERMISSION FORM

(1) I ________________________________ GIVE my permission for
(Parent's or Guardian's Name)

________________________________ to participate in Ms. Terry
(Child's Name)
Grimes doctoral research.

(2) I ________________________________ DO NOT GIVE my permission for
(Parent's or Guardian's Name)

________________________________ to participate in this study.
(Child's Name)

(3) I have further questions about the study and wish to be contacted before granting permission for ________________________ to participate in the study. (Child's Name)

Parent's Name: ____________________________
Phone: ____________________________

(4) I am interested in the results of the study and/or my child's individual performance.

Yes ______ No ______

Please feel free to contact me at one of the following, either by letter or phone.

Mrs. Terry Grimes
War Memorial Gym
College of Education
Division of Curriculum & Instruction
Virginia Polytechnic Institute
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APPENDIX B

Numbers Presented on Each Trial of the Digit Placement Task

Session 1

n	Trial	Ordered Sets of Numbers	Final Number
2	1	5	7
	2	13	9
	3	8	13
	4	15	19
	5	10	4
3	1	5, 9	12
	2	12, 19	15
	3	5, 8	3
	4	12, 16	14
	5	10, 18	8
4	1	3, 8, 12	6
	2	9, 11, 17	7
	3	4, 11, 15	17
	4	3, 9, 19	11
	5	5, 7, 11	9
5	1	31, 36, 40, 49	34
	2	9, 22, 26, 30	7
	3	29, 33, 37, 58	35
	4	2, 8, 17, 21	19
	5	3, 7, 12, 16	10
6	1	7, 12, 18, 21, 30	28
	2	20, 24, 29, 40, 45	18
	3	4, 10, 13, 27, 32	20
	4	14, 19, 22, 34, 39	21
	5	3, 9, 11, 15, 18	13

Session 2

n	Trial	Ordered Sets of Numbers	Final Number
2	1	3	5
	2	17	11
	3	6	11
	4	13	17
	5	12	8
3	1	3, 7,	11
	2	14, 20	17
	3	7, 10	5
	4	10, 14	12
	5	12, 16	8
4	1	5, 9, 13	7
	2	7, 10, 19	5
	3	6, 13, 15	19
	4	5, 11, 21	15
	5	7, 9, 12	10
5	1	35, 42, 50, 59	38
	2	7, 23, 28, 31	5
	3	27, 34, 39, 57	36
	4	4, 10, 19, 23	21
	5	7, 13, 22, 37	9
6	1	5, 11, 17, 20, 41	32
	2	40, 44, 49, 55, 58	47
	3	6, 14, 19, 24, 37	23
	4	12, 17, 24, 33, 37	22
	5	5, 13, 19, 21, 48	17

APPENDIX C

Correlation Coefficients (Pearson r) among IQ, Age, Achievement, and Experimental Task Variables for LD and NA Subjects

Variable	Age	IQ	Read	Spell	Math	DgPl	DgSp	CEFT	BlDg	Piagetian
Age		.11 [-.13]	-.23 [.00]	-.35 [-.11]	-.00 [-.29]	.25 [.02]	.51 [.21]	.09 [-.10]	.09 [-.03]	.12 [.33]
IQ			.77 [.75]	.45 [.62]	.50 [.77]	.24 [-.23]	.05 [-.30]	.25 [.19]	.34 [.21]	.06 [.04]
Read				.68 [.62]	.42 [.63]	.35 [-.22]	.10 [-.28]	.27 [.13]	.33 [.20]	.06 [.14]
Spell					.41 [.56]	.40 [-.26]	-.08 [-.17]	.27 [.33]	.51 [.37]	.11 [.17]
Math						.20 [-.36]	.05 [-.37]	.03 [.34]	.13 [.32]	.32 [.11]
DgPl							.45 [.35]	.36 [.07]	.33 [-.28]	.14 [-.06]
DgSp								.54 [-.06]	.30 [-.10]	.25 [.31]
CEFT									.60 [.50]	.37 [.30]
Piagetian										.35 [.33]

Coefficients associated with the NA group are in brackets
Values at or above .35, $p \leq .05$
Values at or above .60, $p \leq .001$

IQ (Slosson Intelligence Quotient), Read, Spell, and Match (WRAT Standard Scores), DgPl (Digit Placement Task Average), DgSP (WISC-R Backward Digit Span Average), CEFT (Children's Embedded Figures Test), BlDg (WISC-R Block Design Standard Score), Piagetian (Total Correct on the Piagetian Tasks).

VITA

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Educational Background

June 1977	CAGS in Educational Supervision	Virginia Polytechnic Institute and State University Blacksburg, Virginia
June 1975	M.Ed. in Curriculum and Instruction	Virginia Polytechnic Institute and State University Blacksburg, Virginia
January 1974-August 1975	15 Quarter Hours in School Psychology/Special Education	Radford University Radford, Virginia
September 1967-September 1968	14 Semester Hours in Education	Hunter College New York, New York
June 1966	B.A. in Psychology	Marymount Manhatton College New York, New York

Professional Background

January 1980 Present	Supervisor of Special Education, Wythe County Public Schools
August 1977-January 1980	Director, Blacksburg Child Care Center
Fall Quarter 1978	Part-time Instructor, Virginia Polytechnic Institute and State University, College of Education, Director of Curriculum and Instruction

Summer Session 1977	Part-time Instructor, Virginia Polytechnic Institute and State University, College of Education, Director of Curriculum and Instruction
September 1974-June 1977	Full-time Graduate Student, Virginia Polytechnic Institute and State University
August 1973-August 1974	Assistant to the Operations Manager, Donaldson Brown Center for Continuing Education, Virginia Polytechnic Institute and State University, Blacksburg, Virginia
January 1973-June 1973	Middle School Coordinator, Community School, Hollins Virginia
January 1970-January 1972	Kindergarten Teacher, Roanoke City Schools, Roanoke, Virginia
September 1966 June 1968	Teacher of the Educable Mentally Retarded, New York City Schools, New York.

Member of the Virginia Council for Administrators of Special Education and elected into Phi Kappa Phi in 1975.

Thérèse E. Grimes

A COMPARATIVE STUDY OF INFORMATION PROCESSING CAPACITY AND COGNITIVE STYLE IN LEARNING DISABLED AND NORMALLY ACHIEVING BOYS: A NEO-PIAGETIAN APPROACH

by

Therese Ehrgott Grimes

(ABSTRACT)

This study investigated the relevance of a Neo-Piagetian theory of cognitive development in examining the competence/performance discrepancy associated with children who have specific learning disabilities. According to Neo-Piagetian theory (Pascual-Leone, 1970), a cognitive device called the M-operator is responsible for the integration of schemes necessary to solve developmental tasks. The M-capacity available to children increases in an all or none fashion according to a linear scale which corresponds to the Piagetian substages of cognitive development. A moderator variable which is conceptualized as the cognitive style field-independence-dependence may determine whether a child demonstrates his modal M-capacity on a task which demands the application of maximum M-space.

A matched pairs design was applied in order to compare the performance of 25 learning disabled and 25 normally achieving boys ages 8.5 to 10.0 years on measures of M-capacity, field-independence, and level of operative thinking. It was hypothesized that the learning disabled boys would demonstrate M-capacities comparable to the normally

achieving boys, but would be more field dependent, thereby manifesting a discrepancy between their structural and functional M-capacities on Piagetian tasks.

Comparisons of group differences on two criterion measures of M-capacity, two measures of field independence (the Children's Embedded Figures Test and WISC-R Block Design Subtest), and seven classical Piagetian tasks which included measures of conservation, seriation, and classification abilities, yielded the following results:

1. The learning disabled group obtained significantly lower M-space estimates than the normally achieving group;

2. The learning disabled group obtained significantly lower scores on the instruments used to assess level of field independence;

3. The learning disabled group failed more Piagetian tasks than the normally achieving group, therefore manifesting a delay in operative thinking.

4. The relationships between the two measures of M-space and the two measures of field-independence were markedly different for the two samples. The results indicated a lack of independence between M-capacity and a field dependent cognitive style in the LD group; no comparable relationship was found within the NA group.

Further research applying Neo-Piagetian theory in order to investigate the inefficient processing strategies used by children with learning disabilities appears warranted. Testing interventions which restructure cognitive tasks by reducing memory load demands and/or allow LD children to develop and apply efficient task strategies is needed.