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THE UNIVERSITY OF ALBERTA

A COMPARISON OF LEARNING DISABLED AND AVERAGE ACHIEVERS ON THREE ASPECTS OF LEARNING STYLE

by

(C) Janet Elizabeth Johnston

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A COMPARISON OF LEARNING DISABLED AND AVERAGE ACHIEVERS ON THREE ASPECTS OF LEARNING STYLE submitted by Janet Elizabeth Johnston in partial fulfilment of the requirements for the degree of Master of Education in Special Education.

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Supervisor

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Date.....

DEDICATION

This is dedicated to all those individuals who do not share equal opportunity as a result of economic or learning disadvantages.

ABSTRACT

Using the biodevelopmental framework as a theoretical base, the present study compared the performance of learning disabled to average achieving students on three aspects of learning style. These aspects included a battery of cognitive controls, a self report questionaire of learning preferences, and a teacher checklist assessing the behavioural learning patterns of the students. An equal number of L.D. and non-L.D. subjects (N=60) with a mean age of 8 yrs., 9 months were selected from five elementary schools in the city of Edmonton, Alberta.

The subjects were administered the Learning Style Inventory verbally in groups, while the four subtests composing the cognitive control battery required individual administration. These subtests are purported to be arranged hierarchically in terms of the developmental sequence with which these skills are mastered. The sequence of the control principles are as follows: "focal attention" as measured by the SST, "field articulation" assessed with the FDT, "leveling-sharpening" measured by the LSHT, and "equivalence range" which was assessed with the Object Sort Test.

Several specific scores were gathered for each of these subtests amounting to a total of 16 dependent variables associated with the cognitive control battery. The Learning Style Inventory (LSI) was composed of 22 individual elements which afforded the calculation of standard scores for each. The Study of Children's Learning Style scale (SCLS) which

was completed by the respective teachers was made up of 3 behavioural dimensions, and scores were tallied for each of these.

These data were arranged in various conceptual groupings for analysis, and the Hotelling T procedure was used. Additionally, for those variables which the theory predicted specific hypotheses, the less conservative T-Test was also conducted.

When grouped on a large scale, the battery of cognitive controls and the SCLS were found to significantly discriminate between the L.D. and non-L.D. samples with the L.D.s being interpreted as displaying more immature learning style patterns than the average achievers. The LSI was not found to distinguish between these samples.

Results from these and smaller cluster analyses are interpreted as indicating the learning disabled to display more immature cognitive control performance on the first two principles of the hierarchy that deal with attentional processes. This subject group was also considered to demonstrate more immature behavioural styles, being less attentive, more avoidant of learning tasks and more overly independent. Possible reasons for these findings are explained from the biodevelopmental framework, and future research suggestions are made in order to further evaluate the value of this theory as it relates to the study of learning styles.

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I. INTRODUCTION

The focus of much current educational research and practice concerns the learner as an individual. Thus, each student is viewed as having a unique set of intellectual abilities, personality characteristics, and background experiences. These interact with the characteristics of the educational environment to produce large variations between students in both the amount and the quality of knowledge and skills acquired in any classroom.

Although the amount of attention being devoted to understanding the factors responsible for such individual differences has accelerated considerably within the past 10 to 15 years, the recognition that all learners do not benefit equally from the same instruction is not new. Keefe(1982) reports that educational philosophers as early as Socrates recognized the existence of such individual discrepancies among students and encouraged responding to those differences to foster maximum growth. Similarly, teachers have long been aware of such differences and have intuitively sought to provide sufficient instruction in an attempt to teach effectively to all students in their classrooms.

Despite this awareness, however, varying one's mode of presenting the same content was seldom considered. Rather, increased repetition, perhaps at a slower pace and on a one-to-one basis was considered an adequate effort by the teacher. If the student still was not learning, it was

attributed to defects within the student. This notion is alluded to by Keefe in his discussion of education in the past:

> "Educators have tended to view instruction and learning as direct correlates. If one is present to an acceptable degree, the other should naturally follow. If the teacher is working hard, students should learn. If they do not, an earlier generation was inclined to blame the student while the current trend is to hold the teacher (administrator, school) accountable."(Keefe, 1979, p. 1)

Since education is a reflection of the attitudes prevalent in the culture in which it is operating, philosophies concerning the teaching-learning process have likewise changed considerably over the past fifty years. In the earlier eras of this century, psychology was a much newer discipline and tended to focus on identifying the universal principles involved in learning. Such hypothesized principles as those proposed by Piaget and Skinner, for example, were subsequently incorporated into most school curriculums and educational settings. Although the importance and necessity of such theories describing the common elements of learning in all humans is not being contested, these principles tended to give rise to the "Average Child Concept" in the school system. This phrase, as used by Gregorc(1982) refers to the belief of the past that all children, apart from a few exceptions (as the result of

severe neurological impairment) were alike in their cognitive development and potential, and that any observed differences among children were assumed to be the result of preschool and out-of-school experiences. Clearly, this belief absolves the school system itself of any responsiblity for variations among their students. The blame or credit for differences in student learning was shifted from the student to their home background. That is, a student who was experiencing learning difficulty, was considered to have come from a home background that lacked the appropriate experiences necessary for the acquisition of such skills.

Perhaps, the most influential proponent in shifting the causal focus of learning differences from the home to the school came from the more recent attention to Special Education. With greater funding being allocated to those for whom instruction in a traditional classroom was not beneficial, a much greater emphasis was placed on how teaching could be modified to meet the individual requirements of such students. Due to the diversity of their educational needs, it became necessary to plan instruction separately for each child and special educators developed individualized educational programs (IEP) outlining specific long and short term objectives. This present concern with the learner as an individual has been recently reflected in Canada's new Constitution; section 15 of the Charter of Rights and Freedoms. This legislation has mandated that

every child be given *appropriate* educational services regardless of how much they differ from what might be considered "average". Similarly, teacher education programs designed for those in special education as well as those in regular elementary and secondary taining programs emphasize the importance of taking individual student differences into account when planning instruction and remediation.

With this current zeitgeist, there is little question as to the importance for psychologists to study this area of individual learning differences. However, systematic analysis of the cause or effectiveness of intervention techniques addressing such individual differences have continued to perplex educational psychologists for many years. One reason for this confusion is the wide range of possible variables responsible for these differences. Some of these entail factors that are more easily identifiable such as intellectual ability, and past educational experiences. Many, however, are less simple to classify and include such variables as motivation, readiness to learn specific concepts, attention span, classroom mileau etc.. Not only are factors such as these latter ones more difficult to quantify but they are often almost impossible to isolate for the purpose of sound experimental research. These are among the criticisms discussed by Miller (1981) in his critique of past "Aptitude by Treatment Interaction" (ATI) research which was popular in the late '60's and early '70's. Additionally, without the ability to isolate the number of

specific variables for study, statistical analyses often revealed multiple interactions between such variables that were frequently uninterpretable.

Although researchers have continued to investigate this topic, problems such as those mentioned have prevented psychologists from progressing in their study rapidly enough to meet the practical demands of educators who are responsible for providing appropriate instruction to the individuals they teach. Such a practical need has fostered research on the topic of "learning styles". While individual researchers define this term quite differently, in its most general sense, it refers to *how* individuals learn from and adapt to their environment. This perspective offers a great deal of conceptual appeal to educators as it attempts to analyze the manner individuals differ in *how* they interpret incoming information in various educational environments. Typically, those involved in education in the past have tended to focus on the content of *what* was learned. Therefore, this new empasis on *how* carries with it important implications as to how instruction could be varied to increase teacher effectiveness with those who learn in a variety of different ways. Thus, the present concern is on the *processes* involved in learning, while in the past it was the *product*.

The impact of the learning style concept is being felt as:

"...practioners by the score are applying data

> obtained to their educational situations. Books, monographs, entire publications, numerous articles, major conferences, workshops and presentations are being offered throughout Canada and the United States. No other educational movement has gained such momentum and popularity so quickly." (Martin, 1985, p.23)

As an illustration of the effect that this movement is having in this province, the Edmonton Public School Board is presently (1986) in the process of developing a learning style curriculum and plans to implement such assessment and intervention on a large scale within the next two years.

Although these practitioners cannot be faulted for responding to individual learning needs with whatever instruments and techniques psychologists have offered them, there is a need to critically examine these learning style instruments that have been made available. Given the inherent difficulty of measuring *processes* whose existence can only be inferred, this investigation can only be conscientiously done with a larger theoretical framework from which to base comparison. Without such research, the whole learning style area runs the risk of becoming a fad, and as Gregorc (1982) points out:

> "...researchers, theorists, and consultants must be careful not to promise more than can actually be delivered."(p.10)

If this were to happen, as a result of unrefined and

inadequately tested instruments and remediation attempts, educators might be inclined to prematurely discard the whole learning style notion in a state of disillusionment, disregarding its potential merits. Such analysis is, therefore, currently needed so that better instrumentation might be developed and educators could, at the very least, be informed as to their specific limitations.

At present, research on this topic has tended to be very specific and isolated in nature. For the most part, it has resembled exploratory attempts in the sense that it has not been rooted in any defined theoretical base. While this is a necessary beginning stage in the discovery and refinement of any new field of scientific study, at some point, it becomes crucial for a theoretical framework to be constructed (Kuhn, 1970). Without such a referent from which to analyze further findings, there exists no possibility for the recognition of anomalies, which as also noted by Kuhn (1970), are necessary for the further refinement or rejection of such a paradigm. As a result, continued isolated research is of limited value since by definition, it lacks the predictive power necessary for practical implications. The limited existing theories which have on occassion, been associated with some aspects of learning style in the past, have tended to be very limited in their scope. Thus, they have not allowed for the inclusion of other findings on the topic.

Based on a broader, more comprehensive theoretical framework, this study will attempt to examine several measures of learning and cognitive style simultaneously, comparing the performance of learning disabled students enrolled in learning centre classrooms with those who are considered "average" achievers. The learning disabled would seem to be of particular interest in terms of learning style research as they represent a group who would seem to differ in the *process* of learning. Therefore, The purpose of this study is to discover, not only the relationships between some of the various measures available, but also the similarities and differences found among those who appear to be able to profit adequately from a regular classroom placement and those who differ in ways, other than intelligence, that require more individualized instruction.

II. REVIEW OF THE LITERATURE

THE CONCEPT OF LEARNING STYLE:

One of the thorniest problems when attempting to understand the current state of knowledge on the topic of learning style is the failure of researchers to come to any concensus concerning a specific definition of the construct. "Styles" are generally considered to be aptitudes or traits of the individual that are qualitatively distinct from intellectual or scholastic abilities. Thus, they entail the suggestion of stability and they direct one's attention to the *process* of learning as opposed to the content. While all investigators in the area appear to be concerned with individual differences in *how* students approach and process incoming information, the commonality would seem to end there. The following selected definitions represent the disparity that exists in terms of the aspects of learning style emphasized by different researchers proposing to investigate the same construct.

> "There are many different ways to consider learning style; here learning style is described in terms of how much structure the student requires in order to learn best."(Hunt, 1979, p.27)

> "Learning style, from a phenomenological viewpoint, consists of distinctive and observable behaviors

that provide clues about the mediation abilities of individuals." (Gregorc, 1979, p.19)

> "Learning style defines the distinct ways in which a child characteristically goes about the learning process. It includes observable probem-solving strategies, decision-making behaviours and the child's reactions to the expectations and limitations of school learning situations." (McDermott & Beitman, 1984, p.6)

> "Learning style comprises a combination of environmental, emotional, sociological, physical and psychological elements that permit individuals to receive, store, and use knowledge or abilities." (Dunn, 1983, p.496)

Although each author is addressing a similar theme, the particular focus varies from those which are limited and specific (such as that of Hunt) to those which appear to be all-encompassing such as Dunn's. Grasha (1981) likens the problem within this area to that of the three blind men attempting to answer the question: "what is an elephant"; each identifying slightly different characteristics as representing those which are most pertinent.

Following from these definitions, researchers who have developed learning style instruments have subsequently operationally defined the construct to reflect their particular bias. The Learning Style Inventory (LSI) created by Dunn et al.(1981) is a self-report measure which requires students to respond to 104 statements in a True/False or Likert Scale fashion as to how they feel they learn best or how they prefer to learn. In contrast to this, Hunt (1979) advocates the use of the "Paragraph Completion Method" to determine how much structure the student requires to learn best. This procedure requires that the student write two or three sentences to a series of topics such as: "What I think about rules...". These are then scored according to the structure of the response rather than the content, and a decision is made concerning the amount of classroom structure required for the individual. Different again from these previous two examples, McDermott and Beitman (1984) adapted a much more behaviour oriented operational definition in which the classroom teacher is required to complete a 16-item checklist indicating the relative frequency of occurrence of various classroom behaviours for that child.

All of these instruments profess to measure "learning style". Yet, the actual data obtained from each would be quite different and the relationship among them is not at all obvious. Each of these examples contain a series of implicit assumptions concerning the nature of the dependent variable to the original conceptual definition. The L.S.I.

(Dunn, 1981) for example, assumes that one's learning style is the same as one's learning preference. Reszler (1981) addresses this issue, making the distinction that learning style deals with the processes utilized by the student, while learning preference deals with the choices the learner makes. A significant correlation between these two variables must be demonstrated before these terms can be used interchangably. Also, many of the elements professed to be assessed are comprised of a limited number of individual items. Hunt's more indirect method of assessment assumes that the organization of a student's written response is an accurate indication of their need for environmental structure. Similarly, subsumed under McDermott & Beitman's measure is the assumption that a third-party (the teacher) is sufficiently astute to make accurate judgements as to their students' behaviour.

These assumptions are by no means, intended to be all inclusive as there are many more which are associated with each of the instruments described. Rather, their discussion is an attempt to illustrate the potential falibility of the relationship between the construct and the operational definition encompassed by the subsequent instrument. While greater specificity is inherent to the construction of any psychological instrument making validity a concern, the disparity which exists among definitions of the same construct results in a variety of measures which quite clearly assess different things while professing to assess

the same by utilizing similar terminology. This combination of discrepant definitions of learning style and possible psychometric problems (particularly in terms of validity) associated with the instruments themselves make comparison of studies which utilize different instruments very difficult, despite the fact that they are attempting to investigate the same topic.

Apart from the confusion surrounding a widely accepted definition of learning style, there are several other terms closely related to this construct that deserve clarification. These include; "cognitive style", "cognitive control", and "cognitive strategy". Although a few researchers may disagree, an analysis of most literature addressing the topic in an abstract sense, consider these three terms to be subsets of one's broader learning style (Kirby, 1979).

Somewhat less confusing than the diversity of definitions associated with learning style, however, "cognitive style" generally refers to "information processing habits" (Keefe, 1979, p.16). More specifically, Messick (1983) describes them as:

> "...characteristic modes of perceiving, remembering, thinking and problem solving reflective of information processing regularities...they are inferred from consistent individual differences in ways of organizing and processing information and experience," (p.16)

Thus, they are much more specific to the internal mental processing patterns of individuals to the exclusion of physical, environmental, and sociological aspects often included under the heading of learning style. While those who are more restrictive in their definition of learning style frequently tend to use the two terms interchangeably, such a distinction needs to be recognized so that more common discourse amongst researchers on the topic can be facilitated.

The instruments designed to measure cognitive style tend to focus on very specific and limited aspects of the larger definition. The dimensions most often associated with this construct include field independence/field dependence, and impulsivity/reflectivity. Both are bipolar dimensions; field independence referring to an analytic, discrete perception of stimuli and field dependence representing a more global, context based mode of processing information. The other dimension, sometimes referred to as "conceptual tempo" describes "impulsives" as responding quickly and haphazardly while "reflectives" take more time to consider alternatives before responding (Keefe, 1979). Thus, they can each be viewed as continuums with the endpoints representing the opposite extremes. Every individual can be thought to possess a cognitive style which falls at some point along such a continuum for each of these elements. Blackman and Goldstein (1982) cite two major reasons why so much research with children has centered on these two specific dimensions.

The first is that there are objective, easy-to-use instruments available in both areas, and the second is that these techniques have been developed specifically for use with children.

The instrument that is currently most frequently used to measure the field independence/dependence dimension is the "Embedded Figures Test" (E.F.T.) developed by Herman A. Witkin. Students are required to visually locate a specific figure within a distracting background; the assumption being that those with a more field-independent cognitive style can outline the target more quickly and accurately.

The reflection/impulsivity dimension is most often measured by the "Matching Familiar Figures Test" (M.F.F.T.) developed by Jerome Kagan. Subjects are shown a series of standards and six similar alternatives for each, from which they are to chose the exact replica of the standard. This instrument assumes that implusives will respond more quickly with a greater number of errors than reflectives. Thus, individuals falling in the middle of these extremes are assumed to have some impulsive or reflective tendencies depending on which side of the mid-point they fall. Their response styles however, are much less predictable than those who represent the extreme groups.

Closely related to the concept of cognitive style, and considered by many to be merely additional dimensions of this same construct (Keefe, 1979; Messick, 1983; Doyle & Rutherford, 1984)is the concept of "cognitive control",

Originally formulated by George Klein (1951), cognitive controls refer to the stable individual differences in cognitive functioning to manage information. Since its inception, the concept of cognitive control has been refined to now include an integrated set of theoretical propositions and hypotheses. In a general sense, Santostefano (1978) defines the concept as follows:

> "...cognitive controls have the status of intervening variables that define principles by which motoric behaviour, perception, memory, and other basic qualitative forms of cognitive functioning are organized as an individual coordinates himself with his environment. (p.100)

The word "control" is used to connote the governing or regulating role that these mechanisms play in the amount and organization of information available to the individual. In this sense, the notion of "cognitive control" is similar to that of "executive processor" within the information processing paradigm.

Several other characteristics which differentiate the term "control" from "style" as outlined by Santostefano (1978) also deserve mention. One of the major distinguishing features is that cognitive controls are generally discussed in terms of multiple dimensions. That is, several cognitive controls are examined for an individual. In contrast, cognitive style dimensions are treated as single, independently operating traits. Another feature is that cognitive

controls are generally interpreted in conjunction with specific situational demands whereas cognitive styles tend to be viewed as remaining more stable across various situations. Thirdly, cognitive control research has proceeded from a strong theoretical base whereas cognitive style research has not, following more of a path of "accidental discoveries and experimental work" (Santostefano, 1978, p.98). To confuse definitional matters further, those in the field of coghitive control research tend to use the term "cognitive style" to refer to an individual's total cognitive profile. That is, the total compilation of his performance on several cognitive control dimensions.

Similar to the mechanisms associated with cognitive style, cognitive control principles are bipolar in nature. Some of the control principles more frequently studied include the following: 1)Focal Attention, which refers to an individual's deployment of attention when scanning a stimulus field and operates on the bipolar dimension of active vs. passive.

2)Field Articulation is similar to the field independence-dependence concept of Witkin. It refers to the way a person deals with a stimulus field containing various distractors and involves a constricted vs. flexible dimension.

3)Leveling-sharpening concerns how an individual assimilates new, changing visual information with older memory images of it.

4)equivalence range, which refers to the individual's manner of conceptually grouping information in terms of its perceived similarities, and involves the bipolar dimension of narrow vs. broad/global. Other control principles that will not be discussed as they do not pertain to this study and are more frequently used with either adults or very young children include tolerance for unrealistic experiences, cognitive complexity, and body ego tempo.

The focal attention principle has been operationally defined in terms of the "Scattered Scanning Test" where the subject is required to locate and mark specific target shapes within a 30 second time limit while the examiner records the order in which the targets are marked.

The field articulation principle is measured by the "Fruit Distraction Test" which can be thought of as a child's version of the famous "Stroop Test". It requires the subject to name fruit colours in the presence of an increasing level of distracting influences.

The leveling-sharpening principle is assessed with the "Leveling-Sharpening House Test" in which the subject is presented with a series of 60 drawings of the same house where the number of missing details is gradually increased. The subject is to describe any changes noticed throughout the presentation.

The equivalence range principle is operationally defined in terms of an "Object Sort Test" which requires the subject to sort a collection of specified objects into

groups, and then verbalize reasons for such groups as the examiner records the responses.

The performance on a group of tasks such as these described is then analyzed and a cognitive profile is derived depicting the individual's standing in terms of each of the bipolar dimensions assessed.

Similar to the learning and cognitive style instruments, cognitive control measures are subject to criticisms based on their discrete and isolated nature. That is, the specificity required to operationally define a construct results in a more narrow definition than originally subsumed by the conceptual idea. However, these measures differ slightly from those previously discussed in that cognitive control researchers demand that *several* control principles be assessed in some depth so that a complete cognitive control profile for an individual can be formulated. Such a profile ensures that a larger range of behaviours associated with the general construct are examined and should therefore result in greater validity.

The final related term that requires some definitional clarification is that of "cognitive strategy". Although this study does not involve this concept specifically, a brief review of its meaning is appropriate in order that it can be distinguished from the other terms used. If cognitive controls and styles can be thought of as being subsumed under the broader heading of learning style, then cognitive strategies might be viewed as a smaller component of

cognitive controls and styles. Generally speaking, they are specific techniques that are employed in order to meet task demands. Messick (1983) describes the distinction in the following manner:

> "A distinction is commonly made between cognitive styles and cognitive strategies...the former being spontaneously applied without conscious consideration or choice in a wide variety of situations and the latter reflecting decisions among alternative approaches as a function of task requirements, problem content, and situational constraints." (p.17)

The distinction seems to involve a greater meta-cognitve awareness with respect to strategy use, and less stability in use across different situations. Because they tend to operate at a more conscious level than most other aspects of learning style, strategies are more conducive to change. New, more appropriate strategies may be taught through instruction and training (Feuerstein, 1980; Messick, 1983).

In summary, the learning style area is characterized by definitional problems which involve individual researchers adapting a definition for the term which reflects their individual interest. This definition then, becomes even more discrepant form others when it is translated into operational terms. In addition to this, the inconsistent use of several related terms has resulted in a body of literature which is very difficult to compare. Although this topic of study is currently the object of heightened

interest and enthusiasm because of its concern with individual learning differences, it is difficult to review the research to advance our understanding on the topic in any systematic fashion. Rather, the area is typified by much isolated conceptualizing and research that has not been built upon previous assumptions and findings. In this sense, the knowledge one can learn from such a review might be viewed as being lateral in nature as opposed to linear, characteristic of methodical, scientific study.

RESEARCH COMPARING DIFFERENT LEARNING STYLE MEASURES:

Due to the isolated nature of much of the research in the area, very few studies exist which compare the performance of students on different learning style, cognitive style or cognitive control measures simultaneously. Yet, if greater discussion and integration of findings is to be developed across various interpretations of the learning style concept, then this type of research is essential. Such data offer greater insight as to the processes which might be involved in the specific tasks being used to assess the learning style components, and provide a means by which the validity of the separate instruments might be evaluated.

One study conducted by Shade (1984) administered a battery of "cognitive style" tests to 135 ninth-grade students to determine the specific processes involved in the

Group Embedded Figures Test; the most frequently used measure of field independence-dependence dimension. Apart from this test, others in the battery included the Gestalt Completion Task and the Visual Attention Task to assess attentional components involved in the G.E.F.T.; the Picture Completion Task and the Clayton-Jackson Object Sorting Task to measure the recognition and categorization involved; and the Myers-Briggs Type Indicator to examine decision-making skills. Results indicated that those measures related to visual analysis were most hightly correlated with the G.E.F.T.. The author therefore, concluded that field dependence as measured by the G.E.F.T. represents variation in visual information processing patterns much more strongly than it does some underlying behavioural style. Results such as these suggest that researchers utilizing this instrument need to exercise greater caution before generalizing and interpreting such findings in terms of a persistent cognitive style construct.

Perhaps, one of the most popular learning style instruments among educators is the Learning Style Inventory (Dunn et al., 1981) described briefly in the previous section and selected for use in this present study. Hodges (1982) and Cavanaugh (1981) both report the implementation of a school-wide learning style based program utilizing this assessment device. Its popularity for practitioners may be partly explained by the larger range of elements professed to be assessed that have direct implications for specific

environmental and teaching modifications. Studies which investigate the relationship between these student identified preferences and more specific cognitive elements could hold great value. They could not only provide some evidence concerning the validity of this instrument, but also identify possible relationships between some of the environmental and social elements with other mechanisms associated with information processing patterns.

The L.S.I. manual reports several studies that have been conducted addressing some of these issues. Dunn (1981) describes one such study in which 59 subjects were administered both the L.S.I. and the G.E.F.T. (Witkin et al., 1971). Results indicated that those considered to be more field dependent tended to prefer to learn through their kinesthetic senses, and with peers present than did field independent subjects.

A further study (Dunn, 1981) administered the Children's Embedded Figures Test and the L.S.I. to 124 individuals, and the manual reports 11 of the L.S.I. variables to be significantly related to the field independence-dependence dimension. Overall, those who were high scorers in terms of field independence indicated a preference to learn visually, did not like to learn through their tactile sense, were not adult motivated and did not prefer to learn in the evening. Of these, the elements that were most discriminating between the extremes on this cognitive style were visual and tactile preferences with

those considered to be field independent showing a high preference for visual learning and those labelled field dependent preferring to learn through their tactile sense. These findings are consistent with those of Shade(1984) in identifying visual analysis skills as being most highly correlated with the Embedded Figures Test.

Other cognitive style measures that have been compared to the L.S.I. as reported in the manual (Dunn et al., 1981) include the Revised Torrance Questionaire (1977) which is purported to assess cerebral dominance, and Sigel's global versus analytical cognitive style instrument (1967). In each of these comparisons, several perceptual, sociological and environmental factors are reported as being related to an individual's performance on both of these cognitive style instruments. However, Dunn et al.(1981) offer no explanation as to why some specific elements might be related to these other measures, asserting that there is a need for additional research to investigate whether specific similarities exist that differentiate various groups of students.

One aspect of learning style that has undergone numerous correlational studies concerns "cognitive controls". Of interest at this pont, are only those which compared subjects' performance on various dimensions of cognitive control with other measures of either learning style or cognitive style. Although no such comparative research was found with respect to learning style, two

studies discussed in Santostefano (1978) examined the relationship between some specific cognitive control and style measures. Fifty adolescents were assessed with the Fruit Distraction Test; a measure of the field articulation cognitive control, and the Rod and Frame Test; a measure of the field independence cognitive style. Correlations observed concerning these two instruments are important as the definition of the constructs for both are very similar, and both measures profess to assess the selective deployment of attention. Surprisingly, no significant correlations were found between the two tests suggesting that these two instruments do not measure the same cognitive process, at least in adolescents.

An earlier study by Zarembo(1967) investigated the relationship between three tests of cognitive control associated with focal attention, field articulation and leveling-sharpening principles and the cognitive style dimension of reflection-impulsivity. Sixty 3rd and 4th grade children were administered the Matching Familiar Figures Test (Kagan,1964). Those children falling into the more extreme ends of the reflection-impulsivity dimension (n=44) were then given the Circles Test (focal attention), the Fruit Distraction Test (field articulation) and the Leveling-Sharpening House Test. Apart from the impulsives showing significantly more errors on the Fruit Distraction Test card requiring the greatest deployment of attention in relation to one requiring the least, no other significant

differences were observed between the two groups.

These studies illustrate the necessity of correlational research. As was observed in this research, instruments which might appear at first glance to be assessing similar cognitive elements assumed to be involved in the tasks, actually may not be. Because this paricular relationship or lack of relationship would not have been uncovered without such research, it points to the necessity for more such studies to be conducted. Only in this way, can similarities and differences between various learning style, cognitive style and cognitive control elements be discovered so that a more comprehensive understanding of individual learning differences can be attained.

The discussion thus far, has focussed on the concept of learning style as well as its identification, including an examination of the relationship between the various methods of assessment. We turn now to an area where the vast majority of research on the topic lies; that of applying the notion of learning style to the classroom.

MATCHING LEARNING AND TEACHING STYLES: RESEARCH AND ISSUES:

Since the inception of the Aptitude by Treatment Interaction model one branch of educational psychology has been concerned with the effect of matching various student personality or learning traits (Aptitude) to similar or dissimilar instructional environments (Treatment). While few would argue the conceptual appeal of furthering our

knowledge on this topic, the complexity involved when attempting to do sound research in a practical setting with individuals who tend to differ in more ways than they might be considered similar, has continued to frustrate researchers. To date, despite a history of rigorous attempts, there is a lack of consistent findings on the topic, and "opinions differ as to the net result of these efforts" (Miller, 1981, p.33). While it is not within the scope of this paper to examine specific criticisms of past A.T.I. research in much depth, let it suffice to say that the difficulty incurred in isolating specific person and environment variables for study has contributed greatly to the conflicting results found in the area.

> "The general impression conveyed is that considerable improvements in both the conceptualization and operationalization of the components of interaction are needed and this may take some time to achieve." (Miller, 1981, p.34)

Although the vast majority of researchers interested in learning styles do not profess to operate within an A.T.I. framework, reasons for conflicting results concerning the matching of teaching and learning style may stem from similar difficulties.

Different from much of the A.T.I. research which tended to focus on only one personality trait (aptitude) at a time, many recent matching studies in the area of learning style tend to examine several "style" characteristics

simultaneously as several definitions of learning style involve more than one element (for example, as included in the instruments of McDermott & Beitman, 1984 and Dunn, 1981). Others, such as Gregorc (1984) or Hunt (1979) also view learning style in a pervasive manner, describing the way individuals approach and interpret information rather than a single personality characteristic such as "locus of control". Therefore, in this way, the matching model involving learning styles is qualitatively distinct from that of A.T.I followers.

The basic premise of investigators advocating the matching model is as follows: if the educational environment, including the mode of instruction is altered to conform to the learner's identified style, then academic achievement will be increased. Numerous studies utilizing a variety of learning style instruments have reported findings to support this line of reasoning (Domino, 1971; Cafferty, 1980; Douglass, 1979; Krimsky, 1982; Pizzo, 1981; Shea, 1983; Paradice & Block, 1984). Additionally, several studies have been reported which found that when learning style and teaching style were matched, students' attitudes toward school were improved (Pizzo, 1981; Copenhaver, 1979; Renninger & Snyder, 1983).

In contrast to these findings, several studies have not found that matching learning and teaching style significantly increases academic performance (Corbett & Smith, 1984; Allen, 1977). However, it should be noted that Corbett and

Smith (1984) utilized the E.L.S.I.E. which was reported to have questionable validity in terms of an accurate learning style assessment device, and although Allen (1977) did not observe direct achievement increases, he did report increased self-appraisal and school attitudes among the matched sample. Generally speaking, a review of the literature on this topic would seem to indicate that matching a student's learning style with a corresponding educational format supports the validity of the matching hypothesis. This of course, is assuming that it is possible to accurately match a teaching style to a learning style.

As a result of the apparent success of the matching model, some educators and researchers, convinced of its value in the classroom, discuss it as the teaching method of the '80's that will solve the age-old problem of individual learning differences. Such a perspective is exemplified in the following discussion by Dunn and Dunn (1979):

> "All students, and certainly those with learning problems, *need* learning style analysis to identify how they learn best. Then, based on the findings, youngsters can be placed in the programs and provided the resources and methods that most adequately suit them. In much the same manner that physicians have replaced catch-all remedies, contemporary administrators and teachers will need to identify and respond to individual student differences." (p.122)

If, for the moment, we set aside the presumptuous nature of this statement in light of the fact that many do not believe that a learning style instrument capable of such accurate assessment has, as yet, been developed (Davidman, 1981; Keefe, 1982), the advocation of such a learning-teaching style match itself may hold potential danger. Although academic achievement may be increased in the short-term, research has shown that high achievers differ with respect to learning/cognitive style in consistent ways from low achievers. This has been demonstrated, not only with the L.S.I. developed by Dunn (Price, Dunn & Sanders, 1981; Carbo, 1983), but also on a battery of cognitive controls (Letteri, 1980), and specific cognitive style dimensions (Sigg & Gargiulo, 1980; Renniger & Snyder, 1983). The consistency of these findings lead one to question whether specific learning style characteristics or profiles are associated with a higher level of cognitive functioning that fosters such success. If this is indeed the case, then matching the instructional environment to a low achiever's specific learning style might inadvertently encourage that student to remain at a lower level of cognitive development and not attempt qualitative advances in his thinking processes.

Joyce (1984) alludes to this idea stating:

> "...that significant learning is frequently accompanied or impelled by discomfort...If the environment is perfectly matched to the developmental level of the learners they are likely

to be arrested at that level." (p.26-27)

Hunt defines learning style in terms of "conceptual level", referring to the degree of abstraction to which one is capable. As such, he does not advocate a direct match between the learner and the instructional format, but rather, an educational environment that is most likely to facilitate progress from one conceptual stage to the next. The notion that one develops to levels of higher thinking ability is consistent with ideas put forth by both Piaget and Bruner (Flavell, 1972).

Thus, there appears to have emerged two separate camps of thought on the issue of matching; those suggesting that teachers modify their format and environment to align themselves with the student's identified learning style in order to increase achievement in the short-term and foster more positive attitudes toward school (Dunn, 1977; Anderson & Bruce, 1979; Gregorc, 1984), and those who advocate that the teaching environment be organized in such a manner to modify students' learning styles (Hunt, 1979; McDermott & Beitman, 1984).

One possible reason for the growing popularity of the direct learning-teaching style match model may be centered in a seemingly "egalitiarian" perception of learning styles. Such predispositions are viewed as "differences" rather than "deficits" which serve to distinguish amongst individuals. In support of such a model, Gregorc (1984) states:

"Perhaps teachers set a 'tone' in their classrooms

which favours certain styles, systems of thought, and mind qualities. Those learners who comply with the teacher's preferred style may receive favoritism while their counterparts are reprimanded for their individualities." (p.54)

From the opposite camp, research has substantiated the contention that students can be taught "better" learning/cognitive styles which, consequently, also lead to increased academic performance (Learner & Rothman, 1984; Gaskins & Baron, 1985). With research to support both lines of reasoning, at present, this debate is unresolved.

The preceding discussion of the matching model has attempted to address the differing viewpoints in terms of how the concept of learning style should or might be applied to the classroom. As the vast majority of research on the topic of learning styles have involved various forms of matching research, its inclusion is considered crucial. It brings to light differing viewponts concerning the practical significance of research in the area. As will be discussed in the following section, the different perspectives on matching have profound effects regarding the implications of the learning style concept on children considered "learning disabled".

LEARNING STYLES AND LEARNING DISABILITIES

Similar to the definitional confusion that exists in terms of the "learning style" concept, so too are there problems in arriving at a concensus among researchers and practitioners regarding a definition of "learning disabilities". Frustrated researchers face the problem of conflicting results which are frequently attributed to the heterogeniety of most children included in L.D. samples (Keogh, 1981). The current trend among researchers in this area is to classify learning and reading disabilities in terms of various subtypes in an attempt to make the subsample more homogenious and improve the quality of research in the area (Lovett, 1984; Rourke, 1985). However, while many investigators are now advocating subtype distinctions in L.D. samples, the specific subtype classifications would seem to vary with the particular background of the researcher. Additionally, this subtype focus has tended to be restricted to researchers rather than practitioners.

School personnel have generally continued to define pupils considered learning disabled and therefore eligible for such special placements as "learning centres" in a broader manner that resembles that of Torgesen and Licht (1983):

> "A core concept in the definition of learning disabilities is that these children perform in the average range on measures of general ability such as

> standardized intelligence tests but show particular problems learning school subjects in a manner inconsistent with their ability to assimilate the general information and skills measured on I.Q. tests." (p16)

The Edmonton Catholic School District, for example, currently makes learning centre placement decisions based on similar criteria. These students must demonstrate an I.Q. of 90+, but have an academic achievement level that is at least one half below that of their expectancy level (achievement potential).

Warner and Bull (1986) address this issue in their discussion of definitional problems concerning learning disabilities stating that most of the current definitions do not stem from an educational perspective. The authors go on to state:

> "Any definition of learning disabilities (L.D.), if it is to be relevant to the needs of teachers, must address fundamental educational concerns, including implications for intervention." (p.139)

Perhaps, it is no coincidence that both the learning style and learning disability areas are plagued with definitional problems. It is possible that both are merely the consequence of the limited existing knowledge on the topic of individual differences in learning. Because learning style research attempts to deal with such differences, it may have important implications for a practical

educational definition of learning disabilities. Those students who have difficulty learning in an environment which is too discrepant from their own learning style may exhibit lower academic achievement than might be expected from their I.Q. score or level of expectancy. Such a classification would seem to be consistent with that utilized by many school systems such as the Edmonton Separate. Gregorc (1984) makes this point in the following statement:

> "Learners who refuse to accommodate to the preferred style may sometimes be labelled learning disabled." (p.54)

To extend this notion slightly, Butler (1982), in her discussion of Gregorc's research, makes the point that an inability to learn skills such as reading, under certain educational conditions different from one's own style can be thought of as lacking "style flex". This refers to the ability that an individual has to learn in a non-natural style. Perhaps, a person who is learning disabled not only possesses a style which is discrepant from that which is catered to in the traditional classroom, but has little or no "style flex" as well.

Past research comparing the learning disabled on various measures of learning style reveals mixed results. Wild (1979) administered Dunn's Learning Style Inventory to 80 Junior High males, 40 of which were learning disabled and 40 non-disabled. Results identified 4 of the 24 L.S.I. elements as significantly discriminating between the two groups.

Compared to the non-L.D. sample, the learning disabled students were found to be less persistent and less adult-motivated, although they did prefer to learn with adults present, and they did not prefer to learn in several sociological ways while the non-L.D. sample indicated that they did.

In another study utilizing this same earlier version of the L.S.I. Price, Dunn and Sanders (1981) compared the learning style preferences of grade 3 and 7 students rated high and low in terms of reading achievement. The above average readers indicated a preference for studying in a dimly lit, formal environment. They were self-motivated, persistent and responsible. They required opportunities for mobility, and did not learn best in the late morning or require food while studying. They also did not prefer to learn through their kinesthetic or tactile senses. The below average readers, on the other hand, indicated a preference for a brightly lit, informal learning environment. They were adult-motivated and learned best in the late morning. They did not require mobility and indicated a preference for learning through their tactile and kinesthetic senses. This latter finding was supported by Carbo (1983), who also found poor readers to be tactile-kinesthetic learners. Such results however, must be interpreted cautiously as I.Q. differences between the high and low achievers were not controlled. All these researchers who employed the L.S.I. as a means of assessment also advocate matching teaching styles

to the specific learning preferences of the poorer achievers in order to increase achievement. Another learning style instrument that has been used to predict children who may experience learning problems in future years is the "Study of Children's Learning Style" (SCLS). Developed by McDermott & Beitman (1984), and described previously as a short teacher checklist, this measure attempts to assess "unique patterns of learning related behaviour manifest by children as they actually go about learning in the school context" (McDermott & Beitman, 1984, p.6). As a result of factor analysis, three dimensions emerged as reliable behavioural styles indicative of individual learning differences. These included "Inattentiveness" which was characterized by impulse-ridden behaviour and poor attention, "Avoidant" indicated by task aversion and fearfulness, and "Overly Independent" which was typified by distinct, self-minded, unconventional learning behaviour. One year after this data was collected for 1513 kindergarten children, 965 were followed up in terms of grade one achievement. These results indicate an average correlation coefficient of ($r=-.50$) for all 3 dimensions which was significant at the .001 level. Thus, students who were considered more avoidant, inattentive, and overly independent behaviourally, scored lower in terms of reading, and math achievement. Additionally, in a further study conducted by McDermott(1984), scores on the SCLS scale accounted for "appreciable and statistically significant proportions of

variability in later achievement" (p.38), even though I.Q. was found to be a better predictor. Taken together, these findings provide rather strong support for this learning styles assessment device to dicriminate between young children (5 yrs.) who are likely to experience lower academic achievement in future years, independent of I.Q.. McDermott & Beitman (1984) support the intervention approach of modifying the children's behavioural learning styles to improve performance.

Another aspect of learning style that has compared average achievers with learning disabled is that of cognitive control. In an extensive cross-sequential study, Santostefano (1978) examined the performance of children experiencing learning difficulties and those who were not, on a battery of cognitive control tests over a five year period. For three consecutive years, teachers selected kindergarten children who they judged to be at risk in terms of having a learning disability (Suspects) and those who appeared to be handling classroom demands quite comfortably (Typicals). Approximately 30 Suspects and 30 Typicals were selected from several schools by the same teachers each year. These two groups were administered a battery of cognitive control tests that included; the Fine Motor Delay, Scattered Scanning Test, Fruit Distraction Test, Leveling-Sharpening House Test, and the Object Sort Test. These students were tested annually on these tests and achievement data were also obtained. Such data enabled

Santostefano to examine differences in cognitive control performance across ages of both the Suspects and Typicals, as well as differences between these groups at different ages. Generally speaking, the results supported the existence of a developmental trend occurring across ages in both subject groups, with the Suspects being found to be functioning at a more immature cognitive style level at each age than were the Typicals. That is, in terms of each of the bipolar dimensions contained in the battery, the younger subjects tended to demonstrate a more global, undifferentiated style compared to the more analytic, differentiated one of older subjects. Similarly, compared to the Typical learners, Suspects as a group, were found to generally show little fine motor delay, to scan passively and narrowly, to attend to both relevant and irrelevant information, to construct and maintain global images and to categorize objects in terms of concrete concepts.

Although this was the general finding in the samples studied, Santostefano notes that this cognitive control development does not always follow a straight line. In other words, there appear to be slight regressions on some controls at certain ages, but in overall terms, the progression is fairly linear. It should also be noted that in many instances with the individual measures obtained, significant differences were not found that differentiated Suspects from Typicals at different ages. However, Santostefano points out that although statistical

significance may not have been reached in these cases, the Suspect students, as a group, scored consistently lower in terms of maturational level than the Typicals. This finding indicates that there was too much within group variation to reach significance despite the observed mean differences in the expected direction. This could conceivably be the result of outside factors influencing the performance of the subjects that were not controlled. Further research and analysis would be necessary in order to pinpoint such a cause.

Utilizing several of the same measures, and several additional ones, including two related to "cognitive style", Letteri (1980;1982) found that a profile comprised of individuals' performance on all such measures could accurately differentiate between high and low academic achievers with 7th and 8th grade students. Thus, this lends support to that found by Santostefano. Both these researchers provide remedial intervention programs designed to modify the maladaptive cognitive control processes observed in the underachievers and suspect learners.

In a comprehensive review of the literature examining the "cognitive style" performance (field dependence/independence and reflection/impulsivity) of learning disabled, Blackman and Goldstein (1982) report much contradictory evidence. Almost all studies utilized the Embedded Figures Test and the Matching Familiar Figures Test to assess these constructs. An overall synthesis of the

findings caused them to conclude that field independent and reflective children tend to achieve higher in school, while the underachievers tended to exhibit a field dependent, impulsive style. Reflective children were generally observed to show better attentional behaviour, but data relating field dependence to attention was considered too inconsistent to draw any conclusion. Perceptual-motor functioning did not appear to be related to either of these cognitive style dimensions. Hyperactive children were also generally found to be more impulsive. The authors discuss the intervention attempts which stem from both; a direct match of teaching environment and cognitive style, as well as methods designed to modify students' styles. They conclude that both methods have reported sufficient empirical support. More specifically, the impulsive children seemed to be able to improve academic performance with a teaching-learning style match, and both dimensions had purportedly been amenable to modification.

Reasons for conflicting literature on the topic are not suggested by these authors, but possible explanations may involve varying research standards, and very different sample selection procedures that would make comparisons difficult. Additionally, there is some evidence to suggest that the instruments used to assess these dimensions have questionable validity (Shade, 1984).

The research relating learning style to learning disabilities discussed thus far, has reported a great deal

of research to support the contention that learning disabled students differ from non-learning disabled on several aspects subsumed under the learning style heading. However, very limited research presently exists comparing the same sample of L.D.'s on several aspects of learning style measures simultaneously.

Another factor to be considered is the absence of a theoretical framework from which to compare various findings and base possible future predictions in other aspects of learning style, apart from those concerning cognitive controls. This constitutes the next issue to be addressed in this review.

LEARNING STYLES AND THEORY

Need for Theory:

While most would agree that learning style research lacks a comprehensive theory that could be uniformly applied to the diverse aspects it encompasses, opinion regarding the need for such a theory is mixed. Hunt (1981;1982;1984) for example, suggests that teachers are all potential theorists and that most already have intuitive theories that they put into practice whenever they repond to their students' needs. He tends to view the role of theory as being only a "guide to practice" rather than a formal attempt to develop a standard from which to view various educational methods. In his discussion of this issue, he states:

> "...practice and theory must be reciprocally related and that, in many cases, good theory derives from successful practice...All theories must be verified, however, teachers' impicit ideas about student learning styles and matched teaching approaches might well begin with a more thorough understanding of teaching practice and the *implicit* theories that underlie it." (Hunt, 1981, p.647)

Hunt's recognition of the value of good teaching practices with or without the presence of theory is no less than commendable. His assertion that theory derives from practice is also true. However, as delineated by Kuhn(1970), there comes a point when it becomes necessary to assemble the facts found in nature and "articulate a paradigm"(p.27). To assert as Hunt appears to, that implicit, thus unarticulated theories are sufficient for successful practice does not allow for the development of principles from which future practice might be further improved.

Perhaps, a theory of learning style is not as essential to teachers as it is to researchers. Without a framework within which learning style definitions and instruments can find their niche and be compared with others in the area, the task of sorting the valuable from the questionable becomes much more difficult. As a point of illustration, one need only look at the work of Fischer & Fischer (1979) who offer yet another definition of the "learning style" concept. They provide a means by which to categorize

students as to the kind of learner they are, as well as discuss various teaching styles that can respond to such different learners. A program which they claim is "based on experienced observation". While this practical application might, in fact, hold a great deal of value, there is no means by which to judge it. Without any theoretical framework, all views of learning style are treated with equal importance and relevance. Grasha (1981) supports the necessity of a theoretical base with the following discussion:

> "...deciding what to examine in learning style is a lot easier with a theory than without one. A theory certainly makes it easier to pick and choose attributes to study; it also has the advantage of allowing one to build on previous work and to test the limits of its application. However, theories should be explored for their potential in learning style research." (p.32)

The development of a paradigm is a necessary step in the advancement of knowledge in an area since, as further discussed by Kuhn (1970), it defines the problem to be studied next, and ensures the discovery of a solution (p.28).

Towards a Theory of Learning Styles:

There are several theoretical models that have particular relevance to the topic of learning styles. The

"Information Processing Approach" for example, is a cognitive model and as such, might provide some basis for the cognitive aspects subsumed under the learning styles heading. The main assumption underlying this approach is that various stages of internal processing occur between a stimulus and a response. At each stage of processing, operations are performed which transform the information in some way, and each of these requires a specified amount of time. The output of each stage becomes the input for each following stage. The model involves two components; a structural component which refers to the content or nature of the information and a functional component which refers to the specific mental operations performed (Rose, 1980). Included in this model are "executive functions" which suggest the existence of some higher-order control mechanisms, "whose mission it is to determine which problems ought to be tackled, which goals sought, which operations applied, and in which order" (Gardner, 1983, p.23).

A major criticism of this approach concerns the inescapable fact that all internal processing stages and mechanisms are inferred. Their existence cannot be proven or disproven by the task measures, in which reaction time is often the only or most critical dependent variable. Also, this theory focusses exclusively on the cognitive processing of various forms of stimuli without efforts to relate it to a larger theory of human behaviour or development, and is therefore, limited in its scope. For these reasons, although

it holds some relevance to the area of learning styles, it alone is not sufficient as a unifying theory for the area.

A second theory with has relevance to learning styles research is the "Conceptual Systems Theory" (C.S.T.). The basis for much of the A.T.I. research, it stems from the Lewinian formulation that behaviour is a function of the interaction between personality and environment (Miller, 1981). Similar to the Information Processing Approach, C.S.T. entails two components; structure and content. In this case, however, structure refers to the process of how a person thinks or how a task can be approached and content refers to what a person thinks or what a task involves. Different from the Information Processing model, both person related variables and content can be broken down into these two dimensions. Thus, the person is seen to function within a context. Of particular applicability to the learning style concept is that "structure" is considered to be a cognitive predisposition of conceptual level with assumed generality across time and situation. Influences such as stress, however, can affect the conceptual level used. Task aspects of the environment include structural variables such as information load, and amount of punishment or reinforcement received. Without specific ages attached, Joyce (1984) outlines each of the four stages of conceptual complexity moving from a concrete configuration stage to a mature, more abstract system; each of which is based on changing interpretations of one's social world and interpersonal

relations. Based on these stages, Hunt (In Joyce, 1984) has developed educational environments that entail differing degrees of structure moving from one that is highly structured to one of personal responsibility.

The major criticism of this theory, in terms of its application to learning styles research, is its exclusive focus on the conceptual and behavioural strategies used when coping with conflict in the *social* environment. Although these are important factors in one's adjustment in the classroom, it does not deal with nonsocial stimulus domains such as academic achievement directly, and the cognitive processes involved. In this sense, it is quite distinct from the Information Processing Approach. Miller (1981) addresses its applicability to the academic sphere in the following statement:

> "...predictions of nonsocial outcomes cannot be adequately made within the theoretical framework provided by the C.S.T....because "academic achievement" is not couched in theoretically relevant terms, the results obtained may be of little use in extending the theoretical structure of C.S.T." (p.39)

Additionally, its restriction to the one element of conceptual complexity would seem to hold limited value in attempting to account for more than this one definition of learning style. By itself, therefore, it lacks the qualities necessary for a more integrative approach.

The final theoretical model to be examined is one which has been refined and described by Santostefano (1978). Labelled as the "Biodevelopmental Framework", it is a personality theory in which research on cognitive controls has been anchored. Embraced within a developmental perspective, it emphasizes the cognitive interpretation of an individual's world.

Borrowing from the three theoretical paradigms of neo-psychoanalytic, Piaget's cognitive-developmental, and Werner's theory of development, it holds the following assumptions and propositions:

1. **The meaning of any unit of behaviour is determined by the total psychological context.**

This forces the researcher to examine specific task variables and ecological validity.

2. **The person is viewed as an active participant with affective and cognitive response styles that flavour how he approaches, avoids, selects, shapes and organizes stimulation.**

3. **The individual regulates [illegible]e responses in a manner that coordinates his "evolving p[illegible]ogical equipment" with the changing demands of the environment**(Piaget's notion of adaptation).

4. **Development is believed to proceed from a global state that lacks differentiation to one of increasing differentiation and hierarchic integration.**

In this way, an individual's thinking and responses can be

ordered along a continuum defining stages of maturity.

5. The developmental status of an individual is determined by its organizational characteristics, the range of response levels at the individual's avail, and the environmental demands.(including its limits, opportunities and expectations)

6. Individuals are perceived as displaying differences from birth throughout the life span.

7. Earlier response styles are not replaced; rather, they assume a place lower on the hierarchy of functioning levels. This implies that these earlier modes of behaviour are still potentially active and may be utilized if the state of the individual in conjunction with the specific environmental demands are such to warrant it. Thus, the interaction between the person and environment is taken into account. The environment itself is viewed as continually changing its expectations forcing the individual to adapt either by employing earlier response modes or evolving to use newly acquired, differentiated ones. It is from this proposition that Santostefano's (1978) perspective for intervention is based; advocating that the child's cognitive level be altered rather than matching the environmental demands to his lower functioning level.

The existence of "critical periods" is assumed, where if specific experiences are not present, the individual's response system adopts a deviant line of growth. While Santostefano extrapolates on this notion to account for

psychopathology in terms of personality development, the field of neuropsychology has recently found some support for the existence of critical periods in the context of cognitive development (Spreen, 1984). Although this present study is not intended to address learning styles and personality development, such an area remains open to future research.

From this theoretical perspective, each cognitive control principle operates on a bipolar dimension where the lower end of the continuum represents an immature cognitive processing level and the other extreme being the mature response style. Cognitive controls are perceived as "executive processors"(although this term is not used)" and are "triggered by both the content of the information displayed and the adaptive intentions of the individual facing the information"(p.101).

For a complete diagram depicting this specific hierarchical structure, refer to Santostefano (1978, p.339). Each cognitive control assumes a position in the course of cognitive development with each successive control requiring a greater degree of abstraction and sophistication in attending to and organizing information in order that it be mastered sufficiently. As the person develops through these proposed stages, he/she progresses from a global, undifferentiated interpretation of stimuli to an analytic, differentiated mode of processing and categorizing information.

The first level on the hierarchy; "body-ego tempo" is purported to be mastered at a very young age, and was therefore excluded from use in this current study due to the age of the subjects involved.

This theory is thought to hold paricular value as a framework from which to integrate the various defintions and perspectives associated with the learning style concept. From an educational focus, the positive aspects of this approach include its attempt to incorporate cognitive functioning into a larger comprehensive theory of development. These developmental trends have been empirically demonstrated, not only with measures of cognitive controls (Santostefano, 1978), but also with numerous other learning style assessment instruments, including Dunn's L.S.I. (Dunn, 1982), the Embedded Figures Test (Saracho, 1984) and Kagan's Matching Familiar Figures Test (Brodzinsky, 1982). In all of the above mentioned studies, developmental trends were observed to emerge, significantly discriminating subjects of different ages in terms of response patterns and learning preferences. Dunn (1982) for example, examined a total of 3,972 students' responses to a 1978 edition of the L.S.I. from grades 3 through 12. In this crossectional study, she reports finding significant differences across various ages on 18 of the 24 elements, and thus, concludes that developmental trends in learning style as measured by the L.S.I. are very evident. Additionally, such a framework can also speak to various neurological findings where

developmental trends have also been discovered (Spreen et al., 1984; Best, 1985). Taken together, these developmental trends found by different researchers, using different instruments on different subject samples would seem to lend strong support to a theoretical framework which is based on such a developmental model.

Perhaps, of greatest significance is that this framework provides a theoretical viewpoint from which to study the relationship of learning disabilities to learning styles. Learning disabilities are thus interpreted as an immature development of cognitive mechanisms or perhaps, an immature use of them as a result of misperceived environmental demands and expectations. This conceptualization of learning disabilities does not directly contradict many previously proposed definitions such as those suggesting a deficiency in memory, language facilitation, or perception. Rather, it entails a shift in thinking of learning disabilities as a delay or appearance of a delay, instead of an immutable deficit. The fact that this theory allows for the use of less mature learning styles when, in fact, they may be within an individual's repertoire is important. Such a theory may account for many mixed results of the past in the area of learning disabilities that have attempted to match L.D. performance with younger cohorts in order to substantiate a "developmental lag" theory. This conceptualization is not new to the topic of learning disabilities. Orton (1925) was

one of the first authors to propose such an explanation, and it has more recently been incorporated by Satz et al. (1978) in his discussion of reading disabilities. However, the theoretical framework proposed here offers a way to view learning disabilities within the realm of learning styles that may hold greater value as it allows for immature use without insisting that immaturity or lack of development is necessarily the cause. Additionally, such a theory of learning styles would seem particularly applicable to education as remedial programs are a natural extention of this theory.

Although it is recognized that this proposed theoretical perspective is not without problems, it is intended to represent a beginning theoretical framework from which learning style research might proceed in a more systematic fashion.

In summary, the topic of learning style is currently characterized by a variety of definitions and related terms that are not used similarly by different researchers. This makes common discourse on the topic difficult, if not impossible as investigators would seem to be addressing different topics but using the same terms to do so. Attempts to compare different learning style measures have been scarce, however, some that do exist have found that instruments which, on the surface, appear to assess the same aspect of learning style may, in fact not be and therefore, point to the need for more such comparative studies.

The area where the vast majority of the research on learning styles does exist concerns its implementation in the classroom and the resultant achievement gains. Such studies have lent a great deal of support to the idea of matching the teaching environment to the learner's style, as well as to modifying an individual's style to one that ressembles higher achievers. This practical application would seem to hold potential for the study of the learning disabiled as these students have individual learning differences which can not be explained by a difference in intelligence alone. Research exists to support the notion of the learning disabled differing systematically from higher achievers in terms of several aspects of learning style including; cognitive controls, cognitive style and learning preference. However, these findings have often been somewhat mixed. Moreover, there is no way to tell if this is due to the differences in subject selection and/or instruments used. Once again, this indicates a need for more comprehensive research on the topic.

Lastly, the need for a theory from which to base this future research was discussed, and the biodevelopmental framework proposed as a point from which to begin. In this way, there is an attempt to unify future research on learning style by using a common set of propositions from which hypotheses can be derived and tested.

III. RATIONALE AND HYPOTHESES

A. Rationale for Study

Within the past five years, there has been a heightened interest in the topic of learning styles as it relates to school children. Reasons for this most likely stem from the recent focus on individual differences and the perceived accountability of the educational system to attend to them effectively. Given the practical nature of the learning styles concept to the classroom, particularly in light of the intervention techniques suggested by many advocating their use, the whole area has gained rapid momentum as the new method to meet the individual learning needs of their students.

There is however, a danger in applying such ideas in the classroom before adequate research has been conducted to justify their validity and use in general. Ideas such as these may have conceptual appeal and intervention implications but, may not hold the validity and reliability required to warrant their implementation. This study is therefore, designed to provide some needed research on the topic.

Specific to the current area of learning style research, are problems concerning the wide variety of definitions, both conceptual and operational, and the variability regarding the psychometric properties associated with the various instruments. In light of these two main problem

areas, there is a specific need for comparative research examining several of these instruments on the same population simultaneously. In this way, it is possible to analyze the similarities and differences that exist between the different measures without the psychometric complications which ultimately result from attempting to compare results across different sample populations.

This research is designed to compare these different measures of learning style and cognitive control by examining a sample of learning disabled and non-learning disabled. Due to the fact that learning disabled children appear to differ in their ability to learn in a regular classroom, and past research has suggested that learning style might be an important area of difference, it seems to be a valuable topic of study. This present investigation, therefore, attempts to further examine these similarities and differences from a modified version of the Biodevelopmental theoretical framework. In this way, it attempts to provide a more integrative approach to the learning style area, particularly as it relates to the learning disabled by linking these two topics in a developmental context.

This study will examine the relationship between students' identified learning preferences, overt classroom behaviours, and a battery of four cognitive control measures. By comparing the performance of learning disabled and average achieving students using a theoretical framework, it may provide a basis on which future research

on this topic can be built.

This theory would predict that learning disabled subjects will demonstrate a more immature cognitive control profile, and this lower performance will correlate with specific learning style preferences on the Learning Style Inventory and observed classroom behaviours as measured by the Study of Children's Learning Style scale typically characterize younger children than their age cohorts who are average achievers. The cognitive control battery is made up of the Scattered Scanning Test (SST) which examines general attending behaviour, the Fruit Distraction Test (FDT) assessing selective attention, the Leveling-Sharpening House Test (LSHT) measuring the style which memory images are interpreted, and the Object Sort Test which assesses the level of abstraction used in categorizing. The Learning Style Inventory (LSI) assesses how the child feels they learn best in terms of environmental conditions, personal aspects such as motivation and responsiblitiy, in terms of sociological variables as well as perceptual preferences, and perceived physical needs. The sixth instrument, the Study of Children's Learning Style (SCLS), measures the child's classroom behaviour as indicated by their teacher in terms of attentiveness, tendency to avoid learning tasks, and the appearance of overly independent learning approaches.

B. Hypotheses

1. L.D.'s will mark fewer target figures on the SST and will demonstrate more narrow, passive scanning behaviour than will the average achievers.

2. In terms of the FDT, L.D.'s will be more distracted by competing stimuli, attending to both relevant as well as irrelevant information when naming colours on card 3 and 4 compared to their performance on the control card than average achievers, resulting in longer response times, more uncorrected mistakes, and more recall of peripheral figures on card 3.

3. In terms of the L.S.H.T., L.D.'s will report fewer correct changes, more incorrect changes, and will take longer to detect correct changes when taking the number of opportunities available into account, thus, demonstrating a more global, undifferentiated manner of constructing memory images.

4. In terms of the Object Sort Test, L.D.'s will categorize information in a more concrete fashion than average achievers by constructing fewer typical groupings that are labelled in less abstract terms and more atypical groups.

5. L.D.'s will identify different learning preferences as

measured by the L.S.I. than will average achievers. (Although research exists indicating that a developmental trend exists with the L.S.I. the ages and ability level of the subjects examined make specific predictions unfeasible.)

6. L.D.'s will be observed by their teacher to be more inattentive, more avoidant, and to exhibit more overly independent behaviour than average achievers.

IV. METHOD

A. Subjects:

A total of 60 students participated in this study. Of these, 30 were identified as "learning disabled", and 30 were categorized as "average achievers". The learning disabled sample was selected from "learning centre classrooms" contained in 5 separate elementary schools within the Edmonton Catholic School Division. Criteria for placement in such a learning centre stipulates that students must demonstrate an I.Q. of 90+ as measured by the WISC-R, and have an academic achievement level that is at least one half that of their expenctancy level or academic potential as measured by the Bond & Tinker formula:(number of years in school X MA/CA + 1.0). Additionally, such a discrepancy could not be primarily due to hearing or motor handicaps, emotional disturbance or environmental disadvantage. Teacher estimates of their current grade level of functioning in reading and math were also obtained so that an indication of the severity of their learning disability might be determined.

An approximately equal number of non-learning disabled subjects was selected from each of the same 5 elementary schools that contained the specified learning centres. This ensured that both the L.D. and non-L.D. samples were similar in terms of the general socio-economic status of their community. Chosen in cooperation with each school principal,

all non-L.D. students were considered "average achievers" from grades 2, 3 and 4. Specifically, these students were to have achieved a minimum of a letter grade of "C" as indicated on their last report card (Nov./85) in both reading and mathematics. An attempt was made to eliminate those who were very high achievers so that homogeniety within this group could be preserved as much as possible.

Subjects ranged in age from 7 years, 3 months to 10 years, 7 months with the mean age for all students being 8 years, 9.5 months. This range was adapted as a result of the unavailability of this many students exactly the same age. As can be seen in Table 1, however, the vast majority of subjects in both the L.D. and non-L.D. groups were 8 to 9 years of age. A total of 38 males (L.D.=22/non-L.D.=16) and 22 females (L.D.=8/non-L.D.=14) made up the subject sample. Past research suggests that there may be differences in learning styles according to gender (Dunn, 1981; Holland, 1982). However, given that the majority of those considered learning disabled are male, attaining an equal number of males and females in each subsample was not feasible.

An additional criteria which was requested on the parent permission slips, was that particpants be, at least, second generation North American in which English was their first language. This was done in an effort to control for possible learning style differences as a result of cultural background as reported by Holland (1982). Although this stipulation could not totally restrict the sample to a

homogeneous cultural background, it eliminated complications caused by any gross discrepancies on this variable. See Table 1 for a complete description of the sample.

Table 1
Description of Sample

	Learning Disabled				Average Achievers			
	* Reading Grade Level				**Reading grade Level			
Age	1	2	3	4	1	2	3	4
7 yrs.	n=2	n=1	0	0	0	n=3	0	0
8 yrs.	n=9	n=7	0	0	0	0	n=16	n=2
9 yrs.	0	n=3	n=6	0	0	0	n=2	n=5
10 yrs.	0	n=1	n=1	0	0	0	n=1	n=1
	LD (n=30)				Non-LD (n=30)			

LD $\bar{x}$ age = 8yrs., 10 mo.
Non-LD $\bar{x}$ age = 8 yrs., 9 mo.

* Reading leavel as indicated by teacher estimates
** Reading level as determined by grade attending

B. Instruments:

The following instruments were selected for use in this study as they each represented a distincly different approach to the learning style concept, and each can be interpreted as fitting within a developmental perspective. Taken together, the range of variables assessed included; self identified learning preferences touching a wide variety of educational aspects (LSI), learning style behaviours in the classroom as perceived by the classroom teacher (SCLS), and a battery of more internally inferred cognitive processing aspects of learning style assessed by an examiner on a variety of tasks in a one-to-one testing session (cognitive controls).

Learning Style:

1. Learning Style Inventory (L.S.I.) (Dunn, Dunn & Price, 1981)

This instrument is a self-report questionaire designed to assess the external educational conditions which the student considers most conducive to their optimal learning of the subject matter, as well as specific internal conditions such as motivation and persistence that also contribute to one's learning style. Subjects are required to respond to individual statements in a true/false fashion. However, given the tendency of younger subjects to have difficulty with these terms, they were changed to yes/no. The test requires the researcher to send these data away to be scored and he/she subsequently receives a "preference

summary" for each child. Included are the standard scores for each of the 24 elements contained on the inventory as well as a consistency percentage score providing the experimenter with an indication of how consistent each student was in responding to similar statements.

The research report accompanying the test manual reports that the reliabilities found were generally "very good considering the small number of items in each subscale". The authors report that out of the 48 reliability analyses calculated, 33% were greater than .70, 25% were between .50 and .69, 23% were between .30 and .40 and 19% were less than .29 where there was a maximum of 7 items per subscale.

2. Study of Children's Learning Styles (McDermott & Beitman, 1984):

The S.C.L.S. is a 16 item rating scale that is completed by teachers describing individual student's classroom behaviour. It was adapted from "Stott's Preliminary Guide to Children's Learning Skills" (1981) which was originally intended as a screening device to identify those who were likely to experience learning difficulties. There are three distinct learning style behaviours measured by the S.C.L.S.; Avoidant, Inattentive, and Overly independent.

Based on a sample of 1,513 kindergarten children, internal consistency values ranged from r=.82 to r=.93. Test-retest values on a sample of 103 of the same children

over a 2 month period resulted in values from r=.80 to r=.88. Also, inter-observer reliability correlations revealed scores ranging from r=.60 to r=.82. All values were significant at the .001 level.

Although this instrument was normed on a sample younger than those in this study, it is considered appropriate for use given its purported ability to discriminate between students with potential learning difficulties and those unlikely to experience such problems. This seems paricularly relevant in light of the "developmental lag" perspective that is being used to view learning disabilities.

Cognitive Controls:

1. Scattered Scanning Test (Santostefano, 1978):

This test is designed to measure the construct of focal attention; the manner in which an individual attends to and scans a stimulus field for specified target figures. The child is required to mark as many of the designated shapes as possible within a 30 second time limit. In order to obtain an estimate of the subject's motor speed, the child is initially instructed to put a line through each shape while being timed (Motor Tempo Test). This time is later incorporated into ratios along with the number correct, and total distance scanned to control for motor speed affecting the score on this task. A training trial is then administered to ensure that the child can recognize the target figures and understands the task requirements. During the following two test trials, the examiner records the

sequence of the child's markings on an identical test form so that his scanning pattern can later be analyzed. Apart from tallying the total number of correct targets marked, two "ratio" values are calculated that parcel out the subject's motor speed factor as derived from the Motor Tempo Test. The first of these is used to assess the active-passive scanning dimension and is calculated by the following:

$$\frac{\text{Motor Tempo Time}}{100} \times \text{Number of correct shapes marked}$$

The second ratio value is used to determine the broad-narrow scanning dimension and is calculated by the following formula:

$$\frac{\text{Motor Tempo Time}}{100} \times \text{Total Distance Covered}$$

Criterion validity for this test was established by comparing performance on the SST with teacher ratings of classroom attention/ inattention. Significant differences were found between these two groups on the number of correct detections as well as the total distance scanned ($p=.001$ and $p=.05$ respectively). Test-retest reliability over a one year period was established with students originally tested in grade 4 and then again in grade 5 in terms of the number of

correct figures identified (r=.54; p=.01). The administration time for this test is approximately 5 minutes.

2. Fruit Distraction Test (Santostefano, 1978):

This test is designed to measure the field articulation construct; the manner in which a person deals with a stimulus field containing information defined as relevant and irrelevant in terms of the task requirements. The FDT is suitable for children from 3 to 15 years old and is administered individually. This test requires the child to name colours presented as rapidly as possible when they are either embedded among distractions or contradictions. A total of four (10x11 inch) cards are presented, interspersed amongst 3 practice cars (1x10 in.). These practice cards are shown before the test trials to ensure that the child is able to do the task. For each test card, the subject is asked to name the colours only, as quickly as possible while the examiner notes the time taken and mistakes made. The first card contains colour bars only, and the second contains pictures of fruits coloured appropriately. This second card acts as a baseline from which to compare times of cards 3 and 4 containing distractors. The third is the same as the second with the addition of distracting line drawings of objects mixed into the display. The fourth card contains fruits that are coloured in a contrasting colour and closely resembles the "Stroop" test designed for use with adults. As with the Stroop, the subject must ignore the

conflicting yet, irrelevant information in order to complete the task successfully. It differs in that the Stroop test depends on contrasting words to exert a distracting influence whereas the FDT utilizes contrasting colours on already learned fruit colours. This was constructed in this manner so that it would be appropriate for use with children with reading difficulties as the words tended not to be as distracting for those subjects. On this trial, the child is asked to name the colour that the fruit is "supposed to be". See Appendix 1. Values obtained from this test include the reading times of the distractor cards minus that of the control card; (Card 3 Card 2) and (Card 4 - Card 2), the number of peripheral figures recalled from card 4, the noncorrected errors of the card with the maximum distracting influence minus that of the control card (4-2), and the total number of self-corrected errors.

Criterion validity for the FDT was established with significant correlations being found between [illegible] and the "Marble Board Test"(r=.33 to r=.40). Performance on the FDT in terms of time, and number of errors was also found to correlate with teacher ratings of attentive and inattentive classroom behaviour. Test-retest reliability over a one year period has been established with students originally tested in grade 4 and then in grade 5. This was in terms of the total number of recalls made (r=.45; significant at .01).The administration time required for this test is approximately 10 minutes.

3. Leveling-Sharpening House Test (Santostefano, 1978):

This test is suitable for individuals from 3 years to adulthood and is designed to measure the manner in which memory images are constructed when attending to changing and stable bits of information (leveling-sharpening). The LSHT is administered individually and requires the child to attend to a series of 60 pictures of a house displayed in succession for 5 seconds each and report when he/she notices something in the picture that looks different. The subject is initially trained on a sample task involving six successive pictures of a Christmas tree. When the child demonstrates that he understands the task requirements, the test trial containing 60 pictures is then administered. Each change reported by the child is subsequently recorded by the examiner at the card number when first observed. These are later tallied in terms of number of correct changes observed, the number of incorrect changes reported, and in terms of a ratio in which the number of opportunities available to make a correct observation is taken into account as follows:

For each change detected or not detected,

$$\frac{\text{Number of opportunities to perceive each change}}{19(\text{total number of changes in display})}$$

The total administration time is 15 minutes.

Criterion validity for this test has been found with significant correlations between it and the Benton Visual Retention Test (r=.66) and the Incomplete Figures Test (r=.44) in terms of accuracy. Consistency of the LSHT was found by comparing performance on this with that on an alternate form (Hospitals Test). Stability was established with test-retest correlations over a 4-week period being significant at .01 (r=.60).

4. The Object Sort Test II (Santostefano, 1978):

This test is designed to measure the cognitive control known as "equivalence range". This concerns the manner in which an individual relates, categorizes and conceptualizes information. This instrument is suitable for children from 4 years of age to adulthood, and as with all of the cognitive control measures, is to be administered individually. The examiner places 46 objects arranged in a predetermined array before the child and asks him to put together the ones which he thinks belong together. After the subject has completed this task (no specified time limit), he is then quiried as to the rationale behind the groupings.

ex. "Tell me how do these things belong together?"

Each group that is constructed, plus the concept verbalized is then scored according to a specific scoring criteria; typical groupings, miscellaneous groupings and atypical groupings. While the latter 3 are counted in terms of the number of such groupings only, the typical groups are also assigned a numerical value, depicting the level of

abstractness. Verbal labels indicating a correct class or category, for example, would be assigned a high value while those which focus on a concrete attribute would be assigned a lower value. For specific scoring criteria, see Santostefano (1978, p.460). The mean number of objects contained in typical groups was also calculated.

Results of factor analytic studies identify three processes involved in the execution of this task. These include: the number of groupings or categories formed (breadth of categorization), the abstraction level of typical groups (label linked to them), and the number of groups and explanations given that reveal unrealistic, atypical conceptualizations. The identification of these three separate factors lend support to the validity of the construct. Test-retest reliablility, when this test was administered to grade 4 students and again in grade 5 found a significant correlation of the developmental score on this instrument ($r=.40$; $p=.05$).

C. Procedure:

All testing took place within a two month time span and was conducted in the students' respective schools. The Learning Style Inventory (L.S.I.) was administered to the learning disabled sample separately from the average achievers of each school. All subjects were informed that this measure was only concerned with *how* they thought they learned best and that there were no right or wrong answers.

Each item was read out loud by the examiner to all groups of subjects in an attempt to eliminate any confounding effects due to reading difficulty. This is considered an acceptable alternative procedure according to Dunn (1981). Following each statement, students were required to circle either "Yes" or "NO" for each item. These responses were later transcribed on to computer forms and sent to the test manufacturer for scoring.

At this time, teachers were given the Study of Children's Learning Styles (S.C.L.S.) forms to complete for each of their students participating in the study.

All four cognitive control measures were given individually to students in one single session lasting approximately 40 minutes for each. This testing took place in a quiet room in each school. The subject was seated in front of a table directly across from the examiner. All of these measures were administered in the same sequence for every student as follows:

1) Scattered Scanning Test
2) Fruit Distraction Test
3) Leveling-Sharpening House Test
4) Object Sort Test #2

This sequence was followed for all subjects as it had been recommended by Santostefano (1978), beginning with those requiring skills purported to be attained ea[illegible] developmental scale and progressing to higher level[illegible] acquired later. Because these tasks are purported [illegible] a

natural order, either randomization or varying the ordering of these tests systematically was considered appropriate (See Ferguson, 1981). Specific instructions for these instruments were repeated for each subject according to those developed by Santostefano (1978). (See Appendix 1 for specific directions).

V. RESULTS

The purpose of this study was to see if the learning disabled sample differed from average achievers with respect to the various aspects of learning style examined. Specifically, its intent was to see if L.D.s demonstrated learning styles that were at a more immature level than the non-L.D.s.

A total of six individual instruments were administered to the same sample of subjects who comprised these two groups. Thus, this study constitutes a 2-factor experiment with repeated measures on one factor as described by Ferguson(1981). Due to the nature of the instruments, a total of 41 dependent measures were used for analysis for each subject. Of these, 16 were related to the cognitive control assessments, with the Scattered Scanning Test including 3. Although 3 more scores had been collected which related to trial#1 of this test, only those equivalent 3 pertaining to trial#2 were used in the analysis. This was decided as it became apparent from the scores of both groups on trial#1, that it had been too easily completed, thus, both groups having reached a ceiling. Therefore, only scores pertaining to the more challenging second trial were used. The other cognitive control tests included the Fruit Distraction Test which included 6 measures, the Leveling-Sharpening House Test containing 4, and the Object Sort Test including the remaining 3 variables. The Learning Style Inventory involved a total of 22 measures, and these

were divided into 5 categories with a mean of 4.4 individual variables per group. The Study of Children's Learning Styles Scale was the least complex instrument used, involving only 3 variables, and so no further categorization was necessary. For a specific breakdown of the manner in which these measures were grouped, see Tables 3-14.

As this design did involve repeated measures, a Hotelling T statistical procedure was used. This was selected as recommended by Keppel (1973) in order to compensate for the possiblitiy of unequal variance between measures. The more liberal t-test was not used exclusively as it assumes this equivalence. In essence, the Hotelling T procedure adjusts the critical value of the F-ratio accordingly in a more conservative direction taking the individual variances into account, to reduce the possibility of making a Type I error. Similar to the MANOVA, the Hotelling T^2 calculation requires that variables be grouped in a conceptual manner as was previously described for this study. An F-ratio and probability of significance value are computed for each group of variables collectively, as well as for each individual variable included in that grouping. As this statistical program allows for a maximum of 23 variables to be analyzed in such a fashion simultaneously, it was possible to group the variables in larger overall groups, as well as smaller categories. This larger scale grouping made it possible to compare the relative ability of the 3 different learning style areas; cognitive controls,

L.S.I., and S.C.L.S. to distinguish between the learning disabled and average achievers. This was done and the F-ratios and corresponding levels of significance are reported in Table 2 below:

Table 2
Hotelling T^2 on All Large Groupings

	F - Ratio	Probability
1) Cognitive Control Measures (16 Variables)	3.22	.001
2) Learning Style Inventory (22 Variables)	.881	.617
3) Study of Children's Learning Style (3 Variables)	5.39	.002

As is indicated by the probability values depicting the significance level of the measures' ability to discriminate between subject groups, both the battery of cognitive control tests taken together, and the SCLS scale are able to do so with a large degree of confidence ($p=.001$ and $p=.002$ respectively). If .05 is considered the minimum level of significance required, the LSI cannot be considered sufficient to discriminate between these two populations. None of the F-ratios of the individual variables included in the cognitive control measures, when the sixteen were grouped together in this manner approached significance. Similarly, no individual LSI elements when grouped on this large scale could significantly differentiate between groups. In terms of the SCLS scale, however, 2 of the 3 variables were found to be significant group discriminators individually, when grouped in this way. The variables of "Inattentiveness" and "Avoidance" were both found to be significant from this analysis at the .005 and .006 level respectively as reported in Table 16.

This same Hotelling T procedure was performed on the smaller groupings that made up the separate subscales of all the learning /cognitive style measures used. Thus, it was possible to see the magnitude of sample group differences on each cluster of variables together, and the individual discriminating power of each variable when grouped within that specific cluster.

In addition to this procedure, individual t-tests were conducted on variables related to the hypotheses made. Although it is acknowledged that the results of many t-tests will find significant results as a function of the mere number conducted, these are thought to hold meaning when interpreted in light of the hypotheses originally proposed. In order that this reporting of results proceeds in a logical fashion, the Hotelling T findings are reported first for a grouping, followed by the relevant t-test results for variables which relate directly to hypotheses made. The results of these analyses are reported in Tables 3 to 16.

Table 3
Hotelling T^2 for the Scattered Scanning Test.

Cognitive Control	DF1	DF2	F - Ratio	Prob.
SST (Pooled) (Focal Attention)	3	56	.339	.024

Variable	LD$\bar{X}$	Non-LD$\bar{X}$	LD(SD)	Non-LD (SD)	Prob.
1) #Correct Targets Marked	29.4	35.2	6.29	7.67	.027
2) Ratio #1 (Breadth of Scanning)	5.86	6.97	1.57	2.5	.26
3) Ratio #2 (Distance of Scanning)	20.5	22.68	5.48	8.44	.72

Table 4
T - tests for SST Variables

Variable	T	Probability	
		1 - Tail	2 - Tail
1. #Correct Targets Marked	-3.2	.001	.002
2. Ratio #1	-2.07	.022	.043
3. Ratio #2	-1.19	.12	.239

Table 5
Hotelling T^2 for the Fruit Distraction Test

Cognitive Control	DF1	DF2	F - Ratio	Prob.
FDT(Pooled) (Field Articulation)	6	53	3.85	.003

Variable	$\bar{LDX}$	$\bar{Non\text{-}LDX}$	LD(SD)	Non-LD (SD)	Prob.
1) Reading Time (4 - 2)	40.0	32.77	25.0	14.51	.941
2) Reading Time (3 - 2)	1.6	0.6	12.48	6.49	.995
3) # Peripheral Figures Recalled	2.2	1.13	1.81	1.28	.398
4) Errors Not Corrected (3 - 2)	.23	-.30	1.13	1.12	.868
5) Errors not Corrected (4 - 2)	.43	-.30	1.65	1.09	.708
6) Errors Self Corrected	2.8	.83	2.72	1.23	.085

Table 6

T - Tests for FDT Variables

Variable	T	Probability 1 - Tail	2 - Tail
1. Reading Time (4-2)	1.37	.088	.176
2. Reading Time (3-2)	.86	.198	.395
3. # Peripheral Figures Recalled	2.6	.005	.047
4. Errors not corrected (3-2)	1.64	.053	1.06
5. Errors not corrected (4-2)	2.03	.024	.047
6. Errors Self Correted	3.6	.00	.001

Table 7
Hotelling T^2 for the Leveling - Sharpening House Test

Cognitive Control	DF1	DF2	F - Ratio	Prob.
L-SHT(Pooled) (Leveling -Sharpening)	4	55	1.09	.37

Variable	$\bar{LDX}$	$\bar{Non\text{-}LDX}$	LD(SD)	Non-LD (SD)	Prob.
1. Correct Charge	11.77	12.23	2.52	1.7	.95
2. Incorrect Charges	1.7	.67	1.26	1.06	.63
3. Miscellaneous Changes	1.7	1.6	2.71	2.44	1.0
4. L - S Ratio	14.42	13.88	3.97	2.31	.98

Table 8
T - Tests for L - SHT Variables

Variable	T	Probability	
		1 - Tail	2 - Tail
1. Correct Changes	-.84	.20	.40
2. Incorrect Changes	1.66	.051	.102
3. Miscellaneous Changes	.10	.46	.92
4. L - S Ratio	.64	.261	.52

Table 9
Hotelling T^2 for the Object Sort Test

Cognitive Control	DF1	DF2	F - Ratio	Prob.
Object Sort(Pooled) (Equivalence Range)	3	56	5.18	.003

Variable	LD $\bar{X}$	Non-LD $\bar{X}$	LD(SD)	Non-LD (SD)	Prob.
1. # Typical Groups	10.3	11.37	3.01	3.31	.65
2. Mean Typical Score	5.07	5.08	.60	.54	1.00
3. # Atypical Groups	3.96	.00	.81	.18	.004

Table 10
T - Tests for Sort Variables

Variable	T	Probability	
		1 - Tail	2 - Tail
1. # Typical Groups	-1.03	.09	.196
2. Mean Typical Score	.05	.48	.96
3. # Atypical Groups	.396	.00	.00

Table 11
Hotelling T^2 for the L.S.I (Immediate Environment)

L.S.I. Grouping	DF1	DF2	F - Ratio	Prob.
Immediate Environment (4 Variable Pooled)	4	55	.945	.445

Variable	$\bar{LDX}$	$\bar{Non\text{-}LDX}$	LD ST DEV.	Non-LD ST. DEV	Prob.
1. Noise	35.73	38.47	24.16	22.14	.995
2. Light	48.50	47.80	17.87	17.26	1.0
3. Temperature	52.23	51.80	7.63	12.78	1.0
4. Design	44.86	51.43	13.22	13.02	.47

Table 12
Hotelling T^2 for the L.S.I (Emotionality)

L.S.I. Grouping	DF1	DF2	F - Ratio	Prob.
Emotionality (4 Variable Pooled)	4	55	.895	.473

Variable	$\bar{LDX}$	$\bar{Non\text{-}LDX}$	LD ST DEV.	Non-LD ST. DEV	Prob.
1. Motivation	56.87	56.93	21.33	28.66	1.0
2. Persistence	50.3	52.0	11.6	8.63	.983
3. Responsible	51.27	44.4	15.78	23.44	.793
4.Structure	57.23	59.17	12.59	7.03	.972

Table 13
Hotelling T^2 for the L.S.I (Sociological Needs)

L.S.I. Grouping	DF1	DF2	F - Ratio	Prob.
Sociological Needs (5 Variable Pooled)	5	54	.847	.523

Variable	$\bar{LDX}$	$\bar{Non\text{-}LDX}$	LD ST DEV.	Non-LD ST. DEV	Prob.
1. Alone-Peer Oriented	42.17	43.67	15.24	14.68	1.0
2. Authority Present	65.8	67.9	24.03	20.51	1.0
3. Parent Motivated	63.33	63.33	6.92	10.15	.974
4. Teacher Motivated	71.77	66.73	12.30	19.55	1.0
5. Learn in Several Ways	56.33	61.53	25.36	16.35	.93

Table 14
Hotelling T^2 for the L.S.I (Perceptual Preference)

L.S.I. Grouping	DF1	DF2	F - Ratio	Prob.
Perceptual Peference (4 Variable)	4	55	.294	.880

Variable	$\bar{LDX}$	$\bar{Non\text{-}LDX}$	LD ST DEV.	Non-LD ST. DEV	Prob.
1. Auditory	52.27	50.53	9.80	8.30	.968
2. Visual	55.07	56.43	16.70	13.75	.998
3. Tactile	59.60	59.00	4.62	5.63	.995
4. Kinesthesia	59.37	57.20	9.13	11.32	.959

Table 15
Hotelling T^2 for the L.S.I (Physical Needs)

L.S.I. Grouping	DF1	DF2	F - Ratio	Prob.
Physical Needs (5 Variable Pooled)	5	54	.2813	.921

Variable	$\bar{X}$ LD	$\bar{X}$ Non-LD	S.D. LD.	S.D. Non-LD	Prob.
1. Requires Intake	39.63	34.33	23.32	23.98	.982
2. Eve. Morn.	40.43	38.77	19.64	15.87	1.0
3. Late Morn.	47.63	46.67	22.00	19.33	1.0
4. Afternoon	51.77	48.5	13.69	18.03	.988
5. Mobility	36.93	37.33	23.43	25.62	1.0

Table 16
Hotelling T^2 for the SCLS

Grouping	DF1	DF2	F - Ratio	Prob.
SCLS (3 variables pooled)	3	56	5.39	.002*

Variable	LD$\bar{X}$	Non-LD$\bar{X}$	LD(SD)	Non-LD (SD)	Prob.
1) Inattentiveness	9.23	12.83	4.16	3.04	.005
2) Avoidence	9.53	13.43	4.32	3.63	.006
3) Overly Independent	7.03	8.80	2.77	2.12	.071

Table 17
T - tests for SCLS Variables

Variable	T	Probability	
		1 - Tail	2 - Tail
1. Inattentiveness	-3.83	0.0	0.0
2. Avoidance	-3.79	0.0	0.0
3. Overly Independent		.004	.008

Related to cognitive controls, the 3 measures associated with the Scattered Scanning Test, when taken together were found significantly discriminate between learning disabled and average achievers at the .024 level. Within the individual measures, the total number of correct target figures marked was found to contribute most to this battery's discriminating ability, as it was found to be significant alone at the .027 level. Neither of the Ratio value differences were found to be significant according to the Hotelling T but the means reveal that the L.D.s were, in all 3 instances, functioning at a more immature level in terms of the "focal attention" principle than the average achievers. However, these Ratio values do not have sufficient discriminating power on their own when the Hotelling procedure is used. Because specific hypotheses had been formulated with respect to these SST measures, the less stringent, individual t-tests were also calculated. These analyses revealed that 2 out of the 3 variables showed significant differences. Both the number of correct targets marked, and the Ratio#1 value indicative of the breadth of scanning when motor speed was partialed out, were significant at the .001 and .02 level respectively on a one-tailed t-test. With the SST cluster proving to be significant, the first hypothesis stating that L.D.s would mark fewer targets and demonstrate more narrow, passive scanning behaviour was generally confirmed. The one score (Ratio#2) indicating the distance scanned when motor speed is taken into

consideration, did not support the hypothesis on an individual basis. However, an examination of the mean values indicated that this variable contributed to the SST's discriminating power as a cluster.

Similar to the SST findings, the 6 variables associated with the Fruit Distraction Test, as a group, were also found to distinguish between the L.D.s and non L.D.s at the .003 level. When grouped together in this fashion, none of the 6 variables, on their own, were capable of distinguishing between L.D. and Average achievers. As with the SST factors, individual means indicate that the learning disabled attained scores at the more immature end of the continuum with respect to the "field articulation" principle. However, these were not found to be significant discriminators individually, with the Hotelling T , but only when taken together as a group. Subsequent t-test analyses howvever, revealed that 3 of the 6 variables were significant at the .05 level. As was the finding with the SST, the 2nd hypothesis stating that L.D.s would be more distacted by interfering and conflicting information was generally supported. The individual measures which did not show significance were those involving reading time differences compared to their own baseline performance, and the difference between the number of errors made on the 3rd and the 2nd(baseline) card. However, visual inspection indicated the difference was in the appropriate direction thus contributing somewhat to the FDT's overall discriminating

power.

The Leveling-Sharpening House Test was composed of 4 variables. Results show that the group considered collectively does not significantly discriminate between subject samples, nor do any of the other variables on an individual basis within this group. Additionally, none of the t-test results indicated significant differences on this dimension. In terms of the third hypothesis which proposed that L.D.s would emonstrate a more global, undifferentiated manner of constructing memory images, these data do not support it, thus causing the acceptance of the null hypothesis in this instance.

The 3 variables associated with the Object Sort Test, when taken together as a group were found to significantly discriminate between the learning disabled and average achievers. On an individual basis within this cluster, the number of "atypical groups" formed was found to be the only measure to significantly differentiate the subject groups; with the L.D.s composing significantly more atypical groups than the average achievers. Similarly, results from the t-tests show this to be the only factor which was capable of distinguishing between groups on an individual basis. In terms of the 4th hypothesis predicting that L.D.s would categorize information in a more concrete fashion, by constructing fewer typical groups labelled in less abstract terms and more atypical groups, only partial support was found. This support concerned the number of atypical groups

formed only.

Results from the Learning Style Inventory groupings indicate no significant differences between subject samples in any of the clusters formed. Also, according to the Hotelling T analysis, no individual variables within any of the conceptually based clusters were found to show significant differences in preferences between these groups. Because there were no hypotheses made regarding specific relationships between the samples and the LSI elements, no t-tests were conducted on any of these factors. With no differences being found between these groups, however, the 5th hypothesis proposing that the L.Ds would identify different learning style preferences than the non-L.D.s is not supported.

Overall, the Study of Children's Learning Style scale was found to be the most powerful discriminating instrument to distinguish between the learning disabled and the average achievers. The three variables as a group found significant differences between these groups at the .002 level. On an individual basis, within this cluster, Hotelling T analyses revealed that the "inattentiveness" and "avoidance" factor were significant on their own. While the third variable, "overly independent", was not considered significant within this grouping, results from the t-tests indicate that it was a significant discriminator between these subject samples on an individual basis. Thus, complete support was found for the 6th hypothesis which predicted that L.D.s would be

observed to be more inattentive, avoidant and to exhibit more overly independent behaviour.

In summary, while the cognitive control variables as a group were found to be a significant discriminator between the two subject samples, varying degrees of partial support were found on each of the individual tests. In general, both the SST and the FDT support the first two hypotheses to a large extent, while the LSHT was not found to support the hypothesis made in its regard and the Object Sort Test only found support in a very isolated sense. The LSI also did not confirm the hypothesis made as no significant differences at any level were found. In contrast to this however, the SCLS was found to confirm its discriminating power on all 3 variables with the first two being found to be the most discriminating.

VI. DISCUSSION

A. Implications of this Research from a Biodevelopmental Perspective

The central concern of this study was to compare the performance of learning disabled and average achieving students (of equal age) on several measures subsumed under the heading of "learning styles". Stemming from a biodevelopmental framework, it was proposed that L.D.s would demonstrate a more immature learning/cognitive style than the non-L.D.s. Overall, partial support for this general hypothesis was found. When examined in terms of the discriminating ability of the three complete batteries; Cognitive Controls, Learning Style Iventory, and the Study of Children's Learning Style Scale, both the cognitive control measures, and the SCLS were found to significantly differentiate between L.D.s and average achievers in the direction hypothesized by the theory while the LSI did not. The results pertaining to the specific measures are discussed in this chapter as they relate to the theoretical perspective suggested and past relevant research with the learning disabled.

Cognitive Controls:

The fact that the entire battery composed of 16 variables taken together, appears to have impressive discriminating power in distinguishing between the two

subject populations implies that the learning disabled consistently demonstrated different cognitive control abilities than the average achievers. A closer examination of the actual means obtained reveal that the L.D.s as a group were found to perform at a more immature level on every measure pertaining to the cognitive dimensions assessed. Thus, these results confirm the general hypothesis made in terms of this aspect of learning style and support the theoretical viewpoint that a "developmental lag" exists with the learning disabled.

Because none of the individual measures from the Hotelling T analysis on this large scale were found to be significant, it suggests that all 16 variables contribute partially to the significance level of the battery as a whole. This means that no single element can be considered responsible for the majority of the battery's discriminating power. The Hotelling T results of the smaller clusters within this battery indicate that 3 of the 4 tests were able to significantly differentiate between the sample groups.

Both the Scattered Scanning Test and the Fruit Distraction Test are purported to measure cognitive control principles that deal with attention. The "focal attention" principle as measured by the SST and the "field articulation" dimension assessed by the FDT follow one another in terms of the developmental sequence at which they are mastered. (Santostefano, 1978) and are the lowest of the four cognitive control principles that were assessed on

this hierarchy. The learning disabled in this study were found to employ cognitive controls characteristic of less mature subjects than the average achievers on both of these tests; thus, supporting the proposed theory.

In light of this framework, the L.D.s' lower performance can be interpreted in two ways. Either a delay exists in terms of cognitive control development, or L.D.s regress to more immature control patterns in such a testing context. The assumption with this latter interpretation is that higher level controls on these dimensions are not sufficiently mastered to be employed under the forementioned conditions and so less mature, less efficient but more familiar approaches are used as they are more readily at the subject's avail.

This study's finding that learning disabled students are deficient on attentional tasks compared to average achieving students is supported by numerous past research and reviews addressing this topic (Tarver & Hallahan, 1974; Keogh & Margolis, 1976; Rosenthal & Allen, 1980). It should also, however, be noted that the association of attentional deficits with learning disabilities has not been universally consistent, and research exists where no such deficiencies were found (Samuels & Miller, 1985; Richey & McKinney, 1978). If attention can be viewed as one aspect of cognitive control, such discrepant findings can be handled within the biodevelopmental theory as a function of the situational context and the learner's perception of the environmental

demands. That is, a mature level of control (involving attention) may be utilized, given that it is within the repertroire of the learner, if the task demands are perceived as being conductive to its use. The importance of context and the student's perception of it have also been discussed by Jenkins (1979). Such an interpretation is the basis for intervention techniques which advocate the arrangement of the educational environment to foster the use of higher level thinking processes on behalf of the learner.

The cognitive control which is purported to be next along the maturational hierarchy, and thus, requiring more differentiated cognitive processes to complete it adequately, is the Leveling-Sharpening principle (Santostefano, 1978). The fact that no significant differences on this dimension as measured by the Leveling-Sharpening House Test, were discovered between the learning disabled and average achievers suggests that this instrument alone lacks the discriminating power to separate these two subject groups at approximately the 8 year level. As noted previously, however, the means indicate that the L.D.s did consistently perform at a more immature level on all the associated measures, but that the within group variance was large enough to prevent significant differences from being reached. Similar findings have been reported by Santostefano (1978), although his research with the LSHT did not consistently find non-significant differences; either across different ages or between "suspect" and "typical"

learners. Results from this study, on this dimension alone, however, do not appear to provide sufficient support for the theoretical framework being proposed.

Within the biodevelopmental paradigm, nevertheless, at least one explanation seems plausible. It is possible that the restriction in the age of the subjects included for this study(with the vast majority being 8-9 yrs.)may have been responsible in that the average achievers may not have as yet, developed adequate cognitive control functioning to distinguish them from the learning disabled on these higher level tasks. In other words, at this point in the cognitive development of 8-9 year-olds, significant differences between L.D.s and non-L.D.s do not exist because those learning difficulties have, for the time being, reached approximately the same level of cognitive functioning in their integration of memory images with approximately the same level of differentiation. This interpretation finds at least, partial support in the fact that Santostefano (1978) reported finding that development through these cognitive dimensions was not always steady and linear, but that slight regressions was sometimes observed. Yet, in a longitudinal context, progression appears [illegible] consistent.

The finding that the [illegible] cognitive control principle assessed, that of "equivalence range", did discriminate significantly between the two samples does not necessarily refute the explanation stated above. In fact, it may be somewhat deceiving unless one examines the individual

measures contributing to this significant difference. Of the 3 scores collected on the Object Sort Test, number of "typical" groups formed, mean "typical" score, and number of "atypical" groups formed, only the number of "atypical" groups formed was found to sufficiently distinguish the samples on an individual basis. As is evident from the data in tables 7 and 8, this variable accounts for almost all of the discriminating power of the cluster taken together. The fact that the learning disabled made significantly more such groupings implies that they tended to provide more out of the ordinary explanations as to why they decided to group certain objects together. Factors other than a significant delay on the "equivalence range" principle that may account for this could include a less adequate short term memory, for example. This implies that the learning disabled child may have forgotten his/her original reason for putting a group of objects together and so therefore, invented a reason when asked. This is plausible when one considers that no verbal reason as to why groups were formed was requested until after all had been arranged. Another possible contributing factor, particularly in view of earlier findings discussed, is that learning disabled students may be more distractible, thus, once again demonstrating a deficit in attentional abilities. Therefore, rather than attending to the appropriate task demands and recalling what object similarities caused them to place the things together, the L.D. child may have become distracted by the

objects themselves, and consequently made up a story involving some or all of those objects. This is considered possible, particularly in view of the fact that such narratives characterized the vast majority of "atypical" scores.

The fact that little, if any differences were observed in the mean typical score (the level of abstraction verbalized) or in the number of such groups formed is consistent with the lack of significant difference observed on the LSHT. Given the resticted ages of the subjects involved, the finding that few significant differences were present to distinguish the two samples in terms of both of the higher level cognitive control principles appears consistent with the interpretation stated previously. That is, the average achievers may simply have not developed sufficiently to demonstrate functioning that is much superior to that of the learning disabled on these tasks. Thus, perhaps, 8-9 year-olds in general, have not reached a level of abstraction necessary to complete the tasks with anything but lower, more global cognitive control mechanisms.

Support for this line of reasoning can be found with a closer examination of Santostefano's data (1978) which indicates that children younger than 10-11 years demonstrated less significant differences between "suspects" and "typicals" on these last two bipolar dimensions in the hierarchy than the first two. This is also consistent with the

approximate age suggested for the onset of the developmental stage coined by Piaget as "Formal Operations" (Ginsburg & Opper, 1969) that involves more of these higher level abstract thinking skills. As there is no known research to date, however, examining the cognitive control performance on these specific measures used in this study with children older than 11 years, it is difficult to make conclusive statements in terms of this interpretation with much degree of certainty.

Learning Style Inventory:

Results from this investigation found the L.S.I. to be of least value in terms of finding differences with 8 year-olds considered to be learning disabled and those who are average achievers. The fact that no significant differences were found between subject samples on either the 22 elements when analyzed together, or any of the smaller groupings is in contrast to Wild's(1978) reported findings in which several significant differences were found to exist between L.D. and non-L.D. subjects at the Junior High level.

Reasons for these conflicting results may stem from the different ages assessed in the two studies. In view of the previous research reported by Dunn (1983) asserting that children 8 years old are capable of identifying their own learning style, there are at least two explanations available to interpret these present findings. Assuming that the L.S.I. is as valid and reliable an instrument as professed

by Dunn(1981), this lack of difference may be interpreted as indicating that 8-9 year-olds, whether they have learning problems or not, tend to have similar learning style preferences. In terms of a developmental perspective, children in this young age range may all manifest less mature learning styles as being characteristic of the way that they learn best. An earlier study (Price, Dunn & Sanders, 1981) had found, however, that good and poor readers at the grade 3 level showed significant learning style differences and, thus, lends some limited evidence to refute this interpretation.

Alternatively, this lack of difference may indicate that young learning disabled students are simply not capable of identifying their own learning style on a self-report measure. Although Price et al.(1981) found poor readers within a regular classroom apparently capable of this task, the L.D. subjects in this study were such that they could not function in a regular classroom optimally, and were in special "learning centre" classrooms. The fact that these subjects represented more severe learning problems may be associated with an inablitiy to know how they learn best. This latter interpretation is substantiated by research from the meta-cognitive area demonstrating that L.D.s have less awareness of the learning strategies that they use (Torgesen, 1979; Swanson, 1983; Rose et al., 1983).

In terms of the developmental framework proposed, it is possible that this meta-strategy/style knowledge is related

to a more mature level of cognitive processing. This may also be associated with the learning disabled not attending adequately to their own styles and strategies. Therefore, it appears that L.D.s may be functioning at a level that is lower on the developmental scale than that recommended by Dunn for completing the L.S.I.. Perin (1982) has reported successfully extending the L.S.I. for use with younger children with an adapted version entitled the L.S.I:Primary. Perhaps, the use of this version of the L.S.I. may be of greater value with young learning disabled subjects, but this remains to be demonstrated with future research.

The Study of Childrens Learning Styles:

Of the three learning style areas examined, the SCLS was found to hold the most discriminating power in differentiating the learning disabled from the average achievers. The fact that this was found with subjects who were 2-3 years older than those on which this instrument had originally been normed is an important finding for two reasons. First of all, in terms of the developmental theoretical framework, L.D.s may be viewed as possessing a learning style (behavioural learning patterns) that has been found to be typical of younger students experiencing learning difficulties. Thus, the "developmental lag" theory of learning disabilities is supported. Secondly, this finding offers some basis for the extension of this checklist for use with slightly older subjects.

The fact that the learning disabled were found to be less attentive as observed by the classroom teacher is consistent with previous research (Bryan & Wheeler, 1972; Bryan, 1974). Similar to the mixed results on laboratory tasks of attention, however, there have also been a limited number of studies which report no attention differences between these groups in the classroom (Gambrell et al., 1981; Samuels & Miller, 1985). Finding L.D.s in this study to have poorly developed attentional styles on both cognitive tasks assessing attention related dimensions (as indicated by their scores on the SST and FDT) and also in terms of teacher observed behaviour, lends validity to both instruments. These findings, however, are in direct contrast to those reported by Samuels and Miller (1985) where L.D.s were found to exhibit no difference in their attention compared to normals, on either a laboratory vigilence task or in terms of classroom behaviour. In light of the fact that both Samuels & Miller and this current study used similar subject selection criteria and were careful to use the same sample for both the laboratory task and the classroom observation, it is difficult to ascertain specific reasons for such discrepant findings. The major difference in these two studies appears to be the specific assessment instruments used. Thus, if it is possible to make comparisons across different samples, it would seem that the instruments employed in each study are assessing different characteristics, or perhaps, certain task demands inherent

to the tests may cause the learning disabled subjects to perform at a higher maturational level (cognitive and behavioural) than other task demands. While conflicting evidence such as these prevents one from making generalizations about the L.D.s attention in general, the evidence which does exist concerning the cognitive controls assessed in this study is in agreement. Similar to that found by Santostefano (1978) using the same laboratory tasks, differences indicative of a developmental lag in terms of focal attention and field articulation were evident in learning disabled students compared to average achievers, and this was further substantiated by teacher observational reports.

It is important, however, for researchers in the field not to prematurely interpret such reported attention delays as being the cause of learning disabilities. Doehring et al.(1981) makes this point in the following statement:

> "The notion that reading disability in general is *caused* by deficiencies in visual attention, perception, or memory has been abandoned."(p.)

With this caution in mind, conflicting results concerning attention deficits in the learning disabled are more easily interpreted in view of the specific task and environmental demands perceived by the subject. Such an interpretation can be incorporated within the biodevelopmental framework proposed for this research.

Furthermore, the finding that L.D.s also appear more "Avoidant" of learning tasks and are observed to approach them in more unconventional ways (Overly Independent) which were similar to findings of younger children that were found to experience learning difficulty (McDermott & Beitman, 1984) adds further credence to the "developmental lag" theory of learning disabilities or at least, the appearance of a delay in terms of their observable behaviours.

In summary, the interpretations put forth in this chapter have been based on the propositions contained in the biodevelopmental theoretical framework. Therefore, despite the fact that several of the hypotheses are not confirmed by the present data, this paradigm was found to be sufficiently substantive to account for such findings. However, such interpretations are only postulated as being possible within this framework and are dependent on future research to either prove or disprove their explanatory power. A theory which has a scope so vast that it is non-falsifiable is of little value. Therefore, it is imperative that future research systematically test the explanations proposed here, as it is necessary for research to either refute or support those propositions outlined before it can be viewed as bearing any practical significance.

B. Suggestions for Future Research:

In light of the fact that this study represents an initial attempt to compare several learning style instruments from a relatively novel theoretical perspective, there are several areas in which future research is needed.

First of all, in terms of the limitations of this study, future research addressing the performance of students on these instruments across several different ages would be of value. A major assumption of this current research concerned the interpretation of learning disableds' lower performance on the learning style instruments as being indicative of a developmental delay in style or at least, the appearance of such immature styles. While sufficient research exists to justify this assumption within the area of cognitive controls, more research needs to be conducted to confirm the differences as a function of age on other learning style instruments so that there is data on which to adequately compare the learning disableds' performance. Therefore, research designed to assess a wide range of ages on these measures must be conducted to ascertain if L.D.s do, in fact, approach tasks with a style that resembles that of younger students. The optimal research design, given that learning styles are aimed at assessing individual differences, would be longitudinal. In this way, the same individuals might be assessed on a variety of learning style measures across several years, and changes could be attributed with a reasonable degree of confidence to

cognitive development rather than individual subject differences. While Santostefano (1978) reports results of such studies with his battery of cognitive controls, a lack of research exists with children beyond the age of 10, particularly with other learning style instruments being administered as well.

In the interest of testing the theoretical explanation of the results put forth in this study, the following specific research questions need to be addressed in the future:

a) Do learning disabled subjects older than those used in this study show significant delays compared to average achievers on the last two cognitive control principles included in the hierarchy: leveling-sharpening and equivalence range?

b) Are young (8-9 years) disabled subjects capable of identifying their own learning style on the L.S.I.?

With the current popularity of learning style assessments and subsequent intervention techniques, there is abundant opportunity and necessity for more integrative research in general, on this topic. It is crucial that more comparative research be conducted examining how different learning style instruments relate to one another. These studies should be conducted from a theoretical base that can be applied to the diversity that exists within the learning styles network. The biodevelopmental framework has been suggested in this study as having potential in this regard,

and these results have provided some limited support for its use in the future. However, additional research is required on many of the basic tenets subsumed by this perspective as it could benefit from additional refinement to be most valuable to the study of learning styles.

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APPENDIX 1

COGNITIVE CONTROLS: ADMINISTRATION INSTRUCTIONS

SCATTERED SCANNING TEST:

1. Motor Tempo Test (training form)

"Do you see all these shapes? Take your pencil and make a mark on each shape like this."

(E marks the circle at the top with a short vertical line.)

"You do the same thing. Take your pencil and mark that (triangle at top). Now mark all these with your pencil. Start here (child's left) mark them in your regular way, not slow and not fast but in your regular way. When you finish this row, go on the the next. Don't skip any."

(E inconspicuously times the child)

2. Circles and Crosses Practice Form:

"Do you see this sheet of paper? It has alot of shapes on it. See, here is a square, a circle, a triangle, a cross, and 2 lines. Look all around this sheet of paper and put a mark on all the circles and crosses you can find like this."

(E marks a circle and cross in the center of the practice page)

"Now, you do the same thing; go ahead, look all round the page and mark all the circles and crosses you find."

(If S marks the 4 remaining target shapes, administer the test trial ...if not, administer the training trial again.)

3. Test Trial (Form #1)

"Now here's another page with alot of the same shapes on it. Let's do the same thing again, but this time, I want you to look for circles and crosses and mark them as fast as you can. Do you understand? Be sure to look all over the page and go as fast as you can. See how many you can find until I say 'Stop'. Ready? Go ahead."

(E times for 30 seconds...at the same time, E records the sequence of S's markings. If S completes in less than 30 seconds, administer Form #2)

"That's fine, you finished before the time was up. Let's try that again to see how many you can find when there are more shapes on a bigger sheet of paper. When I say 'go ahead' mark circles and crosses as fast as you can until I say 'Stop'. Ready? Go ahead."

(Allow 30 seconds. E records the sequence of markings. If this is too difficult, E should mark the first shape marked and draw oines which follow the general course of the child's markings. Be sure to note the last shapes marked...fill in with the child's protocol.)

THE FRUIT DISTRACTION TEST

1. Place practice card#1 before the child.

"Do you see this? (point to the first colour bar) what colour is this? Good, go ahead and name all the other colours for me."

(If not named correctly, attempt to teach the child)

"Now,start here (left) and name the colours as fast as you can until you reach her (right). I want you to name the colours as fast as you can. Ready? Go."

(E records the time in seconds)

"Now I am going to give you a big card with many rows of the same colours. I want you to name the colours as fast as you can."

(E presents Card #1)"See, start here (point) and name the colours as fast as you can. When you finish the top row, go on to the next row, (E passes finger across form child's left to right) until you reach here (bottom). Try not to skip any and try to go as fast as you can. Do you understand? Ready. Begin."

(E starts stopwatch and follows the child's colour naming with the test protocol. E records reading errors and reading time for each row read.)

2. Place Practice Card #2 before the child.

"Do you see this fruit? What is this (S responds) that's right. And this?

(Child names colours of all the fruits followed by E reinforcing the correct responses.)

"For this par of the game, the apples are coloured red, the bananas are coloured yellow, the grapes...Now I want you to start over here (point to fruit on far left). Name the colours one after another until you reach here. Go ahead and name the colours as fast as you can. Ready? Go."

(If child performs correctly...)

"Now I am goinq to give you a big card with many rows of the same fruit and I want you to ay out loud the colours of the fruit as fast as you can."

(Present Card #2, review directions of where to start and finish)

"Try not to skip any and try to go as fast as you can. Do you understand? Ready Go."

(E begins the stopwatch, and follows the colour nameing and records reading errors and total time taken to read the card)

3. "Now I am going to give you another card that has the same fruit on it and the same colours. But, on this card are alot of little pictures of other things all around the fruit. I want you to name the colours for me again as fast as you can, starting at the top and going to the bottom just like you did with the last card. You should try not to pay attention to those little pictures that are on the card. Look only at the colours. If you pay attention to those little pictures, they will slow you down. You will not be able to read the colours as fast

as you can. Do you understand?(E presents Card #3) Begin here (points) ready? Go."
(E records reading errors and time taken. The child may have to be reminded to pay attention only to the colours.)
(E removes card) "I know I asked you to name the colours and to try not to pay attention to the pictures, but sometimes people notice the pictures around the fruit while they were naming colours. Did you happen to notice any of the pictures?"
(After the child gives the first recall, he is encouraged only once) "Can you remember any others?" (E records the child's recall of figures)
4. Present Parctice Card #3
"Now the next part of this game is a little different. Do you see...the fruits are coloured wrong. The apple is coloured blue. What colour should it be?(child responds) And what colour should the grapes be? (continue for each fruit)
"Now start here and name the colours that should be there as fast as you can. I want you to name the colours as fast as you can that should be there. Ready? Go."(When child performs correctly, proceed as follows)
"Now I am going to give you a big card with many rows of the same fruit but all the colours are wrong. I want you to name the colours that should be there, as fast as you can."
(Present Card #4)
"See, start here and name the colours that should be there as fast as you can. Keep naming colours until you reach here. Try not to skip any, and try to go as fast as you can. Do you understand? Ready? Begin."
(E begins the stopwatch, recording reading errors and time taken)

THE LEVELING-SHARPENING HOUSE TEST

(Cards should be stacked face down on a desk top with the card #1 at the top and Card #6 at the bottom...same with the test cards)
Training Phase:
(Hold up Card #1) "Do you see this picture of a Xmas tree? I want you to look it over for a little while so that you can remember as much as you can about it. Then I will take it away and show you another picture of the same tree. When I take this picture away, I want you to look at the next picture of the tree and tell me if the picture looks the same or whether anything has changed. Do you understand?"
(If S is not atending, encourage him/her to do so. After these instructions, continue displaying Card#1 for 5 seconds...turn card #1 face down so that card #2 is displayed. Whenever the child reports a change, ask him to describe it... correct any misperceptions by reshowing

the previous card during this training phase as follows:)
"Look at this first picture again. Try to remeber all of the picture. (replace with next card) Now look at this picture again. Is this picture the same as the first or has it changed?" (Reinforce correct responses. If S still reports a change, let him/her compare the 2 cards side by side. Continue with the other practice cards. If S makes a mistake, follow the previous procedure for correcting him.)
"Do you understand? With this game I show you one picture at a time for a little while and I want you to look at each picture as hard as you can so you can remember what is in the picture and so you can tell me if you see something change in the picture."
(For children who show considerable difficulty understanding the task, readminister the practice cards)
Testing Phase:
(Position the deck of test cards) "Now we will play the game using this picture. (Raise Card #1 for 3 to 4 seconds...then place face down.)
"I am going to show you alot of these pictures. I'll show you these pictures one at a time, for just a little while. You look at the card as carefully as you can, as long as it is up in front of you. After you see the first picture, if any other pictures look different or something looks like it changed, you say "Stop". Then, tell me and show me what has changed. If the picture looks the same, you don't have to say anything. Just look it over. Remember, sometimes they will look the same and sometimes they will look different. O.K.? Ready?
(E raises the deck so that card #1 is displayed again...5 seconds per card)
(If S does not say "Stop" during the first 15 cards, say:) "Look at each picture carefully and say "Stop" if the picture looks different."
(If S reports the same change twice:) "That's right, those (whatever) are not there. You already told me that. You need to tell me only once about any change you see. Tell me when you notice something else change or look different."
(If S still continues reporting this, repeat above directions only once more.)

OBJECT SORT TEST II

(E places the 46 objects before the child)
"Do you see all these different things (points) spread over the table? Put together the ones you think belong together. Take some things you think belong together and put them here. (Point to the table available for the groupings) Then take some other things you think belong together and put them here. (Pointing) and then some

other things. You can have as many groups as you like, and you can have a few or alot of things in a group. If you think something belongs by itself for some reason, you can put that over here too. Try to find a place for all the things. But if you don't use some things because they don't belong in a group, that's OK too."
(E answers any questions about the task and repeats any directions necessary. If S does not respond for several minutes, E says:) "Take some of those things that you think belong together and put them over here.(pointing)"
(If S asks what a paricular object is, E replies by asking the child to describe what he thinks the object is or could be and the name the child assigns the object is accepted.)
(As the child constructs groups, record the names of objects placed in a group and the order placed there. E also make observational notes about the conceptual groupings and the child's thinking processes. ie.relocation of objects.
INQUIRY:
(When the child indicates that he/she has finished the groupings:)
"That's fine. Now, let's take this group.(pointing to the first group the child constructed) Tell me how do these things belong together. Why did you put them together?"
(With similar questions, E attempts to obtain from the child a label defining some relationship among the objects. Begin with the first group, then, inquire about the other groups in the order in which the child formed them.)