8103953

PASS, RAYMOND

THE EFFECTS OF VERBAL JUSTIFICATION OF ANSWERS, AND A NONVERBAL ATTENTION FOCUSSING TECHNIQUE ON RAVEN COLOURED PROGRESSIVE MATRICES PERFORMANCE IN MILDLY LANGUAGE DISORDERED AND NORMAL CHILDREN

City University of New York PH.D. 1980

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106

PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark ✓.

1. Glossy photographs ________
2. Colored illustrations ________
3. Photographs with dark background ________
4. Illustrations are poor copy ________
5. Print shows through as there is text on both sides of page ________
6. Indistinct, broken or small print on several pages ✓
7. Tightly bound copy with print lost in spine ________
8. Computer printout pages with indistinct print ________
9. Page(s) ________ lacking when material received, and not available from school or author
10. Page(s) ________ seem to be missing in numbering only as text follows
11. Poor carbon copy ________
12. Not original copy, several pages with blurred type ________
13. Appendix pages are poor copy ________
14. Original copy with light type ________
15. Curling and wrinkled pages ________
16. Other ________________________________

THE EFFECTS OF VERBAL JUSTIFICATION OF ANSWERS, AND A NONVERBAL ATTENTION FOCUSSING TECHNIQUE ON RAVEN COLOURED PROGRESSIVE MATRICES PERFORMANCE IN MILDLY LANGUAGE DISORDERED AND NORMAL CHILDREN

by

RAYMOND PASS

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1980

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

9/30/80 ________ date

Steven Mattis, Ph.D. ________ Dr. Steven Mattis

Chairman of Examining Committee

Sept. 30. 1980 ________ date

Martin L. Hoffman ________ Professor Martin Hoffman

Executive Officer

Dr. Steven Mattis

____

Dr. Louis Gerstman

____

Dr. Jeffrey Rosen

____

Supervisory Committee

The City University of New York

Abstract

THE EFFECTS OF VERBAL JUSTIFICATION OF ANSWERS, AND A NONVERBAL ATTENTION FOCUSSING TECHNIQUE ON RAVEN COLOURED PROGRESSIVE MATRICES PERFORMANCE IN MILDLY LANGUAGE DISORDERED AND NORMAL CHILDREN

by

Raymond Pass

Advisor: Dr. Steven Mattis

There are two main research areas which provide background for the present study. The Raven Progressive Matrices tests have come to be widely used in diagnostic clinical neuropsychological examinations as a measure of visual-spatial perception. They have also been frequently used in research applications with various clinical and normal populations. There have been statements in the literature implicating a verbal as well as a visual-spatial perceptual

loading on the tests in terms of internal verbal mediation useful (some say necessary) in the solution of the matrix problems. It has been demonstrated that adult aphasic patients perform worse on the tests than non-aphasic left brain damaged patients. Another area of research germane to the present study is that of developmental patterns of verbal mediation, and mediational deficits in children. Two competing models are the "mediational deficiency hypothesis" which states that there is a period in human cognitive development in which verbal mediation does not aid problem solving, whether spontaneously supplied or artificially stimulated, and the "production deficiency hypothesis" which states that young children don't use verbal mediation because they don't produce it (but can make use of it if shown how to produce it). The present study used mildly language disordered, and normal, children to study both the nature of the language disorder in terms of a "competence/performance" dichotomy, and also the role of verbal mediation in solving the Coloured Progressive Matrices (CPM). Two groups of children (language disordered = ld, control; n = 60/group), controlled for nonverbal visual-spatial ability, were administered the CPM twice. The first administration was per standard instructions for all children. For the second admnistration, each group was split into three subgroups. One subgroup received a second standard CPM ("standard"); one subgroup was asked to verbally justify their answers for each item ("verbal"); one subgroup had its attention to each problem focussed by a passive nonverbal method. Results were as follows: a) The ld children scored significantly lower than the control children on Raven1. b) Within the ld group, those in the "verbal" condition scored significantly greater RDELTA scores (Raven2 - Raven1) than those in either the "standard" or the "focus" conditions, who in turn did not score differently from each other. c) Within the control group, those in the "standard" condition scored significantly lower than those in either the "verbal" or the "focus" conditions, who in turn did not score differently from each other. d) There were no differences in RDELTA scores between groups in the "standard" or "verbal" condition, however the control group scored significantly greater than the ld group in the "focus" condition. Interpretation of these results, and also of the scatter among the three scales of the test (A, Ab, B) yields the following conclusions: a) There is a verbal component to the CPM. b) The deficit in mildly language disordered children such as those in the present sudy is multifactored; there is a "performance" as well as a "competence" component. Language mediated performance can be increased by external stimulation, but there is a limit as to the level of possible improvement in performance. c) There is an additional component to the deficit present in these children besides the observed language disorder. The ld children were matched to the controls on Block Design and Object Assembly (active tasks), but scored significantly lower on the CPM. In addition, they could not make use of a passive nonverbal attention focussing technique, but increased performance when they had to actively deliver verbal justifications for answers. This suggests a deficit in ongoing internal cognitive organization, which is also of a "performance" nature".

Acknowledgements

I am indebted to a number of people for their help and support throughout various stages of this endeavor. First of all I wish to publicly thank, as I have already done so privately, all the children who took part in this study, along with their teachers and principals. The teachers were always cordial and tolerant of my many interruptions to their classrooms, the principals always ready to help with introductions, schedules, arrangements for testing rooms, etc., and the students always willing to cooperate. I sincerely hope that the few questions I have tried to answer will eventually help in the continuous search for methods of improving the education we provide for our children.

I am indebted to Ernesto Delamercede, Jim Bober, and especially to Avi Rubinsztejn, for their help in introducing me to Wylbur, and helping me to master this valuable asset. The many necessary hours spent in the Lehman College Computer Center were made easier and more enjoyable by the constant help and advice given so freely and generously by these people. The fact that I was not a student, faculty or staff member of Lehman College, made absolutely no difference whatsoever. Help given in this manner is the most helpful.

I am truly indebted to my dissertation committee and wish to thank each member individually. Dr. Louis Gerstman was there for me at the beginning and the end, and all the way through. My very first hour of instruction in this graduate program was in Lou's class in Language and Thought. Later, I taught courses with Lou, and worked with him at N.Y.U. He has always been extremely supportive of my efforts, and I am proud to finally answer to the title with which he has encouragingly addressed me for years: colleague.

I truly thank Dr. Jeffrey Rosen for making me go back to the library, when I thought I was through. It was well worth every single long hour, and my understanding of what I have found has been substantially magnified by it. I have learned more of the meaning of scientific scholarship through Jeff's demands that I continuously challenge my conclusions.

Dr. Richard Kovner has been a friend and co-worker for a number of years. He has always had confidence in me, and afforded me the pleasure and honor of listening to my suggestions concerning his own ongoing research and publications. I have found my relationship with Richard to be professionally stimulating and personally gratifying. I look forward to continuing to collaborate with him for many years, both professionally and personally.

Dr. Ellen Rossky has been my direct supervisor at the Center for Child Development for three years. She is also my friend. Ellen has been totally supportive of my attempt to hold down a full time position, and finish my graduate training at the same time. She is quite knowledgeable and understanding, and is truly a lovely lady. I have many times found myself saying "thank you" to Ellen after a minute of advice, or two hours of intense discussion. I value these times, and intend for them to continue, and for our friendship to continue to grow.

Dr. Steven Mattis has been my mentor and teacher ever since I learned that the brain has two sides, in his introductory course in neuropsychology. I have learned from Steve from being in his classroom, from working in his office, from being supervised by him, from being criticized by him, from observing him clinically interacting with patients, and from long sessions discussing our work, and my progress. I have always respected and emulated Steve tremendously, and the mere fact that I now have three more letters after my name, does nothing to lessen these feelings. I feel Steve is the complete psychologist as well as neuropsychologist, professional as well as person, teacher as well as co-worker. Steve is a warm and mature person who can be sober and serious when necessary, as well as sensitive and supportive when needed. He has been my teacher, supervisor, collaborator, and friend. This will continue!

Over the years it has taken me to accomplish this feat, there has been one person, than two people, and now three, who have continuously stood by me with their love and genuine support. Many were the nights when Erica and Dory would ask, "Is Daddy coming home tonight?" only to be told, no, he has to go to the library, or the computer center, again. Until recently, weekends were family time, but these were also sacrificed at times. It was worth all the hours however to be greeted the morning after my oral defense by two beaming faces declaring in unison, with genuine happiness, "Good Morning, Dr. Pass!" That's joy. Erica and Dory are truly beautiful children, and I am so thankful to be able to love, and be loved, by them.

Last on this list, but first in my heart, and the person I owe the most gratitude and thanks to, is my wife Wendy. Nine years ago, I decided to change my career. While others thought I was crazy, Wendy understood and supported me. We have always helped and supported each other. I left a full time, good paying job as an engineer to become a student again. Wendy continued to work and support us both. It took a long time, but she saw me through it. Along the way, she proved to be a marvelous mother as well as a wonderful wife. She rarely complained when I told her, "No, I've got to go back to the library again." She was always there to help me when she could, and gave me her complete faith and trust. Wendy, thank you for sharing my life with me.

Table of Contents

List of Tables

List of Figures

List of Appendices

Introduction

Origin and Development of the Present Study

The Raven Progressive Matrices (RPM) tests in their various forms have come to be widely used as an integral part of a diagnostic clinical neuropsychological examination (Lezak, 1976). They are also a frequently used research tool in investigating various cognitive processes in clinical as well as normal populations (Court, Note 1). After becoming familiar with the administration of the RPM tests and the interpretations of results, it became my contention that the standard administration and scoring procedures did not yield all the important diagnostic and descriptive information that the tests were potentially capable of offering. When used diagnostically, the appropriate version of the test is generally administered as a unit and a final performance score is taken as the total number of items answered correctly. This is then usually related to a percentile score showing the relative position of all possible scores based on previously determined normative distributions (Raven, Court, & Raven, 1976). Proposed refinements on scoring techniques have included looking at the distribution of total numbers of correct items on the various scales of the tests (Cassel, 1949; Knehr, 1956; Raven, 1960, 1965b), examining positional preferences in answer choices (Bromley, 1953; Colombo, De Renzi, & Faglioni, 1976; Costa, Vaughan, Horwitz & Ritter, 1969; Maher, 1960; Miller & Raven, 1939), scatter analysis (Dils, 1960), analysis of wrong answers (Costello, 1959; Jacobs & Vandeventer, 1970), and consistency of failure measures (Urmer, Morris & Wendland, 1960). Many item analyses have been carried out in terms of difficulty of items (Burke, 1958; Jordan & Bennett, 1957; Keir, 1949; Vernon, 1950; Wetherick, 1966; Yates, 1961). It seemed to me however that a totally different type of measuring technique was necessary if the tests were to be fully exploited as a valuable tool in acquiring a qualitative description of various aspects of normal perceptual-cognitive processes as well as defective functioning brought about as a result of brain-damage.

The method I proposed was an item analysis based not on the final answer for each item, but rather on the cognitive processes engaged in by the subject in arriving at that final answer. This form of data has been informally gathered in various studies (Bromley, 1953; Cassell, 1949; Zaidel & Sperry, 1973) by having subjects explain the reasons for their answers, but a systematized method for its elucidation and analysis has not been developed. I then devised a prototype for such a descriptive analysis of the RPM (presented in Appendix A). I was advised that the proposed project was meaningful in its goals, but quite "grandiose" in its design (Costa, Note 2). I therefore decided that some preliminary investigations were in order.

At that point I was routinely engaged in carrying out diagnostic neuropsychological evaluations of children referred for learning difficulties. Part of the test battery employed was the Coloured Progressive Matrices

(CPM). As the test was being used psychometrically, it was necessary to administer it in the standard fashion to yield a total number correct score to relate to published normative age values. I therefore decided to readminister it during the second examination session, usually about one week after the first visit. During the second administration, the children were asked to verbalize their reasons for choosing each answer directly after responding to each item. If they could not generate an answer, they were probed and cued with questions as necessary. After administering the second CPM to 13 children, and examining the elicited answers, it became obvious that the verbalizations themselves were not rich in useful descriptive material. These children were later diagnosed after a full testing battery as being either Mildly Retarded, or mildly language disorded. The language impairment was usually a combination of dsynomia and defective verbal comprehension. Although the collected material was not that useful in terms of the original proposal, it became apparent that another, unexpected phenomena was present. The children's scores on the second administration were higher as a group than those of the first administration. This was borne out statistically; $t(12) = 4.78$, $p < .001$. There seemed to be two alternative explanations. Either the increase was due to a practice effect wherein the children learned how to do the task during the first testing and then used this learning to perform more proficiently on the second administration, or there was something inherent in the elicitations of verbalized justifications of answers on the second administration method which helped them to achieve the higher scores. The practice effect alternative was then tested by having another group of nine subjects take the test twice (also with about one week between test sessions), but using standard test procedures in both testings. No reasons for chosen answers were asked for, and no verbalizations were produced. This second group of subjects did not increase its score; $\underline{t}(8) = 1.44$, $p = .188$. Therefore the improved CPM performance seemed to be due to the externally imposed structure of requiring verbal justifications of answers. Although the two groups were not controlled for age, intellectual ability, diagnostic classification, etc., the observed phenomena and data became the impetus for the eventual design of the present study. The Raven CPM would be used as a prototype to investigate verbal mediation in the solution of ostensibly nonverbal perceptual tasks.

Description of the RPM

The RPM tests as used today are in three forms: (a) Standard Progressive Matrices (SPM), (b) Coloured Progressive Matrices (CPM), and (c) Advanced Progressive Matrices (APM). All three are made up of visual pattern completion problems. The problems are identical throughout in general format. Each one is presented on a separate page of a test booklet and consists of two parts: (a) a major stimulus pattern at the top of the page with a missing part (blank space) located at the lower right hand corner of the pattern (indented in from the right side and up from the bottom of the pattern), and (b) a display of either six or eight choice answers, only one of which correctly completes the major pattern, located below the major stimulus in two rows of either three or four choices. Each test is made up of a number of Scales, or Sets. The Standard Progressive Matrices consists of Scales A, B, C, D, and E, each printed in black and white. The Coloured Progressive Matrices consists of Scales A, Ab, and B (A and B are identical in form to A and B of the SPM), each printed in bright colors except for five of the last seven items of Scale B. The Advanced Progressive Matrices consists of Sets I and II, each printed in black and white. Scales A, Ab, B, C, D, and E, and Set I, each consist of 12 matrix problems. Set II consists of 36 matrix problems. Scales A, Ab, and B each have have six answer choices; the rest of the Scales, and both Sets, have eight answer choices each. Within each Scale or Set, the problems were constructed so as to be progressively more difficult to solve.

Publication History of the RPM

The full collection of Raven's Progressive Matrices Tests was developed over a span of 26 years. The first version of the Standard Progressive Matrices was published in 1938 (see Raven, 1965b). This version consisted of Scales

A, B, C, D, and E. It was originally designed for subjects of all ages and, "intended to cover the whole range of intellectual development from the time a child is able to grasp the idea of finding a missing part to complete a pattern" (Raven,1960, p. 1). Adult norms for this version were collected and published in 1941 (Raven, 1941), and extended norms, including children's norms, were published in 1947 (see Raven, 1960). The test was slightly revised in 1956 (Raven, 1956b) in two ways: (a) rearrangement of items, "to give a more uniform probit distribution" (Raven, 1960, p. 2), and (b) rearrangement of answers choices, "to give a more uniform distribution of common and uncommon errors of judgement" (Raven,1960, p. 2). This 1956 version of the test is the one published and used today (Raven, 1956b). In 1976, all the guides and manuals for the various RPM tests, as well as two vocabulary tests developed by Raven, were revised and published together in one combined manual (Raven, et al., 1976). The SPM section of this manual includes additional norms for children (Byrt & Gill, 1973), and for adults (Heron & Chown, 1967), as well as "Amended Norms" (Orme, 1966) for both children and adults based on fitting the partial percentile norms Raven provided to a normal distribution.

Although the SPM was designed to cover "the whole range of intellectual development from infancy to maturity" (Raven, 1965b, p. 6), it was later felt that for children between the ages of five and eleven, and for persons with any sort of impaired mental ability, a wider dispersion of scores was necessary to more accurately measure ability. In 1947, an additional Scale, Ab, was developed which was supposed to be "intermediary in difficulty between problems 5 and 12 of Set A, and problems 1 and 7 of Set B" (Raven, 1965b, p. 6). The Coloured Progressive Matrices, consisting of colored versions of Scales A, Ab, and B, was first published in 1949 (see Raven 1956a, 1965b). It was revised and published with extended norms in 1951 (see Raven, 1965b), and again revised in 1956 (Raven, 1956a). This 1956 version of the test is the one in use today. The CPM was also designed for elderly subjects and clinical populations, including but not limited to the mentally impaired. In 1958 (see Raven, 1965b), norms for elderly subjects were published by Raven, and these were improved in 1960 (see Raven, 1965b). The 1976 version of the Raven Manual (Raven et al., 1976) also includes "Amended Norms" for the CPM as developed by Orme (1966) for children (ages 5 1/2 - 11, extrapolated 3 1/2 - 5) and elderly subjects (ages 65 - 85, extrapolated 90 - 100), as well as for "Subnormals 40-80 I.Q." (p. CPM33 [sic]) (ages 20 - 60, extrapolated 6 - 12 1/2 and 65 - 80).

After publication in 1938 of the SPM, and its acceptance primarily in Great Britain, a need was seen for a further matrix test to more quickly classify subjects into " 'dull', 'average', or 'bright' " intellectual categories (Raven, 1965a, p. 1). In addition, a test to measure above average intellectual capacity was needed. In 1943 the Advanced Progressive Matrices was originally drafted for use with the British War Office Selection Boards (Raven, 1965a). In 1947 this test was revised for general use (see Raven, 1962, 1965a), and it was again revised in 1962 (Raven, 1962). Norms were then published for subjects between the ages of 11 1/2 and 40. This version of the test, and the accompanying norms, is in use today. No new norms are provided in the 1976 RPM manual (Raven et al., 1976).

In addition to those norms provided in the various manuals produced for the RPM, there have been many studies conducted with normal subjects of different ages, educational levels, geographic and cultural classifications, as well as with various clinical-pathological populations including those with cognitive deficits, physical defects, psychiatric disturbances, etc. A list of 53 such normative studies can be found in the 1976 RPM manual (Raven et al., 1976, p. R49 [sic]).

Definition of Abilities Measured by the RPM

In 1936 (Penrose & Raven, 1936), Raven developed the first version of the various Progressive Matrices tests. These were refined and published in 1938 as the Progressive Matrices. It was described by Raven as "a test of observation and clear thinking" (1960, p. 2). It was developed and seen as "a series of perceptual tests designed to measure eductive ability over as wide a range of mental capacity as possible" (Raven, 1939, p. 16). Raven meant to develop a test that would measure the creative, productive aspects of cognitive ability As opposed to the reproductive aspects. He desired a test which depended totally on a person's ability to observe, perceive, think, create, and respond clearly and immediately, with no dependence on the store of past acquired information. It was only this specific immediate, creative (eductive) aspect of intelligence that Raven wished to measure. He said of the test, "By itself, it is not a test of 'general intelligence' and it is always a mistake to describe it as such" (1960, p. 2). To achieve such a measure of "general intelligence", Raven felt it necessary to also measure a person's ability to "recall acquired information" (1960, p. 1) in addition to eductive ability. For this task, he stated it was necessary to administer a vocabulary test in addition to the matrices (1965b). It is noteworthy that at this early stage in the development of the matrices, Raven saw fit to distinguish the "perceptual tests" (1939) from a "verbal" vocabulary test. His avowed distinction was one of productive versus reproductive ability, but he was implicitly also making a distinction between "perceptual" and "verbal" ability, and therefore also implicitly making the state?ent that his matrices, as he conceived of and developed them, were basically nonverbal in nature. He described the matrices as "a test of a person's capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figure completing each system of relations presented, and, by so doing, develop a systematic method of reasoning" (1960, p. 1). Implicit in this description is an "inductive" method of solution to the problems. The subject decides what is missing based on the information present and a deciphering of the overall relational patterns between the pieces present. By doing this, the entire pattern is then conceived of, the missing part described, and then located as one of the multiple choice answers. An alternative "trial and error" method of solution that Raven did not consider, or at least did not describe, is for the subject to mentally insert each of the possible answers into the stimulus pattern until a satisfactory completion of the pattern was arrived at. This method would not seem to call for the creative processes that Raven described.

Raven took a limited look at "verbal" ability. He seemed to not construe as significant the contribution of immediate ongoing verbal processing in solving the matrix problems. He recognized only that verbal component of "general intelligence" which displayed reception, storage, and recognition ability of verbal information as exemplified by a person's total acquired recognition vocabulary. There is also however an immediate creative (eductive) aspect of a person's lexicon, as displayed in active "working" vocabulary. In everyday discourse, people generally don't use the full complement of words known to them. Studies have shown that multiple-choice recognition type tasks generally yield greater measures of vocabulary than open-ended recall probes (Farley, 1969; Heim & Watts, 1967). A person's competence in terms of potential for verbal ability is rarely matched by actual performance. It can therefore be assumed that the different types of tests are measuring different aspects of verbal ability, one being the amount of verbal knowledge acquired and stored in the past, and the other being the amount available for immediate use. Raven never talked about the contribution of immediate ongoing verbal processing in the solution of the matrix problems.

The question of what abilities the RPM do indeed measure has been a subject for much past and present continuing research. There have been numerous validity studies using correlational and factor analytical methods with subjects of various populations (Bingham, Burke & Murray, 1966; Burke, 1958, 1972; Burke & Bingham, 1969; Court, Note 1; Raven et al., 1976). Demographic dimensions studied have been age, educational level, cognitive ability (intelligence), personality styles, classification and degree of psychiatric disorder, physical disorders including various static and progressive cerebral pathologies, socioeconomic description, race, sex, geographic and geopolitical description, profession, learning aptitudes, etc. Some authors have addressed the question of whether or not the RPM are a measure of general intelligence. Many concurred in describing them as pure measures of Spearman's _g_ (Spearman, 1946; Spearman & Jones, 1950; Vernon, 1947;

Vernon & Parry, 1949; Vincent, 1947). Jastak (1949), concerned with problems inherent in interpreting scatter among psychometric results, wrote, "Eysenck, for example, uses the Raven Matrix test as a measure of intelligence because it is supposed to be a test of pure 'g' " (p. 181). He then criticized this interpretation, stating, "The reviewer suspects that the Raven Matrix test measures several important group factors in addition to the general factor. To find that the Matrix test is a relatively pure test of 'g' must surely be due to faulty experimental design" (Jastak, 1949, p. 181). Numerous factor analytical studies have generally portrayed the various RPM tests as being multifactored (Court, Note 1; Raven et al., 1976). Burke, in a series of validity studies, and reviews of validity studies (Bingham et al., 1966; Burke, 1958, 1972; Burke, & Bingham, 1969) maintained that the tests are valid measures of general intelligence.

The RPM are used today primarily in two applications. They are used clinically, either individually or as a component in an integrated multi-test diagnostic neuropsychological battery, to assess levels of visual perceptual skills and visuospatial reasoning ability, and to provide a nonverbal measure of general intelligence (Lezak, 1976). They are used in research with a variety of assessment intentions, and as such are described differently by different investigators. They have been described as "intelligence tests" (Arrigoni & De Renzi, 1964; De Renzi &

Faglioni, 1965; De Renzi, Pieczuro & Vignolo, 1968), "nonverbal intelligence tests" (Edwards, Ellams & Thompson, 1976; Kertesz, & McCabe, 1975), "spatial intelligence tests" (Colonna & Faglioni, 1966; Gainotti, Caltagirone & Miceli, 1976), "perceptual tests" (Piercy & Smyth, 1962), "tests of visual spatial organization" (Costa & Vaughan, 1962), "tests of visual spatial neglect" (Costa, Vaughan & Horwitz, 1965; Costa, Vaughan, Horwitz & Ritter, 1969), and "tests of reasoning with visual material" (Archibald, Wepman & Jones, 1967). They have also been repeatedly recognized as valid indicators of cerebral pathology when used in studies comparing clinical populations to non brain-damaged controls (Costa & Vaughan, 1962; Costa, Vaughan, Horwitz & Ritter, 1969; De Renzi & Faglioni, 1965; Dils, 1960; Evans & Marmorstan, 1964; Knehr, 1956, 1965; Urmer, Morris & Wendland, 1960). Some investigators did not concern themselves with cerebral laterality of damage, while in others this was a major focus of the study.

Studies of Lateralized Cerebral Damage with the RPM

In 1864, Paul Broca caused no small amount of excitement when he presented the anatomical autopsy report on one of his patients, and in referring to the left cerebral hemispheric damage, concluded that, "In this patient, therefore, the aphemia was the result of a profound, but accurately circumscribed lesion of the posterior third of the second and third frontal convolutions" (Broca, 1864, as cited in Head, 1926). The generally recognized notion that the two cerebral hemispheres of the human brain differ in terms of the various higher cognitive functions that they subserve, has grown in acceptance over the years since Broca. The early discussions, arguments, confrontations, etc., surrounding the vast differences of opinion between the "localizationists" and "diagram-makers" on the one hand, and the "equipotentialists" on the other (Head, 1926), has led to the modern day synthesizers and discussants of the "systems" approach to human cerebral function (Luria, 1966; Das, Kirby & Jarman, 1975). The primary supposed functional distinction between the left and right cerebral hemispheres remains that of verbal verses nonverbal representation of ability (Dimond & Beaumont, 1974; Gazzaniga, 1970; Hecaen & Albert, 1978). Other descriptive dimensions of cognitive organization have been suggested as cogent discriminating functions of cerebral responsibility (e.g. Bever, 1975; Das et al., 1975; Semmes, 1968) and the whole notion of lateralization of higher cortical functions in general is not totally free from critique (Whitaker & Ojemann, 1977). The verbal/nonverbal dichotomy however retains the most widespread support in various degrees of described separation and overlap of function.

The RPM tests in their various forms have been used in many studies of lateralized cerebral damage in adults with varying results. Arrigoni and De Renzi (1964) found overall that patients with left brain-damage (LBD) performed at a significantly poorer level on the SPM than patients with right brain-damage (RBD). A series of other studies (Costa, 1976; Costa, Vaughan, Horwitz & Ritter, 1969; Gainotti, Caltagirone & Miceli, 1976; Piercy & Smyth, 1963) found the opposite results, namely that performance on the RPM (the first author used the SPM, the others used the CPM) was more susceptible to RBD than LBD. Yet another series of studies (Costa & Vaughan, 1962; De Renzi & Faglioni, 1966; De Renzi, Pieczuro & Vignolo, 1968; Edwards, Ellams & Thompson, 1976) found that although on the whole, RPM performance was affected by brain-damage in general as compared to normals, there were no significant differences between RBD and LBD patients. Basso, De Renzi, Faglioni, Scotti, and Spinnler (1973) also found these results, but expanded upon them; RBD patients with an associated visual field defect were significantly more impaired on the CPM than RBD patients without this defect, and LBD patients with accompanying aphasia were significantly inferior to nonaphasic LBD patients. Explanations have been put forth as to qualitatively and quantitatively different performances of RBD and LBD patients in terms of underlying skills necessary for the solution of the task, which are assumed in deficit secondary to the cortical damage. While Colonna and Faglioni (1966) found that hemispheric side of lesion was not significantly related to RPM performance, they, like Basso et al. (1973), also found that among LBD patients alone, those with resultant aphasia did worse on the test than those who were not aphasic. They explained these findings by postulating that, "while left brain-damaged patients fail on account of aphasia, right brain-damaged patients do so on account of spatial visual impairment" (p. 305). Costa and Vaughan, in an earlier study (1962), found that performance on a reduced modified version of the SPM correlated differentially with tests presumed to measure different cognitive functions, depending on the cortical hemispheric site of damage. In the LBD group, SPM scores correlated highly (.72) only with scores on a vocabulary test, while in the RBD group, SPM performance correlated highly only with measures of visual spatial relations (Knox Cubes, .71; Block Design, .77).

The above findings indicate that there is a verbal component as well as a nonverbal component inherent in the solution of RPM problems. Additional studies lend support to this idea. In a study using the CPM as a nonverbal measure of intelligence to investigate the relationships between intelligence and aphasia, Kertesz and McCabe (1975) found that RPM performance did not correlate with overall severity of aphasia, but that defective matrix problem scores were correlated with internal comprehension (verbal mediation) deficits. Dominant hemisphere damaged patients who were "expressively" aphasic, (categorized in this study as having Broca's, Conduction, or Anomic Aphasia) scored higher than patients with "receptive" aphasic disorders (classified in this study as having Global, Wernicke's, or

Transcortical Sensory Aphasia). The authors observed that auditory verbal comprehension was not necessary for the task, since normals were able to do it with no verbal instructions whatsoever. This therefore led the authors to identify the deficit responsible for the poor performance in their aphasic patients as being one of defective internal verbal organization. Archibald, Wepman, and Jones (1968) also found that the CPM differentiated "talking" aphasics from "non-talking" (global) aphasics, although they felt that on a whole, the test did not separate LBD aphasic patients from LBD nonaphasic patients. Zangwill (1964) stated that performance on RPM was not grossly impaired in motor aphasia, jargon aphasia, and amnestic aphasia. A series of studies by De Renzi and co-authors (Arrigoni & De Renzi, 1964; De Renzi & Faglioni, 1964; De Renzi, Pieczuro & Vignolo, 1968) all concluded that low SPM scores can not be attributed to language disorders because LBD patients with aphasia did not perform significantly differently from LBD patients without aphasia. There are thus conflicting results in studies utilizing clinical populations of unilaterally brain damaged adults.

It is not uncommon for different investigators, using the same general classifications of clinical patients, and the same assessment techniques, to obtain results which are at odds with one another on the surface. Costa (Costa & Vaughan, 1962; Costa et al., 1969) has dealt with this issue regarding research with unilaterally brain damaged adults.

He notes that using unselected hospital samples of patients may result in the inclusion of more seriously disordered right hemisphere damaged patients than those with left hemisphere damage. This is because of the nature of the resulting behavioral changes secondary to the cerebral damage. Language disorders come to clinical attention more readily than non-dominant hemisphere disorders, and therefore hospital populations may have less severely damaged LBD patients than those with RBD (Arrigoni & De Renzi, 1964). Whether or not the overall severity of CNS damage is taken into account, will have a direct bearing on experimental results based on behavioral measures. Patient groups may also be selected on the bases of performance on one behavioral measure, and then tested on a second. For example, many of the above quoted studies dealt primarily with constructional apraxia, while others dealt primarily with aphasic disturbances. Patient populations were therefore split along different dimensional guidelines in different studies. In addition, procedures for administration of test items was not identical in all the above quoted studies. There is also the everpresent factor of chance occurrences in the presence of probabilistic statistical analyses. Unless two studies are conducted with the same methods, and the same groups of subjects, by the same experimenters, reasons for differing results can usually be hypothesized.

One further study important to the issue of differential cerebral performance on Raven matrix problems was carried out using commissurotomy patients in which each hemisphere was separately administered a modified version of the CPM (Zaidel & Sperry, 1973). This method differed in one manner of major importance from the above mentioned studies. In one part of the study, four patients who were "relatively free of extracommissural damage and sensory defects" (p. 36) were used. Here performance was being measured by presumedly intact hemispheres working in isolation, and not by one intact hemisphere in conjunction with one damaged hemisphere. There were thus no chances for interference from damaged to intact sides. The results were that there were better (not significant) performances by the right hemisphere overall. There were also however, qualitative differences in lateralized solution performances. The left hemisphere (right hand) worked slowly with much accompanying verbalized labelling and reasoning. The right hemisphere (left hand) in contrast worked quickly, silently, and confidently. In terms of the RPM, the authors conclude that:

> The present findings indicate that the test is not highly specialized for either right or left hemisphere function, ...but can be performed by either, though in different ways. Many aspects of the Progressive Matrices can easily be processed verbally without involving gestalt-like spatial apprehension. Design features like cardinality of lines or dots, and size and

> degree of angularity can be categorized, labelled or conceptualized linguistically. (p. 38)

They go on to say, "It would appear accordingly that the RCPM is not eminently suited for measuring functional differences between the hemispheres" (p. 38). Kertesz and McCabe (1975) agree that, "both a comprehension related as well as a 'visuo-spatial' factor is required" (p. 394) in the solution of CPM items, but they go on to speak to the necessity of both components: "It is likely that integration of function of both hemispheres takes place in solving the problems of the RCPM" (p. 394). The patients in the Zaidel and Sperry study could obviously not use an integrated hemisphere approach. The two findings can however be easily reconciled by stating that the two hemispheres primarily use different methods for solving the problems, but work in an integrated synergistic fashion when transcortical paths are intact.

The Verbalization Hypothesis

Some of the above mentioned studies yield support to what has been labelled the "Verbalization Hypothesis" (Raven et al., 1976, p. SPM22 [sic]). This refers to the notion that nonverbal tests of general intelligence, such as RPM, which require no external reception or comprehension of verbal material other than initial instructions, and no expressive language in the solutions of the problems or the delivery of answers, can use covert internal verbal mediational processes in the solution of the tasks. Research findings noting high verbal loading of the matrices (e.g. Bingham et al., 1966) support this hypothesis. Burke and Bingham (1969, p. 251) stated, "The investigators have noted that some subjects, especially on the more difficult items, appeared to 'talk their way' through the Progressive Matrices: that is they seemed to explain to themselves verbally what the relationships were." The investigators referred to an actual audible, though self-addressed, verbal accompaniment to the solution of the problems.

Luria (1960a, 1960b) has presented a developmental theory on the role of speech in the regulation of behavior. His theory posits that external commands, requests, instructions, etc., given to a child by an adult have a "directing" function on the child's behavior. Eventually the child begins to emit overt verbalizations which serve to direct its motoric behavior. As the child matures, these overt verbalizations become covert, and develop into thinking. When confronted with a difficult problem however, the child who normally uses only covert directions may resort to overt verbalizations as an aid in problem solving. It is possible that the observance of Burke and Bingham (1969) noted above is related to Luria's theory. The external verbalizations of the adults noted on the more difficult items may be an extension of an existing, internal verbalization present in the solution of the easier items. The increased difficulty of the later items may demand an additional, less sophisticated but more powerful, level of verbal mediation, which is executed by audible speech.

The conclusions of Zaidel and Sperry (1973) that there are parallel methods of solution which are qualitatively quite dissimilar, and are differentially used by the functionally distinguished cerebral hemispheres, is quite consonant with statements by other researchers (e.g. Colonna & Faglioni, 1966), to the effect that reasons for failure on the matrices by unilaterally brain-damaged patients are dependent upon which aspect of cerebral function is in deficit. Both conclusions support the idea that some nonverbal tasks can be, and indeed typically are solved with the aid of verbal mediation.

Researchers have differed in the importance they place on the participation of verbal mediational processes. Some suggest that the solution of a nonverbal performance task is merely "aided by implicit verbalization" (Edwards, Ellams & Thompson, 1976, p. 84), while others theorize that it is an absolute necessity. Jensen (1968) stated that:

> Successful performance on intelligence tests, especially so-called nonverbal tests, requires spontaneous verbalization on the part of the subject. The subject who does not verbalize spontaneously is even more severely handicapped in a nonverbal test such as Raven's Progressive Matrices than on a predominantly verbal intelligence test such as the Stanford-Binet, which explicitly calls for verbal responses from the subject. (p. 138)

This somewhat extreme position seems to declare that verbal processes are a necessary foundation for all cognitive tasks, whether explicitly called for and inherent in the mode of response of a verbal task, or implicitly demanded in an adequate solution of a "nonverbal" problem.

The question of the relationship between language, thinking, and cognitive problem solving is an oft-debated and researched one. Early theorists (e.g. Watson, 1913) felt that thought was identical to inner speech and actually accompanied by tiny motor movements in the larynx. Although such minute movements do exist (Cromer, 1976), the notion of the thought-inner speech identity has been effectively argued against by experimental and theoretical proofs. Smith, Brown, Toman, and Goodman (1947), using curare for its muscle paralyzing properties, in a carefully administered study using the senior author as the subject, demonstrated that clear lucid thoughts, and comprehension and recall, were totally unaffected by the inability to speak. Vygotsky (1962) reasoned that although a mental image can only be verbally described in a necessary sequential manner, as all speech is delivered, it is internally realized as an integrated whole. He said, "A thought may be compared to a cloud shedding a shower of words". Thus, thought and speech do not seem to be identical. Others have argued that thought is also possible without language, or at least without verbal symbols (words). Slobin refers to the writings of William James (1892, as cited in Slobin, 1971) in describing the "unpleasant phenomena of groping for a word, or trying to find the best way to express yourself" (Slobin, 1971, p. 100). James felt that the intention of saying a word, indeed knowing that the word is known to you and usually being able to immediately recognize the word if supplied by another person, is a prime example of a nonlinguistic thought. Slobin also presents the examples given by Ghiselin (1955) of the pre-verbal stage of new ideas which take shape in the minds of great creative innovators such as Albert Einstein. Slobin concludes by stating that although thought clearly cannot be equated with either speech or language, "language must play an important role in some cognitive processes" (1971, p. 102).

Bourne, Ekstrand, and Dominowski (1971), in discussing the relationship between language, thinking, perception, and cognitive problem solving, refer to four experiments which yielded research findings germinal to the explication and support of the hypothesis that thought and language are almost ineluctably integrated. These are only a small sample of the vast amount of research and theorizing undertaken to elaborate this relationship. A study conducted by Ranken (1963) investigated the relationship between different types of stimuli encoding (verbal or imaginal), and subsequent performance tasks. One group of subjects learned a series of geometric "nonsense" shapes with accompanying animal names, and another group learned the same shapes in an "Unnamed" condition. Subsequent tasks required half the subjects to solve, "in their heads, a 'mental jigsaw puzzle' composed of the shapes" (Ranken, 1963, p. 49), and the other half to recall a serial order of shapes presented only once. There was a resultant interaction between learning condition and test task. The "Named" group made fewer errors on the serial recall task than the "Unnamed" group, with the opposite results being obtained on the spatial puzzle task. Ranken's interpretation was that, "the interaction reflects a difference in the properties of nominal and imaginal representation" (1963, p. 50). Bourne et al. expanded the meaning of the results: "language can either facilitate or inhibit thinking (problem solving) depending mainly on whether or not the language responses of the subject encode relevant or irrelevant aspects of an experience" (1971, p. 287). They conclude that, "We are probably so accustomed to verbalizing experience that we find it difficult not to make up names (or verbal descriptions) for the shapes, even though we are requested not to" (1971, p. 289). This is a strong statement supporting the notion that thought without language (or more precisely, without labels) is nearly, if not absolutely impossible. Verbal labelling also strongly affects perceptual encoding as demonstrated by Carmichael, Hogan, and Walter (1932) in a classic experiment in which ambiguous drawings were presented to different groups of subjects with alternate sets of plausible labels for the figures. The subjects later drew unambiguous reproductions which resembled the labels they were given. Another classic experiment (Glucksberg & Weisberg, 1966) demonstrated that problem solving is also strongly effected by the presence or lack of verbal labels accompanying drawings of stimuli to be used in the solution of a posed problem. Bourne et al. raise the question of whether the labels merely drew attention to each stimulus individually in its own right, or whether they actually caused the stimuli to be encoded differently then in an unlabelled condition. This distinction is an important one and will be addressed below in the description of the present research design and discussion of results. The last study noted by Bourne et al., (Brown & Lenneberg, 1954), dealt with the relationship between the "codability" (ease of labelling) of stimuli (color patches) and the ease of learning and recognition of such stimuli. There was a significant positive correlation between the two variables. The easier a color was to name, the easier it was to identify in a recognition memory paradigm.

A Model of Language Processing

In order to most efficiently present a description of language disorders in children, and then to specifically deal with the process investigated in this research study (verbal mediation), it is first necessary to briefly outline the process of normal language usage. Many modern theories of language processing employ a sequential model which incorporates sensory input processing, linguistic identification, lexical formulation and encoding, and physical construction of output (e.g. Nation & Aram, 1977;

Wiig & Semel, 1976). The Speech and Language Processing Model (SLPM) proposed by Nation and Aram (1977) is presented and described herein (Figure 1) as an example of sequential language processing models in general, and as a framework from which to describe basic types of verbal processing impairments observed in language disordered children.

The SLPM has three major components: 1) speech and language environmental component, 2) internal speech and language processing component, 3) speech and language product component. The first component is concerned with the language environment the developing child is situated in. Proper language development depends on adequate exposure to all forms of language units such as speech sounds, words, sentences, etc. It is also dependent on exposure to the normal use of language as a tool for communication. There are other environmental factors, which the authors state are not fully understood as such but nevertheless are felt to be important to normal language development. Examples of these factors are: family constellation, ethnic membership, birth order, etc.

The second major component of the SLPM, the "internal speech and language processing component", deals with internal processing of language by the operating organism (person). It is this segment that deals with all cognitive operations on language between the source of language input, and the product of language output. It is therefore also the location of internal verbal mediation. This "internal speech and language processing component" is basically sequential in nature. It begins with the reception of external acousto-mechanical stimuli (variations in air pressure impinging on the ear drum) and the transduction of such stimuli into electroneural impulses through the inner ear apparatus of the cochlea (hair cells of the organ of Corti). The patterns of the "prelinguistic" stimuli are then analyzed and discriminantly identified as language or nonlanguage in nature. The processes described thus far compose the "auditory reception segment" of the "internal speech and language processing component" of the SLPM. Stimuli identified as "linguistic" are then processed for meaning (comprehension). This involves identification of individual morphemes (words), as well as abstraction of meaning inherent in relationsips between words (meaning of the "gestalt" of a phrase or sentence over and above the meanings of the individual component words). The subprocess which is reciprocal and parallel to "comprehension" is "formulation". These two make up the "central language segment" of the "internal speech and language processing component" of the SLPM. Formulation refers to the linguistic encoding of outgoing messages. This requires lexical selection of labels and internal preparation of outgoing messages (relational structure of words in sentences to imply meaning beyond that of individual words). The SLPM posits a reciprocating relationship between "comprehension" and "formulation". It invokes the notion of

Geschwind (1968) that outgoing messages to be encoded are prepared with the aid of the "heard names" of the words to be expressed. The SLPM also makes reference to the motor theory of speech perception (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). The idea of dynamic, intrastimulating, oscillatory processes is thus inherent in the SLPM. The final part of the "internal speech and language processing component" of the SLPM is the "speech production segment". This is where the internally formulated message is transformed into an audible, integrated output. "The speaker initiates, transmits, coordinates, and produces the motor activities necessary for speech production" (Nation & Aram, 1977, p. 77).

The third and last major component of the SLPM is the "speech and language product component". This refers to the actual output of the language-using organism. It has two parts: the "language product", and the "speech product". These final products are the only portions of the entire SLPM which are produced by the organism and can be externally observed and evaluated. Various qualities of the speech (tone, resonance, etc.) as well as of the language (semantic aspects, syntax, etc.) can be examined.

The inner-most portion of the SLPM is the "comprehension - formulation" aspect of the "central language segment" of the "internal speech and language processing component". It is here that language exists not only as the internal representation of active external communication, but also as the medium for internal nondirect language processing (verbal mediation). This would be accomplished through continuous internal interactions between "comprehension" (extraction of meaning) and "formulation" (specifically, lexical selection - labelling).

Language Disorders in Children

The main dichotomizing classification used in the present study was that of language disordered/non language disordered. The language disordered group of children were all also learning disabled, and were either recommended for, or actually attending public school classes for children with learning disabilities. There have been many statements in the recent literature (e.g. Denckla & Rudel, 1976a; Vellutino, 1978) to the effect that learning disabilities (specifically dyslexia) are mainly secondary to language disorders, and not to perceptual impairments as was stated in some of the earlier writings on this issue (e.g. Bender, 1956, 1957, 1975; Hermann, 1959, as cited in Vellutino, 1978; Orton, 1925, 1937). Vellutino (1978) feels that observed perceptual and intersensory defects are basically secondary to verbal mediation deficits. Classification studies such as those by Mattis, French, and Rapin (1975), or Denckla (1977), have shown that the majority of children in their populations of dyslexic students were suffering from one or another type of language disorder, sometimes in isolation (Mattis et al., 1975), or sometimes combined with other impairments (Denckla, 1977). There is thus emerging a strong position implicating language impairments as a major causal agent of learning problems.

There are many reasons for a child to fail to develop adequate language processes (Denckla, 1974, 1979; Rapin, 1977). If a child is deprived of adequate exposure to ongoing language in his environment, this will have a serious effect on language development (Rapin, 1977). This deprivation can be sensory in nature (various levels of hearing deficits) or it can be social. The hearing child who is secluded or otherwise isolated from human contact, and therefore from human communication, will also fail to properly develop normal language processes. The child who suffers from a serious emotional disorder might also fail to develop normal language processes because there may be a disordered need for human interaction. Diffuse cerebral dysfunction resulting in severe mental retardation will also lead to abnormal language development because of generalized cognitive deficits.

Disorders in language development or usage which are resultant from the above types of conditions are all secondary (indirect) in nature; they (the language impairments) are usually not the only result of the primary disorder, or deprivation, and possibly not even the most detracting from the overall well-being of the child. In the absence of these debilitating conditions, language should develop normally. The alternate situation is that in which there is adequate language exposure (both sensory and social), no severe diffuse cognitive dysfunction (mental retardation) or emotional impairments, and yet there still exists a language disorder. This type of specific language impairment can be the result of acquired localized brain damage, or it can be developmental in nature. Acquired aphasia refers to a loss of language ability, secondary to cerebral injury or disease, after normal language development has taken place. Insult to the very early developing cerebral hemisphere which would normally become dominant for language, will generally not result in a severe language impairment due to the plasticity of the developing neural apparatus, and the resultant transfer of some language function to the other hemisphere (Alajouanine & Lhermitte, 1965; Rapin, 1977). Acquired aphasia in older children is generally of a nonfluent type, and although useful conversational language usually returns quicker and to a greater degree than in aphasic adults, there are usually some lasting higher order verbal-cognitive deficits (Denckla, 1979).

Developmental language impairments in children are congenital, not acquired, and exist in the presence of normal sensory input processes, and adequate social exposure, and in the absence of severe diffuse cognitive dysfunction or emotional disorder. Denckla (1974, 1979) has studied these disorders as they relate to learning disabilities, and has provided a basic classification system. Her main categories are: "receptive disorders" (verbal auditory agnosia, central word deafness, central auditory imperception), "articulatory disorders", "audiophonetic disorders", and "expressive disorders" (anomic-repetition disorders). Children afflicted with the first category of impairment, the "receptive disorders" generally demonstrate the greatest deficit in terms of both depth and breadth of impairment. Although the primary problem is one of defective auditory comprehension, there are usually accompanying fluency-expressive and articulatory problems as well. Denckla (1974) states, "There are no fluently speaking, expressively intact 'receptive language disorders' in children, so the name is shorthand for the most global inclusive clinical picture" (p. 285). This clinical picture includes the basic comprehension deficit, possible hyperacusis, some degree of articulatory problem, sparse agrammatic speech, motor clumsiness, poor social relations, and more than the normal amount of wild tantrum behavior. The children usually concentrate better, and perform better, on nonverbal puzzles than on verbal tasks. They are usually not severely impaired on confrontation naming tasks. Severe cases of "receptively disordered children" are most appropriately served educationally in schools for the deaf (Denckla, 1974,1979).

The "articulatory disorders" refer to so-called "speech" impairments primarily. There is usually normal comprehension and naming ability, but expressive language is often marked by poor syntax. The main defect in these disorders is unintelligibility, or intelligible but severely defective speech. Speech sound production begins late in these children, and progresses abnormally slowly. Severe cases of "articulatory disorders" may never develop intelligible speech, and may have to resort to the use of nonverbal sign language techniques for communication.

Children with "audiophonetic disorders" can understand short phrases and commands, but cannot comprehend longer strings, or faster short phrases either. They seem to get "overloaded" and lose the meaning of the whole message, as well as that of individual parts. They may have articulatory problems also, but these are not as severe as those of the "articulatory disorder" children, and are also less severe than the expressive problems associated with the "receptive disorder" children. They may have mild naming deficits of a phonemic rather than a circumlocutory type, and these are not as severe as the last group discussed below. Repetition is usually below average, but is aided when the stimuli are held together by "semantic glue", such as in a Sentence Repetition task as opposed to a Digit Span, or list learning task.

The last category of developmental language problems presented are the "expressive disorders" or "anomic-repetition disorders". These children generally present with no articulation disorder, and comprehension is also usually within normal limits. Parents usually complain of a "poor memory" for names of objects in the face of normal to above normal memory for nonverbal information. Confrontation naming tests display the word finding deficits which usually take two forms. Names are often unavailable regardless of length of time spent in searching, and circumlocutions are often produced. The other manifestation of this anomic disorder is the reduced rate at which known names can be produced in a "rapid naming" paradigm (Denckla & Rudel, 1976b).

The language disorders described above can be related to the Nation and Aram SLPM. Disorders due to social deprivation place the deficit in the "speech and language environment component". Articulatory disorders are the result of impairment of the "speech production segment" of the "internal speech and language processing component". The anomic, audiophonetic, and receptive disorders, are all resultant from deficits in the "central language segment" of the "internal speech and language processing component" of the SLPM. As this is the part of the process wherein verbal mediation is most likely to be located, a defect in comprehension or formulation (naming) could result in defective verbal mediation. All children in the present study included in the language disordered group showed either a comprehension, repetition, or naming defect.

<u>Verbal Mediation and Mediation/Production Deficiencies</u>

A series of investigations have been undertaken over the last 30 to 40 years which studied mediating processes in problem solving behavior. One avenue of this ongoing research has concerned itself with an investigation of developmental patterns of verbal mediation in children. Various experimental paradigms have been utilized. Some of the early work (e.g. Alberts & Ehrenfruend, 1951; Kuenne, 1946) dealt with the phenomena of "transposition". A sample illustration of this paradigm is as outlined by Stevenson (1972). A child is given a simple two stimulus (large square and small square) discrimination problem and must learn through immediate feedback after each choice-trial which of the two stimuli is the "correct" one (in this example the larger one is correct). After this is learned, the child is presented with a new stimulus card, also containing two squares, the smaller of which is identical in size to the previously larger square. If the new larger square is now chosen as correct, the child is said to have "transposed". This means that the concept (verbal label) of "larger" was being utilized, and learned, as the correct stimulus value. Developmental patterns were observed in this research and a relationship seemed to exist between the level of verbal development, and the amount of "transposition" used.

Another paradigm used to study verbal mediation was the "intermediate size problem" (e.g. Spiker, Gerjuoy & Shepard, 1956; Stevenson & McBee, 1958; Reese, 1966). This situation is somewhat similar to the "transposition" problem in that there are alternate methods of learning the correct stimulus on an initial discrimination task. As before, selection of stimuli on succeeding problems can denote whether verbal (conceptual) mediation was involved in initial learning. For example, cards with three squares of different sizes on each one are presented to a child, who learns by direct feedback that the "middle size" square is the correct one (position of sizes is randomized over trials). The next task involves three circles, then three triangles, etc. If the child decreases the number of trials to criteria, over the different shape tasks, verbal mediation (choosing the "middle-size" one) is said to have taken place. Developmental patterns were also observed using this paradigm.

Another paradigm used to study the phenomena of verbal mediation in children was the "dimensional shift" problem. This paradigm will be described in greater detail as it led to a series of hypotheses about the nature of the deficit seen in developmental patterns of verbal mediation in children.

The "dimensional shift" studies used successive visual-perceptual discrimination tasks wherein the correct value of a relevant descriptive dimension is changed between successive sets of stimuli presentations. The stimuli differ in at least two descriptive dimensions. After a subject successfully learns to discriminate stimuli based on one dimension, a new set of trials takes place in which a change in the correct value of a descriptive dimension is made by the experimenter. This change can either be within the originally relevant dimension (reversal shift) or it can now identify a new relevant dimension and a value of this dimension as correct (nonreversal shift). For example, the subject is shown two cards alternatively, one containing a Large Black square and a Small White Square, and the second containing a Small Black square and a Large White square. Through a series of trials in which the subject chooses one figure and is told whether it is correct or not, the subject learns the correct value of the relevant dimension (e.g. color = correct dimension; Black = correct value). In the next part of the paradigm, the dimension can remain the same and the correct value changed (i.e. White is now correct), or a new dimension can become relevant and a correct value chosen by the experimenter (e.g. Small is now correct). The first example is an intradimensional (reversal) shift, and the second is an extradimensional (nonreversal) shift. The number of trials necessary to learn the different types of shifts is a measure of differential ease of learning each type.

It was found that rats learned the nonreversal shift easier than the reversal shift (Kelleher, 1956) and college students found the reversal shift easier to learn (Buss, 1953; Harrow & Friedman, 1958; Kendler & D'Amato, 1955). Two basic hypotheses resulted from these studies. First, it was assumed that there was a mediating response operating in reversal shifts, but not in nonreversal shifts, which was related to the relevant dimension of description; second, that this response was of a verbal nature. In referring to the internal mediation, Kendler (1964) stated, "Since this mechanism operates in adults and older children ... and not in infrahuman animals and younger children ... it seems reasonable to assume that mediating is related to some response system characteristic of the former but not the latter. Language is such a system" (p. 428). Numerous studies by this investigator and her colleagues, and by other sets of investigators, have shown these basic hypotheses to be valid.

The early animal studies and those with adults led to investigations of the developmental nature of this inferred verbal mediating mechanism. Two early studies found that children between three and four years of age used the nonmediating method predominately, as evidenced by less trials to learn the nonreversal shift than the reversal shift (Kendler, Kendler, & Wells, 1960), and children between the ages of five and seven were divided equally between mediators and nonmediators (Kendler & Kendler, 1959). When the older children (five to seven year olds) were separated into "slow learners" and "fast learners" based on the number of trials to learn the initial discrimination, there was a correlation between types of learners and types of strategy predominantly used. The more capable students used the mediating (reversal) strategy. They were said to be at a higher level of cognitive development.

An alternate experimental design was also used

(Kendler, Kendler & Learnard, 1962) which did not force the children to use a certain type of shift in a structured manner, but rather allowed for them to use whichever type of shift occurred naturally in their problem solving processes. An extension of the old design also allowed this choice to be reliably measured by the experimenter. There was a resultant linear increase by age in the amount of mediated processing used by children from three and one half to ten years of age.

Another line of this research was concerned with the effect of having the children supply upon request, through overt means, the verbal mediation that was assumed to be missing, or not operating spontaneously. Subjects of different ages were given the opportunity to verbally describe (label) their answers, as opposed to merely pull a lever, or otherwise nonverbally denote their choices on the various discrimination tasks. The youngest children studied (between three and four years old) were unable to use this overt mediation to improve their performance on structured reversal tasks (Kendler, Kendler, & Wells, 1960), although they were able to label the various values of the descriptive dimensions of the stimuli. Kendler gave alternate hypotheses as to why these young children did not verbally mediate: "One is that, although they are capable of doing so, they nevertheless do not, in the ordinary course of events, make such responses. The other is that they do make some verbal responses, but these responses, for some reasons, do not serve as mediators" (1963, p. 42).

Seven year old children were also unaided by requested overt verbalizations, because, as hypothesized by Kendler and Kendler (1961), "at this age level children are likely spontaneously to supply relevant mediators and, therefore, need no help from the outside" (p. 1620).

Kindergarten age children however behaved differently than their younger and older counterparts. A study of these children was undertaken (Kendler, 1964) which resulted in a developmental model being put forth. This study allowed one group of kindergarteners to overtly describe their answers during the first training discrimination, while another group performed silently. They were then allowed to make either a reversal or a nonreversal shift. Results were that the verbalizing group learned the initial discrimination faster than the control group, and its members chose to make reversal shifts to a greater extent than the control group subjects. Kendler (1964) stated, "Apparently at this developmental stage overt verbalization has the same effect that the model ascribes to covert verbalization among more mature human Ss" (p. 434).

The three stage devopmental model presented by Kendler (1964) is as follows: In the first stage are children who do not use verbalization spontaneously, and cannot use overt verbalization to compensate. "The verbal labels as yet exert relatively little or no control over behavior" (Kendler, 1964, p. 434). In the second stage are those children who do not spontaneously use verbal mediation, but who can make use of it when they are instructed to overtly verbalize. "The child has learned to respond to the direction of others and transfers these associations to overt direction he gives himself" (Kendler, 1964, p. 435). In the final stage are children that supply their "own verbal representations of the external stimulation and these representations provide cues for overt behavior" (Kendler, 1964, p. 435).

The proposal that there was a stage in human cognitive development in which verbal responses could not serve as a mediator in guiding behavior was designated the "mediational deficiency hypothesis" (Reese, 1962). Maccoby (1964) questioned the nature of the deficiency. She asked if the children fail to use generated words (labels) as mediators, after having produced them at the appropriate time, or if they fail to produce verbal mediators at all in response to the external stimuli. Flavell, in a series of studies with other collaborators, strove to demonstrate that it was the latter case that was operating. He also stressed the importance of using methods which would actually allow for an observational quantitative analysis of the presence or absence of verbal mediation, and not to have to rely on inferential methods to postulate their existence or nonexistence.

The first of these studies laid the groundwork for the series. They all dealt with the development of mediation in memory tasks, and all investigated the nature of the "deficiency" in young children. Flavell, Beach, and Chinsky (1966) measured actual audible self-verbalization and also the amount of silent, though mouthed, "verbalizations" present during a 15 second delay period between presentation of stimuli and their later recall. One of the investigators trained himself to lip-read the the semi-covert verbalizations of the names of the items in the study. A subset of a number of pictures displayed before the subject was pointed to by the experimenter, and the subject had to recall and indicate them after the delay period. Although a later naming task showed that the younger children in the group (kindergarten age) did have the names available in their lexicon at all times, they evidenced a significantly smaller amount of verbalizations during the delay. They did not use them spontaneously for mediational (rehearsal) purposes. The authors present two possible reasons for the lack of verbal mediation in the younger group. It is possible, they said, that although the children used the labels, and the labelling process in general, in the communicative aspect of language, they were not "linguistically mature" enough to use internal covert labelling as a verbal mediational strategy. The alternative hypothesis was that the younger subjects were not as yet adequately developed in other cognitive areas. "An S who codes and rehearses is, first of all, responding to the task in an intellectually active fashion" (Flavell et al., 1966, p. 297). They are "not content" to simply use a "passive" method. Also, the "S is demonstrating a capacity for sustained attentional focussing in the absence of both perceptional and social (i.e. instructional) support for doing so" (Flavell et al., p. 297). Although this question was left for later studies, the authors felt the data they collected did not support the "mediation deficiency hypothesis", but rather made a case for the idea that the reason the children did not use verbal mediators was because they did not produce them. Therefore they proposed a new term: "production deficiency".

The next study (Keeny, Cannizzo, & Flavell, 1967) was designed to further investigate the "mediational" versus "production" deficiency question. The stimuli and procedures were the same as the Flavell et al. (1966) study. A group of verbalizing first graders, and a group of nonverbalizing first graders were identified, all being given the same recall task. The first result obtained was that those students who verbalized during the delay ("producers") did significantly better on the recall task than those students who did not verbalize ("nonproducers"). The "producers" were then split into two groups, and the recall task was readministered to all the subjects at a later time. One of the "producers" subgroups performed under identical conditions as the initial testing. The other "producers" subgroup, and the "nonproducers", were given training in whispering to themselves the names of the appropriate items (rehearsal) during the delay. The recall scores of the three groups were now statistically indistinguishable. Two important results emerged from this study. First, the "nonproducers" could be made to benefit from overt verbalizing. This was taken as further support for the "production deficiency hypothesis". Second, the performance of the "producers" subgroup that was given additional training in overt verbalizations, did not improve. These children were already using verbal mediation, and it could not be improved upon.

Corsini, Pick, and Flavell (1968) collected data which supported the notion that there is a "production deficit" for nonverbal mediation techniques as well as for verbal methods. Kindergarteners and first graders were given the opportunity to build paper models of wooden model stimuli in a recall paradigm. When models were built, they were used effectively to increase recall scores. There was no evidence of a "mediational deficiency", only of a failure to build mediating models at all, although this was not seen to a great extent.

The choice of using verbal or nonverbal mediators in memory tasks requiring recall of either spatial position of stimuli, or color of stimuli, was investigated by Daehler, Horowitz, Wynns, and Flavell (1969). Results were that verbal rehearsal was observed more in older subjects than in younger ones on the color recall task (production deficiency), but that it was equally as effective for those younger subjects who did spontaneously use it. Gestural (pointing) rehearsal techniques were equally common for all age groups, but were not particularly useful in aiding spatial position recall.

A final study in this series (Moely, Olson, Halwes, and Flavell, 1969) investigated higher order verbal-conceptual mediation in various age groups. Children were given training, at different levels of relevancy to the task, in categorical clustering of pictures of items in a delayed recall memory task. These different training techniques were compared to one another, and also to a no-training, spontaneous rehearsal group. There was a "production deficiency" observed in the control group along developmental lines. Younger children spontaneously grouped the pictures by categories to a lesser degree than older children. No "mediation deficiency" was observed. Recall scores of the younger improved as the relevancy of training, and therefore the effectiveness of the learned mediating techniques, increased. It was also noticed that the older groups did not derive as much help from the more relevant training techniques as the younger groups. There was less of a "production deficiency" in these older children, and there was therefore less nonpresent mediation to compensate for.

The above is a review of much of the work done in the 1960's specifically related to an identification, and description of the nature of the developmental deficiency in verbal mediation processes in children. This deficiency, or non-use, of verbal mediational processes by young children, was first thought to be of an "inability of use" nature, and that supposition was labeled the "mediational deficiency hypothesis" (Reese, 1962). It was felt that although young children were able to produce the material for verbal mediation, they were unable to use it for this purpose (Kendler et al., 1960). This hypothesis was based on an inferential interpretation of the data. The existence of the deficiency was accepted, but the nature of it was questioned (Maccoby, 1964). Later research (Flavell, 1970) demonstrated that the reason young children were not using verbal mediation, was that they were not producing it at times when it could be used. They were capable of producing, and appropriately using the mediation processes, but weren't doing so spontaneously. This was proposed as a normal developmental phenomena, and named the "production deficiency hypothesis" (Flavell et al., 1966). The research leading up to this proposal was based on quantifiable evidence, and yielded observational statements as opposed to an inferentially based proposition.

A recent, rather extensive treatise on the "instructional approach" to developmental research (Belmont & Butterfield, 1977) shows that the "production deficiency hypothesis" has been generally accepted as the nature of the early stage of mediational development. Belmont and Butterfield outline research conducted in the 1970's which has further expanded the knowledge of mediating processes in children and adults. The basic premise of the type of deficiency present in normal young children has not however been seriously challenged.

Rationales for Using Language Disordered Children in the Present Study

The impetus for the present study was a phenomena previously described in which a group of children referred for diagnostic evaluation of suspected learning disabilities improved their performance on the Raven CPM by supplying verbal justifications of their answers. A portion of these children were later diagnosed as having mild language disorders, and the intervention essential in creating the phenomea was directly language related. The children appeared to be using a verbal process (language) that they were later found to be deficient in, based on normative evaluation techniques, to aid them in solving a primarily nonverbal visual-perceptual task. This led to many possible questions: What is the nature of the deficit in mildly language disordered children? Is it one of "competence" or "performance"? What is the role of verbal mediation in solving the visual-perceptual problems of the CPM? Would normal (non language disordered) children also benefit from this verbal justification technique? What was the role of attention in the observed phenomena?

There are two main directions that the present research takes which are based on different rationales for study. One has to do with the nature of the deficit in verbal mediation in language disordered children, and the other with the contribution of verbal mediation to nonverbal problem solving processes.

Verbal mediation deficits. It has been suggested that normal young children who possess verbal labels in their lexicon, do not use them spontaneously as verbal mediating tools in perceptual discrimination tasks (Kendler, 1963), or verbal memory tasks (Flavell, 1970), but can use them efficiently if specifically instructed to do so. These children can also use higher order verbal-conceptual strategies as well, when they are identified to them as potential aids in problem solving situations (Moely et al., 1969). It has been suggested that this "production deficiency" is part of a normal developmental pattern in children (Flavell, 1970). The mediation studies generally point to a cutoff of around eight years as the age above which extra external mediation is not useful because there is already internal mediation in progress.

The "deficiency" studies quoted above identified verbal mediation as primarily concerned with labelling ability. Verbal mediation in the present study is being defined in a broader sense, encompassing internal comprehension (meaning), and formulation of labels. Children with deficits in one, or both, of these two subprocesses are viewed as having deficient internal verbal mediation. The area to be explored is the nature of this deficiency. If it is an absolute "competence" deficiency, then these language disordered children should not be able to make use of external verbalization aids, as normal young children can do. If the deficiency is one of "performance" (production), then the language disordered children should be able to use external structure to initially compensate for nonoperating internal mediation, and then to stimulate activation and continued use of this internal verbal process throughout the remainder of the task being undertaken.

Verbal mediation in nonverbal problem solving. Perhaps the major differentiation which distinguishes the field of adult clinical neuropsychology from pediatric clinical neuropsychology is the assumption made regarding an observed deficit. With adults, it can usually be logically assumed, and then checked by taking a history, that a process now observed to be in deficit was previously functioning normally. This can not be said of children. The alternate assumption is that the process has not as yet developed, or has developed abnormally.

It has been shown that within the population of brain damaged aphasic adults, those with more posterior left hemisphere lesions, resulting in receptive aphasias, are more deficient in solving Raven matrix problems than expressive or anomic aphasics with more anterior left cerebral involvement (Basso et al., 1973; Colonna & Faglioni, 1966; Kertesz & McCabe, 1975). Some studies (e.g. Costa & Vaughan, 1962) reported that although there was no difference in CPM performance between LBD and RBD patients, these patients as a whole scored significantly poorer on the matrix problems than non brain damaged adults. Keeping the above set of assumptions and observations in mind, it makes sense to investigate the relationship between an observed phenomena in aphasic adults, and a possible parallel deficit in language disordered children. As an initial attempt along this research line, the groups chosen for study differ along the lines of the main category only. Normal children are compared to language disordered children. Future study, specifically categorizing types of language disorder (e.g. expressive, receptive, anomic, etc.) in children is dependent upon results of the present study.

Experimental Design

The design of the study was dictated by various factors. Since the verbal processing component of nonverbal perceptual problem solving was being investigated, it was necessary to sample from two populations differing in verbal language ability, but not differing in visual-perceptual skills. The study was conducted with school-age children to investigate developmental mediation deficiency hypotheses. Two groups of children were therefore included in the study overall. One group was made up of children diagnosed as having a mild language disorder and then referred for a special educational setting on the basis of this diagnosis. The disorder had to be severe enough to be mainly responsible for an accompanying learning disability, but not severe enough as to warrant a recommended inclusion in an educational setting for children with moderate to severe language impairments. The language problems had to be of a sufficient intensity to be detectable upon psychometric testing, but not to a degree so as to render the outwardly nonverbal portion of such testing invalid due to an inability to follow test instructions. In addition, since the ability under investigation was to be limited to language processing, the children in the language disordered group had to display normal visual-perceptual skills as measured by nonverbal (Performance) intelligence. The second group of children studied were students displaying normal academic progress, with no complaint of language or learning disorder.

The serendipitous results of the unplanned pilot study described earlier led to the next dimension of the present research design. A possible explanation of the preliminary results was that those children who improved their CPM performance on the second testing did so as a result of their verbal justifications of answers. Those children receiving two standard test administrations did not significantly improve their performance. Although these results were not based on a controlled design in which important classifying variables such as age, diagnosis, intellectual ability, language ability, etc., were accounted for, the phenomena nevertheless seemed well worth studying. The increase in CPM score could have been the result of various factors.

Three main possibilities dictated the three conditions used in the present study. All subjects in the study received two administrations of the CPM (Raven1, Raven2) separated from each other by a reasonably long length of time (approximately one week) to control for short term memory familiarization effects. The first CPM administration (Raven1) was the same for all subjects; it was given as per instructions in the CPM manual (Raven, 1965b). Subjects were assigned to one of three conditions for the second CPM administration (Raven2). Those in the "standard" condition received two standard administrations. Those in the "verbal" condition were asked to supply verbal justifications for their Raven2 answers. A third "focus" condition was included in which each child's attention was focussed on each problem of the test in a nonverbal manner during the second CPM administration.

Attentional deficits in children variably diagnosed as hyperactive, minimally brain damaged (MBD), learning disabled, etc., have been well documented (Cantwell, 1975; Dykman, Ackerman, Clements, & Peters, 1971; Dykman, Peters, & McGrew, 1974; Gardner, 1979; Ross & Ross, 1976). Douglas (1975) specifies that it is the ability for "sustained attention" that is in deficit. Peters and colleagues (Peters, 1974; Peters, Davis, Goolsby, Clements, & Hicks, 1973) feel that MBD children can attend to "kinetic" stimuli better than to "static" stimuli. The deficit has been observed in visual as well as auditory tasks (Douglas, 1972, 1974; Sykes, Douglas, & Morgenstern, 1972) in which sustained attention to continuous repetitive vigilance tasks is necessary.

The "focus" condition was included in the design to help isolate the unique "verbal" component of the "verbal" condition. The required verbalizations may have also served to focus the subjects' attention on the task to a degree which was greater than that of the "standard" condition. A nonverbal method of attention focussing was therefore necessary.

Intercomparisons of the three conditions served to delineate any observed increases in performance between a practice effect alone, a simple focussing of attention effect, and lastly, a verbalization effect over and above practice and attention focussing.

One further dimension to the present experimental design was that of age. Equal numbers of children of four age levels (8,9,10,11) were used in each of the group-condition combinations. This provided the opportunity to investigate developmental patterns. Therefore, the final experimental design contained twelve cells; 2 groups (ld, control), by 3 conditions (standard, verbal, focus), by 4 agegroups (8, 9, 10, 11). This design is outlined in Figure 2.

Hypotheses

Several hypotheses were put forth as to the results of intergroup and intercondition comparisons. These predictions were based first on previous research concerning the "Verbalization Hypothesis" in relation to the RPM (Hypothesis I), secondly on documented developmental patterns (Hypothesis II), and finally, on observation and interpretation of the preliminary pilot data described above in relation to existing literature regarding verbal mediation/production deficiency hypotheses and attentional deficits in learning/language disordered children (Hypotheses III - VII).

Hypothesis I. Although the RPM tests were originally designed, and are primarily used as measures of nonverbal perceptual ability, there exists a body of research and theoretical statements which indicate a significant role played by verbal mediation in the solution of the problems ("Verbalization Hypothesis"). It has been stated that there are alternate verbal and nonverbal processing methods with which these solutions can de evolved (Zaidel & Sperry, 1973), but that the most efficient solution comes about as result of an integrated approach (Kertesz & McCabe, 1975). The two groups of children to be tested were to be of equivalent overall visual-perceptual skills, but of differential language ability. Based on findings that internal verbal mediation is important in perceptual encoding (Carmicheal et al., 1932), nonverbal learning (Brown & Lenneberg, 1954; Ranken, 1963), and problem solving (Glucksberg & Weisberg, 1966), and also on the conception that deficits in internal comprehension or formulation of labels could result in defective internal verbal mediation, it follows that defects in these internal language processes (comprehension, labelling) could result in inefficient (subnormal) nonverbal problem solving. It was therefore predicted that the language impaired group (defective internal verbal mediation skills) would not score as highly as the control group on the initial standard administration of the test, thus confirming the "Verbalization Hypothesis".

Hypothesis II. Performance on the CPM has been shown to follow developmental trends (Raven, 1965b). Perceptual development in children has also been well documented (e.g. Pick & Pick, 1970). As the children to be used in all groups were to be of normal visual-perceptual skills as assessed by age dependent measures (age corrected WISC-R Block Design and Object Assembly scaled scores), but of differential verbal ability, it was predicted that there would be linear age trends present for scores on the initial CPM administration in both the language disordered and the control groups, with the language disordered scores below control scores at each agegroup level.

Hypothesis III. Practice effects on psychological tests do exist to varying degrees (Cronbach, 1970). Experience would not be expected however to differentially effect one group over another (language disorder verses control). Therefore, in the "standard" condition, practice would be expected to benefit both groups equally, and no significant difference in increase of scores (Raven2 - Raven1) would be expected between groups.

Hypothesis IV. There is much evidence in the recent literature of an attentional deficit in MBD children. It has been shown that "hyperactive" children can be treated with beneficial results in terms of reducing excess motor activity, and increasing concentration and sustained attention, by means of biochemical stimulant therapy (Conners, 1974; Fish, 1975). A study by Rapoport, Buchsbaum, Zahn, Weingartner, Ludlow, and Mikkelsen (1978) showed that "normal" children (boys) could also increase attentional and concentrational performance through the use of biochemical stimulant administration. Thus, it has been shown that one mode of intervention (biochemical) could have similar results in both normal children and children whose deficit is felt by some to be basically of an attentional nature (Gardner, 1979). It was hypothesized that a behavioral intervention (nonverbal focussing of attention) would have a similar beneficial effect on the two groups being compared in the present study, and thus no significant differences in increase of scores would be expected between groups for the "focus" condition.

Hypothesis V. Based upon preliminary pilot results, a directional difference would be expected between groups on the "verbal" condition. This prediction is based on the assumed nature of the language disorder in the ld group.

The subjects in the pilot study did increase their CPM scores with the added verbalizations. This suggests that the impairment is one of "performance", not "competence". In terms of the history of the investigation of developmental mediation deficiencies, the language disordered children are assumed to have a "production deficiency" as opposed to an absolute "mediation deficiency". This means that basic language ability (competence) is present on an internal cognitive linguistic level, but is not being fully utilized (performance deficit). It is in a state of ready-reserve, present and available if called upon through extra-ordinary means, but not being used as a natural state of affairs. The questions and probing of the "verbal" condition would serve as an external stimulus. The response of the subject, the verbal justification, would be the external response. Listening to, and responding to the probes asked on the initial items of the test would require internal comprehension of questions and formulations of answers, dealing directly with the perceptual problem solving process just completed. This would then serve to fill in the verbal mediation missing in the initial problem solving process. After a certain number of items, the subjects would no longer need the external questions; they would be automatically self-supplied. The verbal answers would also be spontaneously generated. As a result of this, internal verbal mediation would now take place in relation to the problems being solved, as they were being solved. This is assumed not to have taken place on the original administration under standard conditions.

The control group of children are assumed to have all language processes intact, including internal comprehension and formulation subprocesses. It is therefore assumed that verbal mediational skills would also be intact. Since it is assumed that these children are already using internal verbal mediation in the solution of the problems, the external verbal structure would not serve to stimulate them further.

It was therefore predicted that in the "verbal" condition, the ld group would improve its performance from Raven1 to Raven2 to a greater degree than the control group.

Hypothesis VI. In the ld group, increases in CPM scores would be expected to follow a predicted hierarchy. Nonverbal focussing of attention ("focus" condition) would be expected to help increase performance over mere repetition of task ("standard" condition). The "verbal" condition would incorporate both repetition of task (practice) as well as attention focussing, in addition to stimulating dormant verbal mediation processes. It was therefore predicted that for children in the ld group, those in the "verbal" condition would show the greatest increase in CPM scores (Raven2 - Raven1), followed by those in the "focus" condition, with those in the "standard" condition showing the smallest increase.

Hypothesis VII. In the control group, the nonverbal attention focussing technique would be expected to aid performance more than mere repetition of task. The extra imposed structure of requesting justifications of answers would not however be expected to contribute more than just a verbal attention focussing aid. These children are assumed to be already using internal verbal mediation processes in solving the problems. It was therefore predicted that increases in CPM sores would not differ between "verbal" and "focus" conditions, but that increases in each of these two conditions would be greater than that of the "standard" condition.

Method

Subjects

Subjects used in this study were all school children between the ages of 8 years, 0 months and 11 years, 11 months at the time of testing. All children resided in the New York City Board of Education District 9 in the Bronx, New York City. This is a predominantly Black and Hispanic section of the Bronx, and the children used were all from these ethnic backgrounds. This community is also of predominantly lower socioeconomic status (SES) and the children were also predominantly from this SES group. No selection was made on the basis of race, color, nationality, or sex, with the exception that Spanish speaking children must also have been fluent in English and considered as English dominant by their school in order to take part in the study. All prospective subjects in the study were definitionally from one of two groups; those children diagnosed as experiencing a mild language disorder, and those children considered to be experiencing normal language development.

All children initially considered for inclusion in the control group (normal language ability) were students in one of four elementary schools in the Bronx, all in District 9. The children considered for inclusion in the ld group (language disordered) came from two sources. The first source was those children referred to the Center for Child Development (CCD, a muldidisciplinary evaluation clinic located in the South Bronx, New York City) for evaluation of possible learning difficulties, who were then diagnosed after a complete evaluation as having a mild language disorder and subsequently referred for special educational placement. The second source of children for this group was students already enrolled in HC-30 classes in three elementary schools in the Bronx, all in District 9 (three of the four schools from which the control subjects came). These classes are for children found to be learning disabled after evaluation by the New York City Board of Education, and/or by additional outside evaluation agencies such as the CCD.

Within each group, control and ld, 20 children were eventually placed in each of three experimental conditions: "standard", "verbal", "focus". Each 20 child experimental condition group was made up of four agegroups as follows: 8 years, 0 months to 8 years, 11 months; 9 years, 0 months to 9 years, 11 months; 10 years, 0 months to 10 years, 11 months; 11 years, 0 months to 11 years, 11 months. There were thus five children in each group-condition-agegroup combination for a total of 120 subjects in the study. This design is outlined in Figure 2. The actual age breakdowns of the various cells of the design are shown in Table 1.

All children initially considered for acceptance into the study were given letters to take home to their parents, and were requested to return written parental consent forms for participation in the study. Written consent was obtained from parents of CCD patients considered for acceptance into the study at time of CCD evaluation. Samples of letters and waivers are found in Appendix B. Permission to use students in the public schools was obtained from the Office of Educational Evaluation of the New York City Board of Education prior to my approaching the principal of each school (Appendix C). Further permission was then obtained from each principal, and each classroom teacher, before removing children from the classroom for testing. All subjects in the study were treated in accordance with ethical standards for experimental participation of human subjects as established by the American Psychological Association, (APA,1973).

Primary Selection Criteria

Children were selected for inclusion in the study based on two levels of selection criteria. The first level was based on the child's academic and language history, and the second level was based on performance on the selection tests included in the study

Primary criteria for acceptance into the control group were: (a) adequate academic progress as judged by teacher report, (b) no incidence of a prior holdover in any grade (children were also excluded if there was a possibility of their being held over in their present grade, (c) English dominant, and (d) within stated age range of 8 years, 0 months to 11 years, 11 months.

Primary selection criteria for acceptance into the ld group were: (a) English dominant, and (b) within stated age range.

Secondary Selection Tests

The following tests were administered for final selection purposes. Standardized instructions were used for all tests (instructions for administration of the nonpublished Mattis Naming Test were as per test author: Mattis, Note 3).

Mattis Naming Test. This is a confrontation naming test developed by Steven Mattis, Ph.D. in 1974 and used regularly in the evaluation of children in the CCD. It consists of 30 items to be named upon their actual presentation to the subject. The list consists of 14 common objects, seven colors presented and pointed to on a color chart, and nine body parts pointed to on the examiner's body. A score sheet denoting the actual items used appears in Appendix D. Normative values were obtained in the District 9 elementary school student population when the test was developed. The child's score was the number of items correctly named.

Spreen-Benton Sentence Repetition Test. This test is part of the Neurosensory Center Comprehensive Examination for Aphasia (NCCEA) (Spreen & Benton, Note 4), and measures auditory reception and reproduction of sentences of increasing length and complexity. Normative values for children were developed by Gaddes and Crockett (1975). The test items (sentences) were administered to each child until two consecutive items were failed. Failure consisted of a nonverbatim repetition of the stimulus sentence. The child's score was the number of items correctly repeated verbatim. A score sheet of this test appears in Appendix E.

Spreen-Benton Token Test. This test is also part of the NCCEA and measures auditory reception and comprehension of increasingly complex commands regarding the identification and manipulation of plastic chips of various sizes, colors, and shapes. Normative values for children were also developed by Gaddes and Crockett (1975). The entire test was administered to each child and the child's score was the number of items correctly performed as per published instructions (Spreen & Benton, Note 4). A score sheet of this test appears in Appendix F.

Subtests of the Wechsler Intelligence Scale for Children - Revised. (Wechsler, 1974).

1. Similarities
2. Vocabulary
3. Block Design
4. Object Assembly

Standard administration and scoring procedures were used (Wechsler, 1974). It was necessary to obtain an estimate of intellectual ability of all participants in the study, and specifically to delineate between verbal and visual-perceptual skills. Wechsler IQ scores were chosen to serve this purpose, however certain factors led to the selection of prorated IQ scores over those obtained from the administration of entire WISC-R batteries. Primary among these factors was that it takes approximately an hour to an hour and a half to administer the entire battery. This was deemed as too long to spend testing each child, in addition to the other tests being administered, as it would have necessitated each student missing that much more classroom instruction. It was therefore decided to use two subtests from each portion of the exam, Verbal and Performance. Kaufman (1979) states the importance of administering equal numbers of Verbal and Performance subtests when using a short form of the WISC-R so as to minimize the possible disproportionate representation of Verbal or Performance scales. This is especially true when the VIQ-PIQ discrepancy is an important variable in the testing or experimental situation, as it is in the present study.

A prorated Verbal IQ score (ProVIQ) was obtained by taking the sum of the Similarities and Vocabulary subtest scaled scores, multiplying this sum by 5/2, and then recording the corresponding Verbal IQ value from the WISC-R manual. A prorated Performance IQ score (ProPIQ) was obtained by taking the sum of the Block Design and Object Assembly subtest scaled scores, multiplying this score by 5/2, and then recording the corresponding Performance IQ value from the WISC-R manual.

Similarities and Vocabulary were chosen as most representative of those verbal skills being tested by the Verbal section of the WISC-R overall, and Block Design and Object Assembly were chosen as being most representative of those skills tested by the Performance portion of the WISC-R overall. Kaufman (1975) has factor analyzed the WISC-R, using the original standardization data, at yearly age intervals from 6 1/2 to 16 1/2 years. His findings have basically replicated Cohen's factor structure of the WISC (Cohen, 1959). The three main factors which evolved were Verbal Comprehension (Information, Similarities, Vocabulary, Comprehension), Perceptual Organization (Picture Completion, Picture Arrangement, Block Design, Object Assembly, Mazes), and Freedom from Distractibility (Arithmetic, Digit Span, Coding). Vocabulary and Similarities emerged as having the greatest factor loadings on the Verbal Comprehension factor, and Block Design and Object Assembly were the most highly associated with the Perceptual Organization factor. Kaufman has also presented strong evidence in this study in support of Wechsler's Verbal/Performance dichotomy. Various short forms of the WISC-R have been evaluated in terms of their correlation with the entire WISC-R administration (Silverstein, 1975). Correlations of combinations of Verbal subtests with entire Verbal IQ administration, and of combinations of Performance subtests with entire Performance IQ administrations, are not reported in the literature. Intercorrelations among WISC-R subtest scores and derived IQ scores are given in the WISC-R manual for the original standardization data. Using these as a base for calculations, the following multiple correlation coefficients are found: R(VIQ - Similarities, Vocabulary) =

.82; R(PIQ - Block Design, Object Assembly) = .72. In the present study, 26 of the subjects in the ld group were children seen for evaluation at CCD. Their entire WISC-R Verbal and Performance IQs were therefore available. Using these data, the following multiple correlation coefficients are found: R(VIQ - Similarities, Vocabulary) = .76; R(PIQ - Block Design, Object Assembly) = .77. These are comparable to the original standardization data results.

Secondary Selection Criteria

Prospective participants in the study were either included or excluded based on their performance on the selection tests administered. The secondary selection criteria were designed to serve two purposes: (a) to insure that all participants were of normal visual-perceptual ability, and (b) to delineate between the control and ld groups along the lines of language usage ability. The first purpose was served by excluding all potential subjects who achieved a prorated WISC-R Performance IQ score of less than 80. The second purpose of the selection criteria, that of separating the two groups, control and ld, on the basis of language ability, was served by insuring that all children selected for the control group showed no signs of a language disorder, while all children selected for the ld group did show evidence of a language deficit upon testing. Cutoff values for the three language tests administered, Mattis Naming Test, Sentence Repetition Test, Token Test, were established for the various agegroups by determining raw score values for each test corresponding to z-scores of -2 (two standard deviations below the mean for each agegroup). These cutoff values, along with other secondary selection criteria are displayed in Table 2. Any potential control group member who scored below any of these cutoff values was not included in the study. Any potential ld group member who scored above all cutoff values was also excluded from the study. In addition, any potential control subject who achieved a ProVIQ score of less than 80 was excluded.

A further criterion adopted to separate the groups in the study along the lines of verbal/nonverbal skills was the ProVIQ/ProPIQ discrepancy. In describing VIQ/PIQ discrepancies in the WISC-R manual (Wechsler, 1974, p. 34), the author states that, "a difference of 15 points or more is important and calls for further investigation.". Kaufman (1976), using the original WISC-R standardization sample, states that this difference reflects significance at the 1% level. This level of significance was adopted in the present study (as opposed to 5%) because prorated IQ values were being used instead of full battery scores. ProPIQ - ProVIQ scores were calculated for all prospective participants in the study. All potential control group members who achieved a difference score of greater than 15 points were eliminated from the study. All potential ld group members who achieved a difference score of less than 15 points were also eliminated from the study.

One further exclusion criterion was established for acceptance into the study. Any prospective participant, either control or ld, who achieved an initial Raven CPM score of 33 or greater was eliminated from the study. This exclusion value was arbitrarily established so as to allow for a possible increase in Raven CPM score of at least three points in all conditions.

In all, 157 children were considered for inclusion in the control group and 60 children were actually accepted. Ninety-five children were considered for inclusion into the ld group and 60 children were actually accepted. Table 3 shows the number of children initially tested, the number of children excluded from the study, and the reasons for their exclusion.

Procedure

Order of tests administered. Children were tested in random order with regard to group (control,ld) and agegroup (8,9,10,11). Within each group-agegroup combination, they were assigned to an experimental condition ("standard", "verbal", "focus") on a sequential rotating basis as they entered the study. This was done until all group-agegroup-condition cells in the design were complete (five children per cell). All children finally included in the study were seen in two testing sessions. Some children were eliminated from the study after the first testing, some after the second, depending on performance on the stated selection criteria. The tests administered in each session, and order of administration, was dependent on whether the subject was being tested at CCD, or at school. Those children in the study who were being seen for evaluation at CCD were given a complete neuropsychological test battery which included all tests given in this study. (The second administration of the Raven CPM was additional to the standard test battery.) The first test session at CCD began with the following tests in the order listed:

1. Raven CPM (administration 1)
2. WISC-R (entire administration)

Other tests were given to these children which are not reported in this study. The second test session at CCD began with the following tests in the order listed:

1. Mattis Naming Test
2. Sentence Repetition Test
3. Token Test
4. Raven CPM (administration 2)

Other tests were then given to these children which are not reported in this study.

Subjects tested at school received their tests in a slightly different order. The first test session consisted of the following tests in the order listed:

1. Raven CPM (administration 1)
2. Mattis Naming Test
3. Sentence Repetition Test
4. Token Test

The second test session consisted of the following tests in the order listed:

1. WISC-R Similarities
2. WISC-R Vocabulary
3. WISC-R Block Design
4. WISC-R Object Assembly
5. Raven CPM (administration 2)

These different testing orders suited different purposes. At CCD, as part of a standard neuropsychological evaluation of children referred for experiencing academic difficulty, it was desirable to begin the evaluation with a measure of general intelligence. This was followed by academic screening. The next session included language, perceptual, motor testing, etc. The children being tested in the schools were being seen for the purposes of this study only. As the main descriptive selection criterion was the presence or absence of a language disorder, the language tests were given during the first test session. In this way, most of the prospective participants who would be eliminated from the study on the basis of this criterion, could be eliminated after the first test session without having to be tested twice. This was the most efficient use of my time, and also necessitated the minimum absence from classroom activities for all participants.

Instructions for Raven CPM Administrations. All children included in the study as a result of the secondary selection criteria were given the Raven CPM twice, separated by approximately one week. This time frame could not be strictly adhered to due to CCD and school schedules, student absences, etc. The Raven1 administration was given to all subjects according to published standard instructions (Raven, 1965b). The Raven2 administration was given in one of three different modes depending on which experimental condition the subject was in.

_(a)_ Those in the "standard" condition received a standard administration of the Raven CPM on the first as well as on the second test administration.

_(b)_ Those in the "verbal" condition were asked to verbally justify their answer for each item, after first reporting it to the examiner. Instructions for the test were modified as follows:

> We're now going to do this one again. Everybody has to do this one twice. Do you remember doing it last time? Good. This time it will be a little different. I want you to look at all the different pieces and tell me which one belongs in the space, just like you did last time, but then I want you to tell me why you chose that one; why that one is the one that belongs there. Do you understand?

Further elaborations were made on these basic instructions as needed to fully insure that the instructions were understood. Item A1 was then given as per basic standard instructions, with an accompanying explanation as to why choices 1,2,3, and 6 were not correct. After supplying an answer to the problem, the subject was asked, "Why did you choose that one? Why is that the correct answer?" If the answer was sparce in terms of choice criteria, such as, "It goes there", or, "It fits there", the subject was asked to elaborate, using phrases such as, "Yes, but why does that one belong in the space and not the others; why does that one complete the big picture?" This method of asking for elaborations concerning specific details and parts of the stimuli in a general sense was continued for three or four items if necessary to try to teach the subject what was desired. At no time were specific details of the stimuli such as lines, shapes, colors, etc., mentioned by the examiner. The questions were always designed to be innocuous on this point so as not to influence which part of the stimuli the subject attended to, or which possible solution strategies the subject employed. No probing for more adequate verbalizations was done after the fourth item, A4. At that point, whatever verbal answers were given were accepted. The subjects were however asked for a verbal justification whenever it was not spontaneously given. In this way, every subject in the "verbal" condition gave a verbalized reason for the choice on every item.

(c) For the subjects in the "focus" condition, an attempt was made to focus their visual attention through nonverbal means on each of the six answer choices for each item before they were allowed to give their answer. This was accomplished by means of a window used to present each choice individually in a highlighted manner, while also allowing all other choices, as well as the upper stimuli, to be visible. The apparatus used to accomplish this was a red oaktag rectangular frame, 2.50 in. by 2.00 in. in outside dimensions, and 2.00 in. by 1.75 in. in interior dimensions (width of each side was .25 in.) This was attached to a straightened length of white clothes hanger so that the hanger extended horizontally from the bottom side of the frame. A diagram of this apparatus in use is shown in Figure 3. While the frame highlighted the choice it was placed over, it covered no part of any other choice, or any part of the upper stimulus. Instructions to the subjects were as follows:

> We're now going to do this one again. Everybody has to do this one twice. Do you remember doing it last time? Good. This time it will be a little different. Do you see this red window I have here? First I'm going to show you only the top part of each page. Then I'm going to place this window over each of the little pieces below it, one at a time. I want you to look at the piece that's in the window only. After you've looked at them all, tell me which piece goes in the space. Wait until you've seen each little piece in the window before giving me your answer. Do you understand?

The subject was then shown item A1 and the six answer choices were covered with a piece of grey cardboard, 5 in. by 8 in. in size. The subject was instructed to look at the top part of the page. After eight seconds of viewing time, the screen was removed and the six answers were highlighted with the window in a random order. This order was constructed so that each correct answer appeared in the 1st, 2nd, 3rd, 4th, 5th, and 6th sequential position an equal number of times in each scale of the test. In addition, each answer choice (1,2,3,4,5,6) appeared in each sequential position an equal number of times in each scale of the test. The order used is presented in Appendix G. The order for item A1 was 1-2-3-6-5-4 to match the standard instructions for this item as much as possible. If a subject offered an answer before all six choices were highlighted, the child was told to wait until all six choices were seen before answering. Each choice was highlighted for a four-second viewing interval, so the entire item was studied silently for a total of 32 seconds before being responded to. This procedure was carried out for all 36 items, A1 - B12.

Results

Selection Variables

The structure of the experimental design used herein called for the creation of two groups of subjects: (a) mildly language disordered children (ld group), and (b) children with normal language development (control group). Certain selection criteria were employed in regulating the entry of prospective subjects into the study to insure that the groups would: (a) differ along the main diagnostic dichotomy of language ability/disability, and (b) not differ with respect to visual-perceptual skills, both groups being of normal ability in this area. Table 4 presents descriptive data for the two groups on all selection variables, along with t-test values for comparisons between the ld and control groups on these variables (Footnote 1). As can be seen by inspection of this table, the ld group was significantly lower than the control group on all measures of verbal ability used (Naming, Token, Sentence Repetition, Similarities, Vocabulary, ProVIQ). The groups did not differ significantly on Block Design or ProPIQ. On Object Assembly however, the ld group scored significantly higher than the control group.

As can also be seen from Table 4, the mean age of the two groups did not differ significantly. Tables 5 thru 8 present the equivalent data and statistics as Table 4, broken down by the four agegroups used to study developmental patterns. Within each agegroup, the two experimental groups differed in the required manner on all language area tests, and did not differ on the visual-perceptual measures, with one exception. The tables point out that the observed overall significantly greater Object Assembly score for the ld group as a whole was in actuality limited to the 11 year old subgroup. Analysis of Variance (ANOVA) trend analyses over agegroup were carried out for each experimental group separately on all selection variables and are presented in Tables 9 thru 26. Significant linear trend components were obtained for all three language tests in both groups ($p = .0599$ for Token Test in the control group). There thus seems to exist a developmental gradient underlying these tests in both the language disordered and the normal children. There also seem to be higher order trend components present in the naming test in the control group. Although the WISC-R scores are derived and age-corrected, there nevertheless were linear trends present in all but Similarities in the control group. No such trends were found in the ld group.

Tables 5 thru 8 also display the interval times in days between the first and second CPM administrations. No significant differences are noted between groups overall, or for separate agegroups.

Although sex was not a variable under observation in this study, the male/female breakdown followed oft-reported demographic statistics which show a disproportionate amount of language disordered dyslexic boys as compared to girls in the general population (cf Berger, Yule, & Rutter, 1975;

Eisenberg, 1966; Owen, 1971). The present breakdown was: ld male = 49, ld female = 11, control male = 30, control female = 30. This is a statistically significant occurrence, Chi Square(1) = 24.01, $p < .001$.

Hypotheses

Hypothesis I stated that the language impaired children would not perform as well as the control group on a standard administration of the Raven CPM. Ravenl scores for both groups (entire group scores, and scores broken down by agegroup) are displayed in Table 27 and Figure 4. Table 28 presents the results of a two-way ANOVA carried out on these data. The ld group did perform significantly below the control group (group main effect).

Hypothesis II stated that Ravenl performance would increase along developmental lines in each group, and that control group scores would be greater than the ld scores at each age level. Post-hoc Neuman-Keuls pairwise comparisons (Kirk, 1968) carried out between the ld and control groups yielded significant differences at each agegroup level. These results are displayed in Table 29. This finding is also indicated by the nonsignificant group by agegroup interaction as seen in Table 28. Although the agegroup main effect was also significant, it was felt more appropriate to analyze each experimental group independently in investigating age trends in the data. One-way ANOVA trend analyses were carried out separately for the ld and control groups, and are presented in Tables 30 and 31. There was a significant linear trend present in each group. Post-hoc Neuman-Keuls pairwise comparisons did not yield significant agegroup differences within each experimental group, as shown in Table 29.

Hypotheses III thru VII stated that subjects would differentially increase their CPM performance from the first to the second testing, dependent on which group and condition they were in. To assess these predictions, RDELTA scores (Raven2 - Raven1) were calculated for each subject. With the exception of the control-standard group, all groups did significantly improve their test score from the first to the second testing. Results of correlated t-tests, conducted separately for each group-condition cell, of the null hypothesis: Mean(RDELTA) = 0, are shown in Table 32.

A two-way Analysis of Covariance (ANOCOVA) was conducted on the RDELTA scores using group (ld, control), and condition (standard, verbal, focus) as the main effects, and using the Raven1 score as the covariate. Underlying ANOCOVA assumptions were tested and confirmed (Table 33, and Footnote 2). This statistical method was used to control for initial CPM performance. What was of interest was the differential effects of the Raven2 administration types (condition) as measured by change in scores from first to second administration, and not the absolute level of Raven2 score. This change in CPM score was however felt to be related to initial ability on the test regardless of which condition a subject happened to be in. This hypothesized relationship did hold forth for the control group as demonstrated by a significant Pearson product-moment correlation coefficient of $r = -.365$, $p = .004$, between Ravenl and RDELTA scores across conditions. This indicated that the higher a subject scored on initial CPM performamce, the less likely that subject was to increase the performance on the second CPM administration. The Pearson coefficient in the ld group was also negative, but not significant: $r = -.148$, $p = .258$. This is attributable to a mild ceiling effect in the normal population. The ld groups were benefitted by a second administration overall, regardless of condition, or initial performance.

Results of the two-way ANOCOVA of RDELTA scores are presented in Table 34. Within-cell descriptive data are presented in Table 35. Adjusted RDELTA cell means are also displayed in Figure 5. Although the condition main effect was significant, further analysis of this finding would yield incomplete and meaningless information in light of the highly significant group by condition interaction. This interaction was further analyzed using Neuman-Keuls post-hoc pairwise comparisons and the results are shown in Table 36.

Hypothesis III stated that practice alone would not differentially aid the two groups, and that RDELTA scores would not differ in the "standard" condition. This hypothesis was confirmed as displayed in Table 36.

Hypothesis IV stated that nonverbal focussing of attention would also not differentially effect the two groups, and that RDELTA scores would not differ in the "focus" condition. As is seen in Table 36, this hypothesis was not confirmed. The RDELTA scores for the control group were significantly greater than those for the ld group.

Hypothesis V stated that verbal justification of answers would aid the ld group to a greater extent than the control group, and therefore that in the "verbal" condition, RDELTA scores for the ld group would be significantly greater than for the control group. This hypothesis was not confirmed as can be seen in Table 36.

Hypothesis VI stated that within the ld group, those in the "verbal" condition would obtain significantly greater RDELTA scores than those in the "focus" condition, who in turn would score higher than those in the "standard" condition. This prediction was not upheld. Table 36 shows that those ld subjects in the "verbal" condition scored significantly higher as a group than those in either the "standard" condition, or the "focus" condition, who in turn did not score significantly different from each other.

Hypothesis VII stated that within the control group, those in the "standard" condition would score significantly lower than those in either the "verbal" condition, or those in the "focus" condition, who in turn would not score significantly different from each other. This hypothesis was confirmed as seen in Table 36.

The results of the pairwise comparisons used to test Hypotheses III thru VII are also displayed graphically in Figure 5.

Supplementary Analyses

Agegroup was not used as a categorizing factor in the above ANOCOVA. This variable was included in the experimental design to insure an equal age distribution in all group-condition cells, and also to make it possible to study developmental patterns on the initial CPM administration. The ANOCOVA was rerun however, including agegroup as a factor, to investigate the possibility that the observed interactional findings would be further influenced by age differences of the subjects. The homogeneity of regression coefficients assumption was met for this expanded design as shown in Table 37. The ANOCOVA source table is presented in Table 38. As can be seen by the nonsignificant three-way interaction (group by condition by agegroup), age of the subjects did not further affect the interactional findings noted earlier between group and condition as displayed in Table 34.

The three scales of the CPM (A,Ab,B) were analyzed separately, in addition to the preceding entire CPM analysis. This was done to take advantage of the inherent increase in complexity of the scales, from A to B, in examining proposed underlying cognitive solution mechanisms. Table 39 shows the data broken down by scales, by groups, and by agegroup within group. Table 40 shows an ANOVA table for the first administration data. As can be seen by the significant scale main effect, and the nonsignificant group by scale interaction, there was a similar decrease in performance from A to B in both groups, ld and control. Although the interaction was not significant, the two groups were nevertheless analyzed separately for interscale differences. As shown in Table 41, within each group (ld and control), all interscale differences were significant by Neuman-Keuls post-hoc pairwise comparison analysis. Although the entire Ravenl scores did show linear trends over agegroup in each group (Tables 30 and 31), with the exception of the Ab scale in the ld group, these significant trends did not occur in the data when broken down by scale (Tables 42 thru 47). Agegroup as a classifying factor was not considered further in the scale analyses.

Delta scores were calculated for each scale separately, as for the entire CPM data, and within-cell descriptive data are shown in Tables 48 thru 50 (along with adjusted scale-delta scores based on covariance techniques). ANOCOVAs similar to the RDELTA analysis were carried out for each scale separately. Tests of the homogeneity of regression coefficients assumption are shown in Tables 51 thru 53 for each scale ANOCOVA (all assumptions were met), and the ANOCOVAs themselves are presented in Tables 54 thru 56. The analyses were done separately so as to yield modified scale-delta scores adjusted for initial performance solely on the appropriate scale, not on the total initial performance over all scales. These adjusted scale-delta scores are also displayed in Figure 6. Results of correlated t-tests conducted separately for each group-condition-scale cell, of the null hypotheses: Mean(scale-delta) = 0, are shown in Table 57.

Certain trends are apparent by a graphic observational analysis of the data presented in Figure 6 and Tables 48 thru 50. Direct intercomparisons could not be made among the scales because they were analyzed separately as stated above to yield appropriate adjusted scores. There seems to be a ceiling effect present in the "verbal" and "focus" conditions over scales, in the control group. As complexity of the scales increased from A to B, the subjects performed less proficiently on the initial testing, and were helped to a greater extent by the external verbal or focusing aids. In contrast to the "verbal" or "focus" conditions (control group) where all score increases were significant, there were no significant changes for those control subjects as a group in the "standard" condition (Table 57). In the "verbal" condition, the trend for the ld subjects went the opposite way than that for the control subjects. As the complexity of the task increased, the ld group as a whole was less able to be aided by the verbal structure of the task.

Various computer statistical packages were used to analyze these data, in addition to manual methods. Appendix H lists the various procedures performed, and the package and program used in each type of analysis.

Discussion

Selection Variables

The ld group (actually only the 11 year old subgroup) scored significantly higher than the control group on Object Assembly, with no significant difference being obtained on block design. In addition, both groups scored at equivalent levels on the ProPIQ measure. The observed difference in Object Assembly scores is viewed as a sampling artifact in the present study. The main criteria used to match the groups was ProPIQ, which was derived from Block Design and Object Assembly scores. It has been demonstrated on the WISC-R (Wechsler, 1974) as well as on the WISC (Wechsler, 1949) that Block Design has the greatest single Performance subtest correlation with Performance IQ, and in conjunction with Vocabulary, the greatest Verbal/Performance dyadic predictive relationship with Full Scale IQ (Glasser & Zimmerman, 1967; Kaufman, 1979; Silverstein, 1970).

Although many statistically significant trend patterns were observed in the selection data, it is realized that the agegroups used in this study represent a truncated portion of the age range of measurement for these tests. The sample size per group-agegroup combination was also rather small (15) for meaningful statements. Therefore these trends are noted in the results, but no further clinical significance is attributed to them in light of the present experimental design and research questions posed.

Internal Verbal Mediation and the CPM

One of the major suppositions presented in this study is that the Raven CPM, a test generally utilized as a measure of nonverbal abstract problem solving ability, is in actuality dependent to a certain extent on internal verbal mediation for the successful solution of its component problems. The process of internal verbal mediation is conceived of in the present study as encompassing comprehension of incoming information, and formulation of outgoing messages. The supposition was experimentally translated into the following prediction: children with disorders in certain parts of the language usage process, either comprehension or formulation, or both, and with normal visual-perceptual ability, would not perform as well on a standard administration of the CPM as children with no such language disorder (Hypothesis I). This hypothesis was tested and the results support the initial supposition. Internal verbal mediation accounts for a significant portion of those cognitive processes necessary for the solution of the CPM problems. The results lend support to the statements of other investigators, that both verbal and nonverbal methods can be used in the solution of these problems (Zaidel & Sperry, 1973), and indeed are used in an integrated cooperative approach (Kertesz & McCabe, 1975), when these processes are intact and there is no cerebral (cognitive) pathology present. In the present study, Pearson correlation coefficients between Ravenl scores and prorated IQ scores, were statistically significant in both groups (ld, control), for both IQ measures (ProVIQ, ProPIQ): (ld, Ravenl-ProVIQ), r = .32, $p = .014$; (ld, Ravenl-ProPIQ), r = .63, $p = .001$; (control, Ravenl-ProVIQ), r = .28, $p = .030$; (control, Ravenl-ProPIQ), r = .35, $p = .005$. Thus, initial CPM performance was related to both verbal and nonverbal skills in both groups. In the control group, the correlation between Ravenl scores and the ProPIQ measure was comparable to that between Ravenl scores and the ProVIQ measure, $z = .52$, $p > .30$. In the ld group however, the correlation between Ravenl scores and the ProPIQ measure was significantly greater than that between the Ravenl scores and the ProVIQ measure, $z = 2.81$, $p < .003$. In the presence of defective verbal ability, CPM performance is dependent on nonverbal visual-spatial skills to a greater extent than when verbal ability is intact. When both verbal and nonverbal skills are normal, they are of comparable levels of importance to successful CPM problem solving.

The significance of the nonverbal component in the solution of CPM items could be further ascertained in a study similar in design to the present one, in which the main dichotomizing variable would be nonverbal ability/disability, as opposed to the verbal counterpart presently used.

Improvement of Performance in the "Verbal" Condition

Hypothesis V dealt with the "verbal" condition. It was felt that the control subjects, being of normal verbal ability, would naturally be using internal verbal mediation in the solution of the problems, and would therefore not be aided significantly by the extra structure of the required verbal justification of answers. Children above the age of about eight years, generally are not aided by overt verbalization methods in perceptual discrimination problems (Kendler, 1964). (Although the Raven problems are not truly perceptual discrimination tasks, they do involve conceptual problem solving methods.) The ld subjects on the other hand should be helped by the verbal aids, if their problem is a "production deficit". This would mean that they have the ability to use verbal mediation, but are not doing so because they are not generating it. The nonspontaneous production of useful internal verbal mediation should however be able to be stimulated by external means. It was felt that the required external verbalizations would initially substitute for the missing internal verbal mediation, and would eventually become internalized over the course of the test. Behavioral observations of several of the ld subjects in this study clearly indicated that this did take place. There were many instances wherein a subject gave an incorrect answer to an item, and then spontaneously changed (and corrected) the initial answer after beginning to supply a verbal justification for the first answer. The ld subjects therefore were able to be helped by an external aid which presumedly stimulated a dormant cognitive process (internal verbal mediation), and led eventually to its unelicited use. To some extent, the ld subjects were not initially performing at their maximum levels of competence.

The control group however was also aided by the verbal justification technique, and in fact their improvement was not statistically different from that of the ld group. This leads to the alternative conclusions that either both groups improved in the "verbal" condition for the same reason, or for different reasons.

If the children were aided for the same reason, there are two possible explanations. One is that both groups are deficient in the production of verbal mediation. None of the children in the control group showed any sign of a language deficit on psychometric testing, and there is no reason to suspect that they were not verbally mediating. It has already been stated that overt verbalization methods have been shown to be ineffective in increasing performance of children who are already employing verbal mediation.

The second possibility has to do with attending to the problems at hand. Since the verbalization of answers may have served as a potent attention focussing technique, it can be hypothesized that it was this attentional factor that was being stimulated in both groups in the "verbal" condition. The differential group performances in the "focus" condition however, and the results of the the A-Ab-B scale analysis, can be interpreted as lending support to the conclusion that the attentional factor was not the one responsible for both groups' improved performance in the "verbal" condition.

It was hypothesized that both groups would benefit equally from nonverbal focussing of attention (Hypothesis IV). This was obviously not the case. The greatest difference obtained in the study was that between the RDELTA scores of the ld and the control groups in the "focus" condition. Since the ld group was not as able as the control group to make use of the attention focussing factor in the "focus" condition, and since the ld group's RDELTA scores in the "focus" condition were significantly lower than their scores in the "verbal" condition, it is logical to assume that the attention focussing factor was not the one responsible for the ld group's improvement in the "verbal" condition. The A-Ab-B scale analysis supports the notion that the attention focussing factor was however the one responsible for the control group's improvement in both conditions. Examination of Figure 6 shows that the rate, and pattern, of increase of scores for the control group, over the three scales, was practically identical for both "verbal" and "focus" conditions. It is suggested that the control group and the ld group improved in the "verbal" condition for different reasons; the control group by the hypothesized attention focussing property of the required verbal justifications, and the ld group by stimulation of dormant internal verbal mediation.

A Model of Integrated Multiple Deficits

The differential performance of the two groups in the "focus" condition, and the suggestion of different reasons for improvement in the "verbal" condition raises another important question concerning the total nature of the impairment in the ld subjects. Why was the ld group not as able to benefit from the attention focussing properties of the "focus" condition as was the control group (Hypothesis IV)? In order to answer this question, the ld group's differential performances in the "verbal" and "focus" conditions must be re-examined, along with the hypothesized reason for this group's improvement in the "verbal" condition.

It has been suggested that the ld group's improvement in the "verbal" condition is related to a verbal "performance" deficit already discussed. There is however another descriptive dimension in terms of task structure which differentiates the "verbal" and "focus" conditions, and leads to the positing of an additional cognitive deficit in the ld group. The "verbal" condition required an active output process by the subject, formulating and delivering the requested verbal justifications. The "focus" condition required no such active process. The attention focussing was passive as concerned the subject. It is possible that the active nature of the external verbal structure helped the ld subjects to organize their attention, perception, and cognitive problem solving process in general, to a greater degree than without this imposed structure. This would point to the possible identification of an additional cognitive deficit in the ld group, namely a lack of ongoing, maximized active internal organization. This could then be related to their internal language deficits in that to a certain extent, the organized processes involved in problem solving are dependent on thinking which is organized by language (Huttenlocher, 1973; Slobin, 1971).

This set of assumptions makes possible the following hypothesized scenario. The "focus" condition used a passive focussing technique. The subjects were not required to externally act, and internal organization was therefore not stimulated in the ld group. Internal organization cannot be imposed, it must be self-generated and supplied. The subjects in the control group, being of normal internal language ability, have ongoing internal organization. They were therefore able to use the passive external focussing aid because they had an existing internal organization (foundation) to base it on. They were able to put to use the attention focussing properties inherent in both the "verbal" and the "focus" conditions (Hypothesis VII).

The ld and control groups were matched on the Block Design and Object Assembly tasks, and although these are not outwardly verbal in nature, they are active output tasks. In addition, the external manipulation of the stimuli is somewhat based on necessary prior internal planning of moves, and subsequent checking (validation) of hypotheses. Even if manipulation of stimuli is done on a trial and error basis, with no real prior planning, the resulting combinations must be critically judged for congruence with either the model presented on the Block Design cards, or with internal representations (images) of the objects being created on the Object Assembly task, and then refined as necessary. It is possible that the active (planned or unplanned) manipulation of the stimuli, and the necessary congruence checking, helped to stimulate internal organization which aided in the solution of the puzzles in these two WISC-R Performance subtests.

An analogous situation to the present manipulations, using Block Design as the main focus is possible, and yields certain predictions. In this design, the initial stimulus pattern (card) of each Block Design item would be presented with a multiple choice array of possible component block face combinations, and the subject would have to choose that combination which would yield the completed pattern upon rearrangement. Since this would be a strictly passive presentation, it is hypothesized that the ld group would no longer match the control group in performance. If they were allowed to verbally justify answers, an improvement would be expected.

Another possible way to investigate the role of the active/passive dimension in attentional factors, using the Raven CPM, would be to provide a method of nonverbal, active focussing of attention on the task. The simplest method would be for the subject to manipulate a highlighting apparatus, such as the frame used in this study, instead of having this manipulation carried out by the experimenter. More complex methods could easily be produced which would call for the subjects to manipulate the test materials in some nonverbal manner.

The Nature of the Verbal Mediational Deficit in Language Disordered Children

Verbal mediation, in this study, has been defined as encompassing internal comprehension (meaning) and formulation of labels (naming). The language impairments identified in the ld children are therefore such as to yield deficient verbal mediation. It has been suggested that the nature of this deficit is basically one of "performance" (production) as opposed to one of "competence"; that the ld children, being only mildly disordered in verbal language processing as per psychometric testing, were truly possessive of greater verbal competence on some level, but were not performing at a consonant level. The problem was seen in the execution phase of the verbal process, and not so much in the capability stage. The A-Ab-B scale analysis suggests that this is not totally the case. There does seem to be a true "competence" component to the observed language disorder present in the ld group in addition to a "performance" component. Both the ld and the control groups initially performed less efficiently on the scales as complexity increased (A1-Ab1-B1 scores). On the second test administration, in the "verbal" condition, the control subjects were able to actually increase their rate of improvement (accelerate) as the complexity of the task increased (it is assumed that the overall complexity of the problems increases homogeneously in terms of verbal and nonverbal mediational requirements). The ld group alternately could not improve performance beyond a ceiling level (A scale), and were helped by the verbalizations less and less on the succeeding scales due to a limitation on their actual level of internal verbal competence. That they were able to make use of the verbal aids overall speaks to the "performance" component of their deficit; that they were not able to utilize these aids beyond inherent limits (ceilings), speaks to the "competence" component of their deficit. Both components are present and identifiable.

Conclusions

The hypotheses put forth in this study have been supported to various degrees. The "Verbalization Hypothesis" (Raven et al., 1976) is supported in terms of the Raven CPM. Language disordered children perform more poorly on the Raven CPM then do controls matched for WISC-R Block Design and Object Assembly. As the Raven CPM is basically used as a test of nonverbal perceptual abstract problem solving ability, the pronouncement of Zaidel and Sperry (1973), that this test is not "eminently suited for measuring functional differences between the hemispheres" (p. 38) is supported. To functionally paraphrase this finding, poor performance on the CPM in a subject with documented language difficulties does not necessarily indicate defective nonverbal processing.

The competence/performance hypothesis has been partially supported. It has been suggested herein that the language disorder present in this group of mildly impaired children is multifactored; that there is a "performance" component as well as a "competence" component. Language mediated performance can be increased by external stimulation, but there are limits as to the level of increased performance.

The results of this study suggest that there is another component to the deficit present in the ld subjects. The ld group performed equally as well as the control group on nonverbal tasks which are active in nature (Block Design and Object Assembly require manipulation of the test materials), but performed significantly lower than the control group on a passive nonverbal task (Raven CPM - standard administration only requires an indicating response). This suggests a disorder in internal cognitive organization. This disorder is also of a "performance" nature as opposed to "competence". When a task required an active output process (verbalization of answers, manipulation of materials), it is possible that the initiation and execution of this activity served to stimulate internal organization in the ld subjects. They could not use passive aids to increase efficiency in the solution of cognitive tasks because there was no fully functioning existing internal organizational foundation upon which to base this potential help.

The implication for educational practice which results from this study is that active as opposed to passive stimulation is the optimal method of stimulating and aiding children with mild internal-language/cognitive-organizational deficits.

Footnotes

1) Although the homogeneity of variance assumption for the t-test appears to have been violated for the three language area tests given (homogeneity of variance test values: Naming, $F[59,59] = 15.43$, $p < .001$; Token, $F[59,59] = 17.82$, $p < .001$; Sentence Repetition, $F[59,59] = 1.85$, $p = .019$), the t-test statistics presented are nevertheless valid. The t-test has been shown to be quite robust in terms of withstanding this particular assumption violation if sample sizes are equal and large (Hays, 1973). The reason for the present observed sample heteroscedasticity is directly related to the selection procedures used. All control subjects had to score above cutoff levels on all three language area tests to be included in the study. All ld subjects had to score below the cutoff level on at least one of the language tests, but not necessarily more than one. There were thus instances wherein an ld subject scored within normal limits on one or two of these language tests. The range of possible scores was therefore limited for the control subjects (all above cutoffs), and not curtailed for the ld subjects (above and below cutoff levels allowed).

2) The major assumpyion underlying the use of ANOCOVA (in addition to the standard ANOVA assumptions of homogeneity of variance, random sampling, independence and normality of distribution of variables) is that the within-cell regression coefficients (dependent variable regressed on covariate) are homogeneous (Kirk, 1968). Table 33 shows a one-way ANOVA source table used to test the homogeneity of regression coefficients, as well as the null hypothesis of zero slope (regression coefficient) in the overall population. Kirk (1968) and Winer (1971) both suggest using a large level of significance, such as .10, in evaluating the homogeneity of regression coefficients test. As can be seen from the table, the assumption of homogeneity of regression coefficients was not violated in the present analysis. In the presence of fairly large cell sample sizes, and more importantly, equal cell sizes, the Analysis of Covariance has been shown to be as robust as the Analysis of Variance in withstanding violations of the basic ANOVA assumptions listed above (Hays, 1971; Kirk, 1968). Thus the use of ANOCOVA, and the use of the Ravenl score as a covariate, was justified in the current study.

Table 1

Ages of Subjects in Months

Group[a]	Standard Mean	Standard SD	Verbal Mean	Verbal SD	Focus Mean	Focus SD
LD						
8	102.80	3.83	101.00	2.12	101.20	2.86
9	113.40	3.44	115.00	2.45	118.60	10.55
10	128.40	2.88	125.60	4.34	125.60	1.14
11	138.20	3.96	134.80	3.56	138.40	3.36
Total	120.70	14.32	119.10	13.25	120.95	14.76
Control						
8	101.40	3.51	101.20	3.49	103.00	3.81
9	114.20	3.56	114.20	3.90	111.40	2.88
10	123.80	2.49	127.60	3.05	124.20	4.09
11	139.40	2.19	136.20	4.44	138.20	3.03
Total	119.70	14.50	119.80	14.07	119.20	14.03

[a] n = 5 for each age level within each group

Table 2

Secondary Selection Criteria

Language test cutoff values				
	Age			
Test	8	9	10	11
Mattis Naming	27	27	28	28
Sentence Repetition	9	9	10	10
Token Test	150	151	152	154

Control group: Exclude from study if:

a) any language test score is below cutoff, OR

b) ProVIQ < 80, OR

c) ProPIQ < 80, OR

d) (ProPIQ - ProVIQ) > 15, OR

e) Ravenl > 33

LD group: Exclude from study if:

a) all language test scores are > or = cutoffs, OR

b) ProPIQ < 80, OR

c) (ProPIQ - ProVIQ) < 15, OR

d) Ravenl > 33

Table 3

Number of Children Excluded from Study

Control Group - Reason for Exclusion	Number Excluded	% of Total
Failed at least one language test (Naming, Sentence Repetition, Token Test); score < age cutoff	35	22
ProVIQ < 80	22	14
ProPIQ < 80	15	10
(ProPIQ - ProVIQ) > 15; (ProVIQ, ProPIQ > 80)	12	7
Ravenl > 33	6	4
Held over on grade (discovered later)	5	3
Data discarded because of unsuitable testing conditions during Ravenl administration	1	1
Too old for study (mistake in school records discovered later)	1	1
Total excluded	97	62
Total used	60	38
Total tested	157	100

LD Group - Reason for Exclusion	Number Excluded	% of Total
All language test scores > age cutoffs	14	15
Moderate to severe language disorder	2	2
ProPIQ < 80	11	12
(ProPIQ - ProVIQ) ≤ 15	5	5
Ravenl > 33	1	1
Moved out of NYC area after first testing	1	1
Behavioral disorder - extremely uncooperative	1	1
Total excluded	35	37
Total used	60	63
Total tested	95	100

Note. Children are listed in only one exclusion category. Some potential control subjects were actually excluded for more than one reason, but are listed in that category felt to present the more serious reason for exclusion from the study.

Table 4

Selection Variable Statistics - Total Population

	Group[a]					
	LD		Control			
Variable	Mean	SD	Mean	SD	t[b]	p[c]
Naming	25.73	3.09	29.40	.79	-8.92	.000
Token	146.15	8.81	159.25	2.09	-11.20	.000
Sent. Rep.	9.28	1.71	12.13	1.26	-10.41	.000
Sim.	4.33	2.55	9.93	2.46	-12.24	.000
Voc.	4.05	1.95	10.00	2.42	-14.84	.000
Bl. Des.	9.15	2.21	9.53	2.17	-0.96	.340
Ob. Ass.	10.33	1.98	9.35	2.34	2.48	.014
ProVIQ	64.43	11.83	99.68	12.68	-15.75	.000
ProPIQ	98.18	12.06	96.30	12.00	.86	.393
Age (months)	120.25	13.91	119.57	13.96	.27	.789
Interval (days)	13.75	12.48	13.62	11.53	.06	.952

[a] n = 60 for each group

[b] t-test value for ld vs. control

[c] significance value for t-test

Table 5

Selection Variable Statistics - 8 year old groups

	Group[a]					
	LD		Control			
Variable	Mean	SD	Mean	SD	t[b]	p[c]
Naming	24.27	2.84	28.73	.88	-5.82	.000
Token	143.40	8.81	158.47	2.20	-6.43	.000
Sent. Rep.	8.80	1.82	11.73	.88	-5.61	.000
Sim.	4.27	2.92	9.80	2.46	-5.62	.000
Voc.	4.73	1.75	10.87	2.23	-8.37	.000
Bl. Des.	10.00	2.48	10.87	1.60	-1.14	.265
Ob. Ass.	10.27	2.31	10.27	2.34	.00	.999
ProVIQ	66.47	12.22	101.93	9.69	-8.81	.000
ProPIQ	101.07	13.85	103.80	10.90	-0.60	.553
Age (months)	101.67	2.92	101.87	3.44	-0.17	.865
Interval (days)	10.67	3.37	12.67	10.81	-0.68	.500

[a] n = 15 for each group

[b] t-test value for ld vs. control

[c] significance value for t-test

Table 6

Selection Variable Statistics - 9 year old groups

	Group[a]					
	LD		Control			
Variable	Mean	SD	Mean	SD	t[b]	p[c]
Naming	24.73	3.65	29.73	.59	-5.23	.000
Token	142.07	5.78	159.13	2.13	-10.74	.000
Sent. Rep.	8.87	1.41	11.67	1.11	-6.04	.000
Sim.	4.00	2.51	11.07	2.49	-7.74	.000
Voc.	4.33	1.63	10.87	2.83	-7.75	.000
Bl. Des.	9.27	1.71	9.13	2.50	.17	.866
Ob. Ass.	10.27	1.62	9.87	2.48	.52	.605
ProVIQ	64.27	10.89	105.93	15.61	-8.48	.000
ProPIQ	98.13	8.99	96.67	13.38	.35	.727
Age (months)	115.67	6.48	113.27	3.49	1.26	.217
Interval (days)	14.53	12.84	9.20	4.59	1.52	.141

[a] n = 15 for each group

[b] t-test value for ld vs. control

[c] significance value for t-test

Table 7

Selection Variable Statistics - 10 year old groups

	Group[a]					
	LD		Control			
Variable	Mean	SD	Mean	SD	t[b]	p[c]
Naming	26.47	2.56	29.47	.64	-4.40	.000
Token	147.13	11.43	159.53	2.03	-4.14	.000
Sent. Rep.	9.47	1.92	12.20	1.27	-4.60	.000
Sim.	4.53	2.77	9.67	2.70	-5.14	.000
Voc.	3.53	2.23	9.27	2.43	-6.72	.000
Bl. Des.	8.73	2.22	9.00	1.41	-0.39	.698
Ob. Ass.	10.20	2.18	8.67	2.47	1.80	.082
ProVIQ	63.40	13.82	96.47	12.74	-6.81	.000
ProPIQ	96.27	12.98	92.40	10.53	.90	.378
Age (months)	126.53	3.16	125.20	3.51	1.09	.283
Interval (days)	17.27	20.28	20.47	16.18	-0.48	.637

[a] n = 15 for each group

[b] t-test value for ld vs. control

[c] significance value for t-test

Table 8

Selection Variable Statistics - 11 year old groups

	Group[a]					
	LD		Control			
Variable	Mean	SD	Mean	SD	t[b]	p[c]
Naming	27.47	2.23	29.67	.62	-3.68	.001
Token	152.00	4.71	159.87	1.92	-5.99	.000
Sent. Rep.	10.00	1.51	12.93	1.39	-5.54	.000
Sim.	4.53	2.17	9.20	2.00	-6.12	.000
Voc.	3.60	2.06	9.00	1.56	-8.09	.000
Bl. Des.	8.60	2.29	9.13	2.56	-0.60	.553
Ob. Ass.	10.60	1.92	8.60	1.77	2.97	.006
ProVIQ	63.60	11.14	94.40	9.43	-8.17	.000
ProPIQ	97.27	12.59	92.33	10.24	1.18	.249
Age (months)	137.13	3.78	137.93	3.39	-0.61	.546
Interval (days)	12.53	6.61	12.13	9.29	.14	.893

[a]n = 15 for each group

[b]t-test value for ld vs. control

[c]significance value for t-test

Table 9

Trend Analysis for Control Group (Naming)

Source	SS	df	MS	F	p
Bet. groups	9.4599	3	3.1533	6.556	.0007
linear	4.8135	1	4.8135	10.008	.0025
dev. fr. lin.	4.6465	2	2.3232	4.831	.0116
quadratic	2.4000	1	2.4000	4.990	.0295
dev. fr. quad.	2.2465	1	2.2465	4.671	.0350
Within groups	26.9333	56	.4810		
Total	36.3932	59			

Table 10

Trend Analysis for Control Group (Token)

Source	SS	df	MS	F	p
Bet. groups	16.2437	3	5.4146	1.259	.2974
linear	15.8729	1	15.8729	3.689	.0599
dev. fr. lin.	.3708	2	.1854	.043	.9579
quadratic	.4167	1	.4167	.097	.7568
dev. fr. quad.	.0000	1	.0000	.000	.9999
Within groups	240.9331	56	4.3024		
Total	257.1768	59			

Table 11

Trend Analysis for Control Group (Sentence Repetition)

Source	SS	df	MS	F	p
Bet. groups	15.3330	3	5.1110	3.688	.0171
linear	12.8135	1	12.8135	9.247	.0036
dev. fr. lin.	2.5194	2	1.2597	.909	.4088
quadratic	2.4000	1	2.4000	1.732	.1935
dev. fr. quad.	.1194	1	.1194	.086	.7701
Within groups	77.5999	56	1.3857		
Total	92.9329	59			

Table 12

Trend Analysis for Control Group (Similarities)

Source	SS	df	MS	F	p
Bet. groups	28.6670	3	9.5557	1.626	.1936
linear	7.6799	1	7.6799	1.307	.2578
dev. fr. lin.	20.9871	2	10.4935	1.786	.1771
quadratic	11.2667	1	11.2667	1.917	.1716
dev. fr. quad.	9.7204	1	9.7204	1.654	.2037
Within groups	329.0663	56	5.8762		
Total	357.7332	59			

Table 13

Trend Analysis for Control Group (Vocabulary)

Source	SS	df	MS	F	p
Bet. groups	45.5997	3	15.1999	2.853	.0453
linear	38.8796	1	38.8796	7.296	.0091
dev. fr. lin.	6.7201	2	3.3600	.631	.5360
quadratic	.2667	1	.2667	.050	.8238
dev. fr. quad.	6.4534	1	6.4534	1.211	.2758
Within groups	298.3997	56	5.3286		
Total	343.9993	59			

Table 14

Trend Analysis for Control Group (Block Design)

Source	SS	df	MS	F	p
Bet. groups	35.7335	3	11.9112	2.743	.0516
linear	21.3331	1	21.3331	4.912	.0307
dev. fr. lin.	14.4004	2	7.2002	1.658	.1997
quadratic	13.0667	1	13.0667	3.009	.0883
dev. fr. quad.	1.3337	1	1.3337	.307	.5817
Within groups	243.1998	56	4.3429		
Total	278.9331	59			

Table 15

Trend Analysis for Control Group (Object Assembly)

Source	SS	df	MS	F	p
Bet. groups	32.0500	3	10.6833	2.052	.1170
linear	28.8297	1	28.8297	5.537	.0222
dev. fr. lin.	3.2203	2	1.6101	.309	.7353
quadratic	.4167	1	.4167	.080	.7783
dev. fr. quad.	2.8036	1	2.8036	.538	.4662
Within groups	291.5997	56	5.2071		
Total	323.6497	59			

Table 16

Trend Analysis for Control Group (ProVIQ)

Source	SS	df	MS	F	p
Bet. groups	1235.8052	3	411.9348	2.798	.0484
linear	771.2031	1	771.2031	5.238	.0259
dev. fr. lin.	464.6020	2	232.3010	1.578	.2155
quadratic	138.0167	1	138.0167	.937	.3371
dev. fr. quad.	326.5854	1	326.5854	2.218	.1420
Within groups	8245.1951	56	147.2356		
Total	9481.0000	59			

Table 17

Trend Analysis for Control Group (ProPIQ)

Source	SS	df	MS	F	p
Bet. groups	1309.9546	3	436.6514	3.401	.0238
linear	1121.3333	1	1121.3333	8.733	.0046
dev. fr. lin.	188.6214	2	94.3107	.734	.4843
quadratic	187.2667	1	187.2667	1.458	.2323
dev. fr. quad.	1.3547	1	1.3547	.011	.9186
Within groups	7190.6621	56	128.4047		
Total	8500.6133	59			

Table 18

Trend Analysis for LD Group (Naming)

Source	SS	df	MS	F	p
Bet. groups	100.4059	3	33.4686	4.063	.0111
linear	96.3338	1	96.3338	11.694	.0012
dev. fr. lin.	4.0720	2	2.0360	.247	.7819
quadratic	1.0667	1	1.0667	.129	.7203
dev. fr. quad.	3.0054	1	3.0054	.365	.5483
Within groups	461.3330	56	8.2381		
Total	561.7388	59			

Table 19

Trend Analysis for LD Group (Token)

Source	SS	df	MS	F	p
Bet. groups	891.4171	3	297.1389	4.507	.0067
linear	714.5859	1	714.5859	10.838	.0017
dev. fr. lin.	176.8311	2	88.4156	1.341	.2699
quadratic	144.1507	1	144.1507	2.186	.1448
dev. fr. quad.	32.6804	1	32.6804	.496	.4843
Within groups	3692.2632	56	65.9333		
Total	4583.6797	59			

Table 20

Trend Analysis for LD Group (Sentence Repetition)

Source	SS	df	MS	F	p
Bet. groups	14.3167	3	4.7722	1.693	.1790
linear	13.2302	1	13.2302	4.693	.0346
dev. fr. lin.	1.0865	2	.5432	.193	.8253
quadratic	.8167	1	.8167	.290	.5925
dev. fr. quad.	.2698	1	.2698	.096	.7582
Within groups	157.8665	56	2.8190		
Total	172.1831	59			

Table 21

Trend Analysis for LD Group (Similarities)

Source	SS	df	MS	F	p
Bet. groups	2.9333	3	.9778	.144	.9331
linear	1.3333	1	1.3333	.196	.6594
dev. fr. lin.	1.6000	2	.8000	.118	.8891
quadratic	.2667	1	.2667	.039	.8437
dev. fr. quad.	1.3333	1	1.3333	.196	.6594
Within groups	380.3997	56	6.7929		
Total	383.3330	59			

Table 22

Trend Analysis for LD Group (Vocabulary)

Source	SS	df	MS	F	p
Bet. groups	15.2501	3	5.0834	1.358	.2650
linear	13.2300	1	13.2300	3.535	.0653
dev. fr. lin.	2.0201	2	1.0100	.270	.7645
quadratic	.8167	1	.8167	.218	.6422
dev. fr. quad.	1.2034	1	1.2034	.322	.5730
Within groups	209.5997	56	3.7429		
Total	224.8497	59			

Table 23

Trend Analysis for LD Group (Block Design)

Source	SS	df	MS	F	p
Bet. groups	18.1833	3	6.0611	1.266	.2971
linear	16.8031	1	16.8031	3.492	.0669
dev. fr. lin.	1.3802	2	.6901	.143	.8667
quadratic	1.3500	1	1.3500	.281	.5984
dev. fr. quad.	.0302	1	.0302	.006	.9371
Within groups	269.4664	56	4.8119		
Total	287.6497	59			

Table 24

Trend Analysis for LD Group (Object Assembly)

Source	SS	df	MS	F	p
Bet. groups	1.4667	3	.4889	.119	.9485
linear	.6534	1	.6534	.159	.6914
dev. fr. lin.	.8133	2	.4066	.099	.9058
quadratic	.6000	1	.6000	.146	.7037
dev. fr. quad.	.2133	1	.2133	.052	.8205
Within groups	229.8664	56	4.1048		
Total	231.3331	59			

Table 25

Trend Analysis for LD Group (ProVIQ)

Source	SS	df	MS	F	p
Bet. groups	88.8962	3	29.6320	.203	.8937
linear	67.2133	1	67.2133	.461	.4999
dev. fr. lin.	21.6828	2	10.8414	.074	.9284
quadratic	21.6000	1	21.6000	.148	.7018
dev. fr. quad.	.0828	1	.0828	.001	.9811
Within groups	8163.8608	56	145.7832		
Total	8252.7539	59			

Table 26

Trend Analysis for LD Group (ProPIQ)

Source	SS	df	MS	F	p
Bet. groups	192.5175	3	64.1725	.428	.7336
linear	132.0033	1	132.0033	.881	.3521
dev. fr. lin.	60.5142	2	30.2571	.202	.8178
quadratic	58.0167	1	58.0167	.387	.5364
dev. fr. quad.	2.4976	1	2.4976	.017	.8978
Within groups	8394.5283	56	149.9023		
Total	8587.0430	59			

Table 27

Ravenl Scores

	Group[a]			
	LD		Control	
Agegroup	Mean	SD	Mean	SD
8	20.27	4.33	24.80	3.61
9	20.53	3.27	24.53	4.26
10	22.20	5.57	27.00	3.49
11	24.13	5.01	27.27	3.01
Total	21.78	4.77	25.90	3.74

[a]n = 15 for each age level in each group

Table 28

Ravenl ANOVA

Source	SS	df	MS	F	p
Group (G)	508.409	1	508.409	29.475	$<.001$
Agegroup (A)	223.559	3	74.520	4.320	.007
G x A	12.158	3	4.053	.235	$>.500$
Within	1931.875	112	17.249		
Total	2676.000	119	22.487		

Table 29

Neuman-Keuls Analyses for Ravenl ANOVA (Group by Agegroup)

Critical W values			
	Range (r)		
p value	2	3	4
.05	3.012	3.613	3.956
.01	3.977	4.513	4.835

Agegroup Mean Differences (column - row)

LD	9	10	11	Control	8	10	11
8	.266	1.933	3.866	9	.267	2.467	2.734
9		1.667	3.600	8		2.200	2.467
10			1.933	10			.267

Group Mean Differences (control - ld)

Agegroup	Mean Differences	
8	4.533	**
9	4.000	**
10	4.800	**
11	3.134	*

Note. * $p < .05$

** $p < .01$

Table 3Ø

Trend Analysis for Control Group (Ravenl)

Source	SS	df	MS	F	p
Bet. groups	92.3336	3	3Ø.7779	2.351	.Ø82Ø
linear	73.Ø138	1	73.1Ø38	5.578	.Ø217
dev. fr. lin.	19.3198	2	9.6599	.738	.4827
quadratic	1.Ø666	1	1.Ø666	.Ø81	.7764
dev. fr. quad.	18.2532	1	18.2532	1.394	.2427
Within groups	733.Ø664	56	13.Ø9Ø5		
Total	825.3999	59			

Table 31

Trend Analysis for LD Group (Ravenl)

Source	SS	df	MS	F	p
Bet. groups	143.3885	3	47.7962	2.233	.0944
linear	132.0040	1	132.0040	6.166	.0160
dev. fr. lin.	11.3845	2	5.6923	.266	.7675
quadratic	10.4167	1	10.4167	.487	.4883
dev. fr. quad.	.9679	1	.9679	.045	.8324
Within groups	1198.7984	56	21.4071		
Total	1342.1868	59			

Table 32

RDELTA t-test Values

	Condition					
	Standard		Verbal		Focus	
Group[a]	t	p	t	p	t	p
Control	1.72	.102	5.95	.000	8.72	.000
LD	2.15	.045	6.28	.000	2.49	.022

Note. df = 19 for all t-tests

[a]n = 20 for each group

Table 33

Test of Homogeneity of Regression Coefficients

(RDELTA/Raven1)

Source	SS	df	MS	F	p
Zero slope	56.0278	1	56.0278	5.9340	.0164
error	1066.9202	113	9.4418		
Equality of slopes	48.8640	5	9.7728	1.0367	.3999
error	1018.0562	108	9.4264		

Table 34

RDELTA/Ravenl ANOCOVA

Source	SS	df	MS	F	p
Group (G)	32.620	1	32.620	3.455	.066
Condition (C)	107.673	2	53.836	5.702	.005
G x C	120.981	2	60.491	6.407	.003
Cov. (Ravenl)	56.028	1	56.028	5.934	.017
Error	1066.921	113	9.442		

Table 35

RDELTA Data

		Group[a]			
		Control		LD	
Condition	Variable	Mean	SD	Mean	SD
Standard	Raven1	26.550	3.927	23.100	4.529
	Raven2	27.700	4.194	25.000	6.391
	RDELTA	1.150	2.996	1.900	3.959
	Adj. RDELTA	1.599		1.777	
Verbal	Raven1	26.500	3.348	21.900	4.621
	Raven2	29.900	3.712	26.350	4.082
	RDELTA	3.350	2.519	4.450	3.170
	Adj. RDELTA	3.799		4.128	
Focus	Raven1	24.600	3.761	20.350	4.977
	Raven2	29.750	3.596	22.200	5.396
	RDELTA	5.150	2.641	1.850	3.329
	Adj. RDELTA	5.276		1.271	

[a]n = 20 for each group in each condition

Table 36

Neuman-Keuls Analyses for RDELTA ANOCOVA (Group by Condition)

Critical W Values		
	Range (r)	
p value	2	3
.05	1.926	2.319
.01	2.552	2.896

Condition Mean Differences (column - row)

LD	Standard	Verbal
Focus	.506	2.857 *
Standard		2.351 *

Control	Verbal	Focus
Standard	2.200 *	3.677 **
Verbal		1.477

Group Mean Differences (control - ld)

Condition	Mean Difference
Standard	- .178
Verbal	- .329
Focus	4.005 **

Note. * $p < .05$

** $p < .01$

Table 37

Test of Homogeneity of Regression Coefficients

(RDELTA/Ravenl) with Agegroup Included as a Factor

Source	SS	df	MS	F	p
Zero slope	53.8079	1	53.8079	5.5406	.0206
error	922.5903	95	9.7115		
Equality of slopes	224.2646	23	9.7506	1.0053	.4705
error	698.3257	72	9.6990		

Table 38

RDELTA/Ravenl ANOCOVA with Agegroup Included as a Factor

Source	SS	df	MS	F	p
Group (G)	35.424	1	35.424	3.648	.060
Condition (C)	105.288	2	52.644	5.421	.006
Agegroup (A)	51.809	3	17.270	1.778	.157
G x C	121.184	2	60.592	6.239	.003
G x A	40.474	3	13.491	1.389	.251
C x A	39.866	6	6.644	.684	>.500
G x C x A	11.583	6	1.931	.199	>.500
Cov. (Ravenl)	53.807	1	53.807	5.541	.021
Error	922.591	95	9.711		

Table 39

Scale Data for First Administration (A1, Ab1, B1)

		Group			
		LD		Control	
Scale	Agegroup[a]	Mean	SD	Mean	SD
	8	8.6000	1.5024	9.5333	1.3558
	9	8.9333	.8837	10.0667	.9612
A1	10	8.5333	1.6847	10.0667	1.5796
	11	9.4000	1.2984	10.1333	1.0601
	Total	8.6667	1.3835	9.9500	1.2545
	8	6.1333	1.9952	8.5333	1.8179
	9	6.2000	1.8593	8.0000	1.7674
Ab1	10	7.8000	2.1448	9.5333	2.0702
	11	8.2667	2.4919	9.2000	1.5055
	Total	7.1000	2.2900	8.8167	1.8167
	8	5.5333	2.2949	6.7333	2.1202
	9	5.4000	1.7238	6.4667	2.2636
B1	10	5.8667	2.1668	7.4000	2.1974
	11	6.4667	2.0999	7.9333	1.4864
	Total	5.8167	2.0707	7.1333	2.0705

[a]n = 5 for each age level in each group

Table 40

Scale Data (Al, Abl, Bl) ANOVA

Source	SS	df	MS	F	p
Group (G)	169.470	1	169.470	27.678	<.001
s.w.g.	722.490	118	6.123		
Scale (S)	516.289	2	258.144	123.439	<.001
G x S	6.156	2	3.078	1.472	.232
S x s.w.g.	493.540	236	2.091		
Total	1907.943	359	5.315		

Table 41

Neuman-Keuls Analyses for Scale ANOVA (Group by Scale)

Critical W Values		
	Range (r)	
p value	2	3
.05	.5227	.6273
.01	.6907	.7841

Inter-scale Differences		
	Group	
Difference	LD	Control
Al - Abl	1.7667	1.1333 **
Al - Bl	3.0500	2.8167 **
Abl - Bl	1.2833	1.6834 **

Note. ** $p < .01$

Table 42

Trend Analysis for Control Group (A-scale1)

Source	SS	df	MS	F	p
Bet. groups	3.5167	3	1.1722	.735	.5356
linear	2.4301	1	2.4301	1.523	.2223
dev. fr. lin.	1.0866	2	.5433	.341	.7128
quadratic	.8167	1	.8167	.512	.4773
dev. fr. quad.	.2699	1	.2699	.169	.6824
Within groups	89.3332	56	1.5952		
Total	92.8499	59			

Table 43

Trend Analysis for Control Group (Ab-scale1)

Source	SS	df	MS	F	p
Bet. groups	21.1165	3	7.0388	2.267	.0906
linear	9.3633	1	9.3633	3.016	.0880
dev. fr. lin.	11.7532	2	5.8766	1.893	.1602
quadratic	.1500	1	.1500	.048	.8268
dev. fr. quad.	11.6032	1	11.6032	3.737	.0583
Within groups	173.8664	56	3.1048		
Total	194.9830	59			

Table 44

Trend Analysis for Control Group (B-scale1)

Source	SS	df	MS	F	p
Bet. groups	19.7331	3	6.5777	1.580	.2045
linear	15.4133	1	15.4133	3.701	.0595
dev. fr. lin.	4.3198	2	2.1599	.519	.5981
quadratic	2.4000	1	2.4000	.576	.4509
dev. fr. quad.	1.9198	1	1.9198	.461	.4999
Within groups	233.1997	56	4.1643		
Total	252.9328	59			

Table 45

Trend Analysis for LD Group (A-scale1)

Source	SS	df	MS	F	p
Bet. groups	7.0668	3	2.3556	1.246	.3018
linear	3.0001	1	3.0001	1.587	.2130
dev. fr. lin.	4.0667	2	2.0334	1.076	.3480
quadratic	1.0667	1	1.0667	.564	.4557
dev. fr. quad.	3.0000	1	3.0000	1.587	.2130
Within groups	105.8665	56	1.8905		
Total	112.9333	59			

Table 46

Trend Analysis for LD Group (Ab-scale1)

Source	SS	df	MS	F	p
Bet. groups	53.9334	3	17.9778	3.941	.0127
linear	48.0000	1	48.0000	10.522	.0020
dev. fr. lin.	5.9334	2	2.9667	.650	.5258
quadratic	.6000	1	.6000	.132	.7182
dev. fr. quad.	5.3334	1	5.3334	1.169	.2842
Within groups	255.4664	56	4.5619		
Total	309.3997	59			

Table 47

Trend Analysis for LD Group (B-scale1)

Source	SS	df	MS	F	p
Bet. groups	10.1832	3	3.3944	.783	.5085
linear	8.0033	1	8.0033	1.846	.1797
dev. fr. lin.	2.1798	2	1.0899	.251	.7786
quadratic	2.0167	1	2.0167	.465	.4980
dev. fr. quad.	.1632	1	.1632	.038	.8469
Within groups	242.7998	56	4.3357		
Total	252.9829	59			

Table 48

ADELTA Data

		Group[a]			
		Control		LD	
Condition	Variable	Mean	SD	Mean	SD
Standard	A1	9.950	1.504	9.250	1.209
	A2	10.200	.952	9.400	1.353
	ADELTA	.250	1.164	.150	1.309
	Adj. ADELTA	.550		.062	
Verbal	A1	10.150	1.182	8.950	1.605
	A2	10.800	1.005	10.700	1.380
	ADELTA	.650	1.040	1.750	1.618
	Adj. ADELTA	1.061		1.496	
Focus	A1	9.750	1.070	8.400	1.231
	A2	10.850	.988	9.000	1.947
	ADELTA	1.100	1.252	.600	1.789
	Adj. ADELTA	1.289		.041	

[a] n = 20 for each group in each condition

Table 49

AbDELTA Data

		Group[a]			
		Control		LD	
Condition	Variable	Mean	SD	Mean	SD
Standard	Ab1	9.300	1.455	7.800	2.238
	Ab2	9.700	1.809	8.450	2.328
	AbDELTA	.400	1.569	.650	1.814
	Adj. AbDELTA	.960		.584	
Verbal	Ab1	9.100	1.832	6.950	2.064
	Ab2	10.100	1.294	8.550	1.986
	AbDELTA	1.000	1.556	1.600	2.010
	Adj.AbDELTA	1.477		1.179	
Focus	Ab1	8.050	1.959	6.550	2.481
	Ab2	9.850	1.694	7.400	2.161
	AbDELTA	1.800	1.542	.850	1.785
	Adj. AbDELTA	1.838		.262	

[a] n = 20 for each group in each condition

Table 50

BDELTA Data

		Group[a]			
		Control		LD	
Condition	Variable	Mean	SD	Mean	SD
Standard	B1	7.300	2.342	6.050	2.282
	B2	7.800	2.331	7.150	3.167
	BDELTA	.500	1.821	1.100	1.832
	Adj. BDELTA	.698		.998	
Verbal	B1	7.300	1.838	6.000	1.919
	B2	9.000	2.471	7.100	2.614
	BDELTA	1.700	2.296	1.100	2.808
	Adj. BDELTA	1.898		.986	
Focus	B1	6.800	2.067	5.400	2.037
	B2	9.050	2.013	5.800	2.308
	BDELTA	2.250	1.585	.400	1.353
	Adj. BDELTA	2.328		.142	

[a]n = 20 for each group in each condition

Table 51

Test of Homogeneity of Regression Coefficients

(ADELTA/A1)

Source	SS	df	MS	F	p
Zero slope	60.3862	1	60.3862	42.9664	.0000
error	158.8134	113	1.4054		
Equality of slopes	3.3959	5	.6792	.4720	.7964
error	155.4175	108	1.4391		

Table 52

Test of Homogeneity of Regression Coefficients

(AbDELTA/Abl)

Source	SS	df	MS	F	p
Zero slope	82.0193	1	82.0193	36.2209	.0000
error	255.8796	113	2.2644		
Equality of slopes	5.3847	5	1.0769	.4643	.8020
error	250.4949	108	2.3194		

Table 53

Test of Homogeneity of Regression Coefficients

(BDELTA/B1)

Source	SS	df	MS	F	p
Zero slope	28.7126	1	28.7126	7.5343	.0070
error	430.6362	113	3.8109		
Equality of slopes	29.9304	5	5.9861	1.6134	.1626
error	400.7058	108	3.7102		

Table 54

ADELTA/A1 ANOCOVA

Source	SS	df	MS	F	p
Group (G)	4.782	1	4.782	3.403	.068
Condition (C)	19.335	2	9.667	6.879	.002
G x C	14.204	2	7.102	5.053	.008
Cov. (A1)	60.386	1	60.386	42.966	$<.001$
Error	158.814	113	1.405		

Table 55

AbDELTA/Abl ANOCOVA

Source	SS	df	MS	F	p
Group (G)	14.219	1	14.219	6.279	.014
Condition (C)	6.108	2	3.054	1.349	.264
G x C	10.250	2	5.125	2.263	.109
Cov. (Abl)	82.019	1	82.019	36.221	<.001
Error	255.881	113	2.264		

Table 56

BDELTA/B1 ANOCOVA

Source	SS	df	MS	F	p
Group (G)	23.644	1	23.644	6.204	.015
Condition (C)	7.266	2	3.633	.953	.389
G x C	30.901	2	15.451	4.054	.020
Cov. (B1)	28.713	1	28.713	7.534	.008
Error	430.637	113	3.811		

Table 57

Scale DELTA data t-test Values

		Scale					
		ADELTA		ABDELTA		BDELTA	
Group	Condition	t	p	t	p	t	p
Control	Standard	-.96	.349	-1.14	.269	-1.23	.234
	Verbal	-2.80	.012	-2.87	.010	-3.31	.004
	Focus	-3.93	.001	-5.22	.000	-6.35	.000
LD	Standard	-.51	.614	-1.60	.126	-2.68	.015
	Verbal	-4.84	.000	-3.56	.002	-1.75	.096
	Focus	-1.50	.150	-2.13	.047	-1.32	.202

Note. df = 19 in all t-tests; n = 20 for each condition in each group

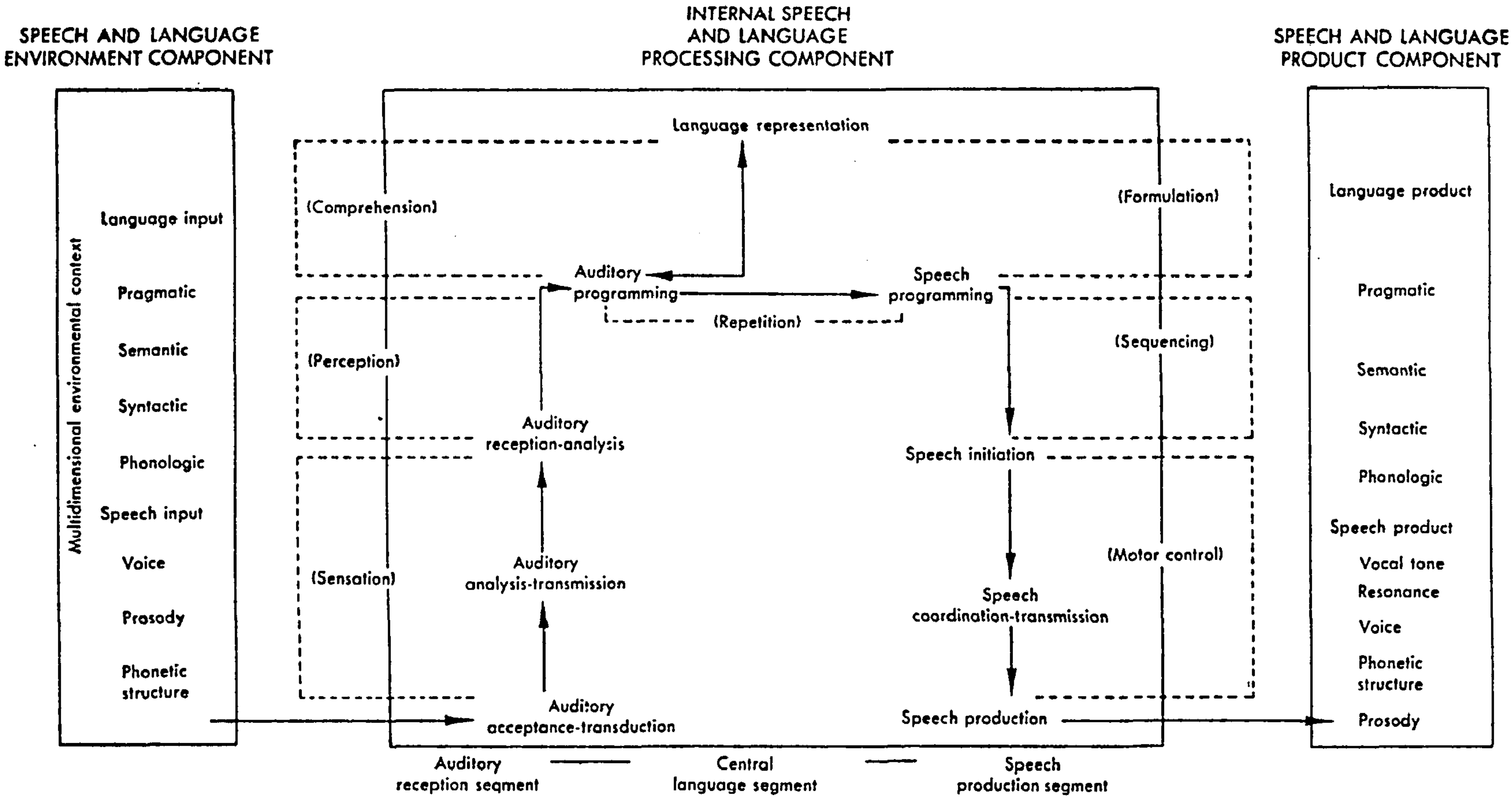

Fig. 3-2. Speech and language processing model.

Figure 1. Nation and Aram's Speech and Language Processing Model.

Note. From Nation, J. E., & Aram, D. M. Diagnosis of speech and language disorders. Saint Louis: The C. V. Mosby Company, 1972. Reprinted by permission of authors and The C. V. Mosby Company.

		Standard	Verbal	Focus
LD	8			
	9			
	10			
	11			
Control	8			
	9			
	10			
	11			

Figure 2. Experimental Design. Completely Randomized Factorial Design (Kirk, 1968). n = 5 per cell.

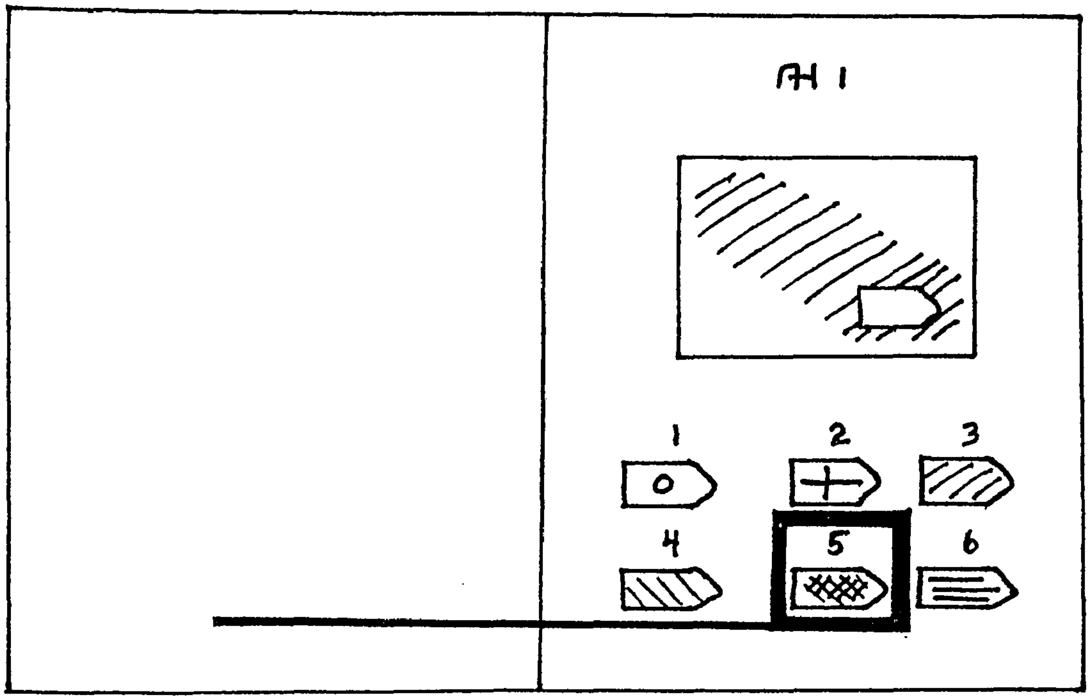

Figure 3. "Focus" condition window apparatus in use

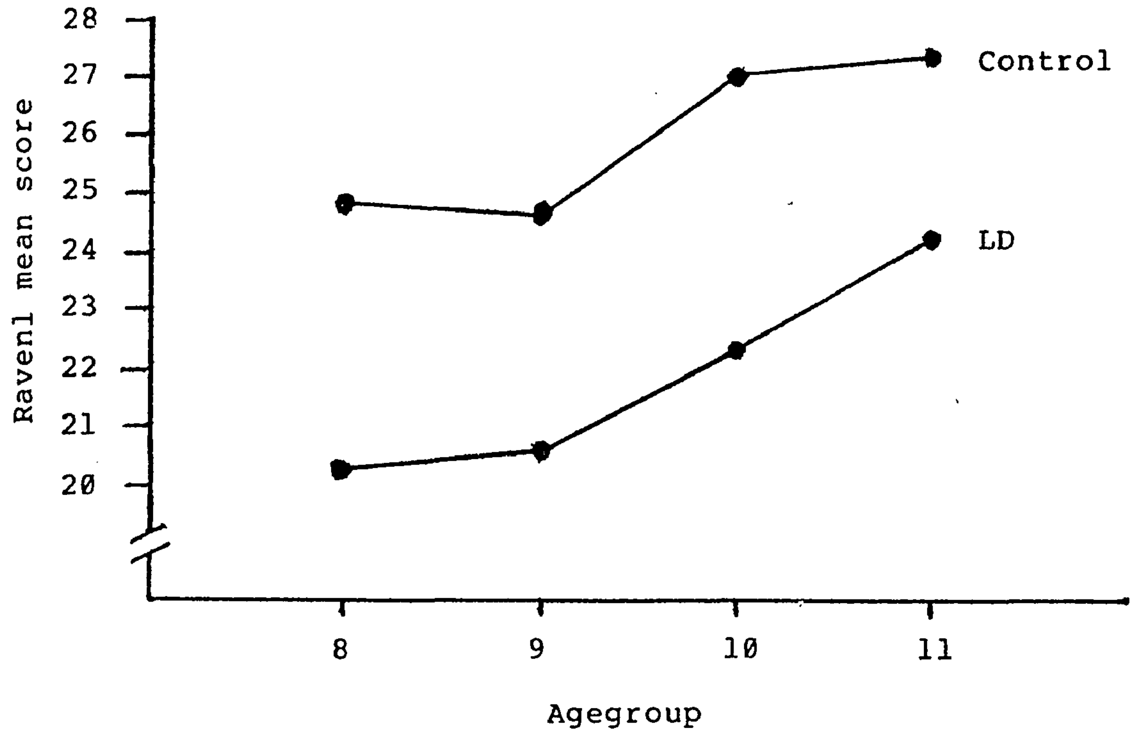

Figure 4. Ravenl mean scores (agegroup by group)

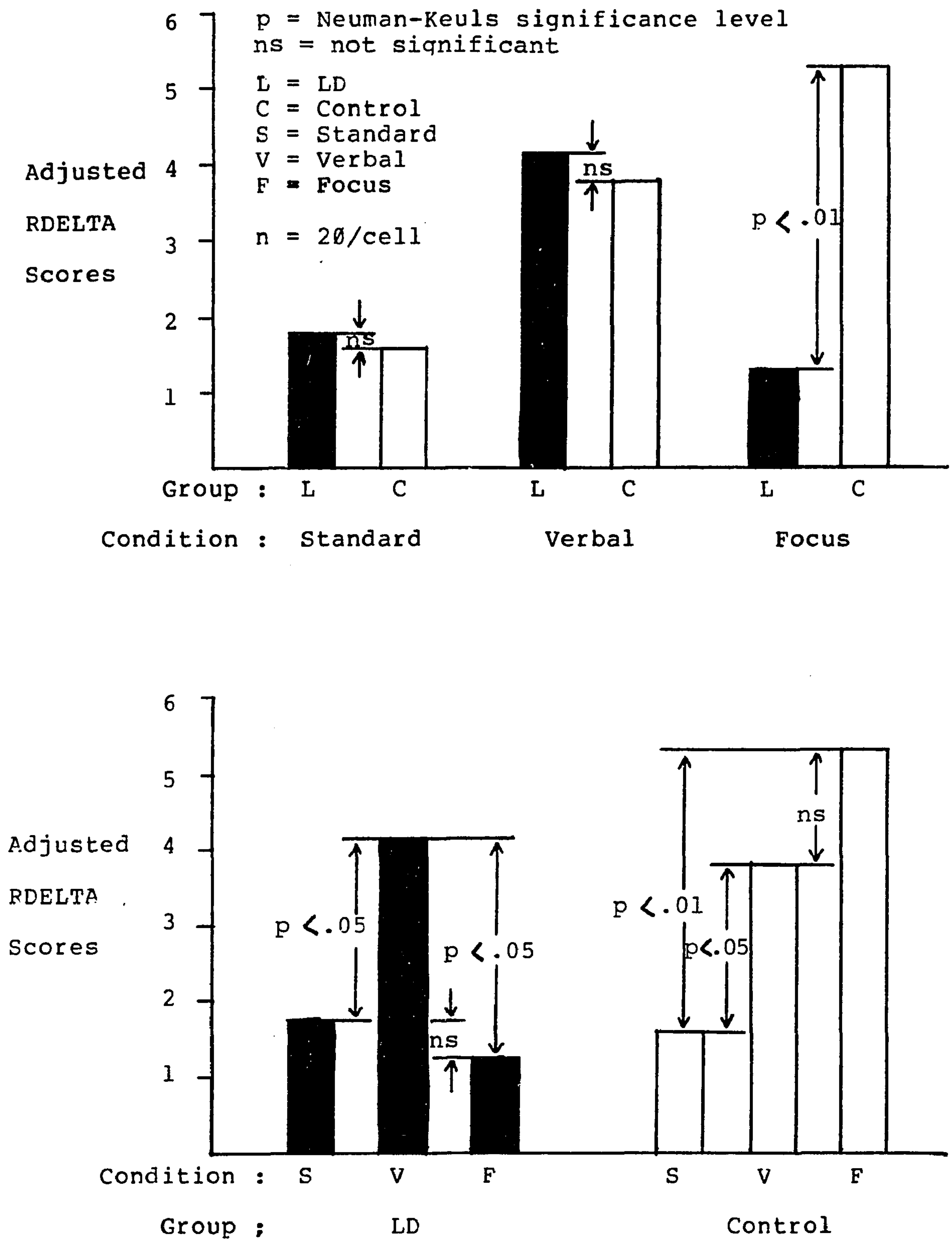

Figure 6. Adjusted RDELTA mean scores - group by condition

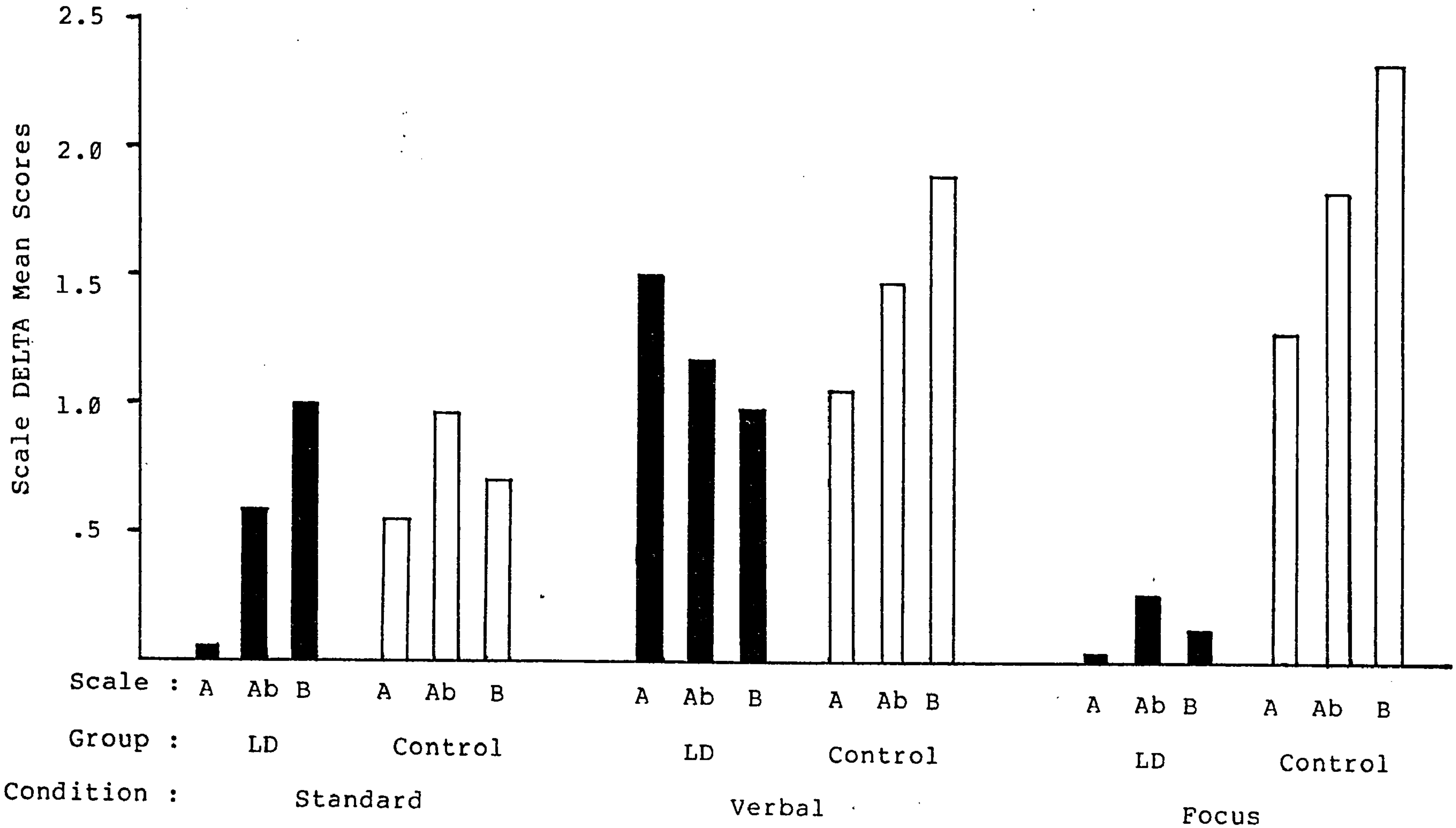

Figure 6. Adjusted scale DELTA mean scores - group by condition by scale

Appendix A. Proposed Descriptive Analytical Study of the RPM

The proposed method would have involved having a group of normal, non brain-damaged subjects of various ages talk out their answers, and the processes leading to them, using a continuous self-reporting introspective method. The resultant stream of consciousness type of discourse would be recorded and later analyzed for various important points, e.g.: (a) references to component parts of the stimulus figure and the response choices, (b) comparisons made between and within any portions of the stimulus and response figures, (c) equivalences and differences noted, (d) hypotheses entered into, (e) discussions of methods of resolutions of these hypotheses, (f) inferential routes taken, and (g) conclusions arrived at. Subjects would be encouraged to fully describe any parts of the figures which entered into their problem solving techniques and to point to the parts of the figures when mentioning them. After an extensive set of responses was collected, the next step would be to codify and categorize the items and component parts of each item. An overall system for classifying matrix items such as that developed by Ward and Fitzpatrick (1973) would be used initially, and a more detailed method of classifying individual components of the matrix items would be derived from the collected data.

The final step in the process would be to take the completed "Normal Reference Manual" and use it to score modified RM protocols obtained from brain-damaged patients who would also be asked to respond to the items in the proposed "talking out" method. Certain problems with the method were recognized and solutions were proposed. It has been noted (Bromley, 1953; Cassell, 1949) that "mentally deficient" subjects tend to give up easily, respond randomly, and have difficulties giving reasons for choices on the RM tests. To deal with these problems, the tests could be given in short sections over extended sessions, with innocuous verbal probes inserted wherever necessary such as, "What part of the page are you looking at now? Point to it". The problem of nonspeaking or nonfluent aphasic patients could be approached by recording eye movement scan patterns (Noton & Stark, 1971) and then qualitatively analyzing the scanning patterns for sequences of movement, frequency and duration of localized fixations, etc. Wamba and Marzolf (1955) have shown that using eye movement as a response indicator on the CPM in normal children is an extremely valid and reliable method of obtaining overall scores.

Appendix B. Parental Letters and Waivers

Dear Parent,

I am writing this letter to ask for your assistance. I am a psychologist with the Center for Child Development at the Morrisania Neighborhood Family Care Center, 169 St. and Gerard Ave., Bronx, N.Y. 10452. Perhaps you are aware of the NFCC and have used it in the past for regular medical care. The CCD has been working with the schools in this district for over five years, helping over 1000 students. In my job there, I test children who are having trouble learning at school and try to find ways to help the children learn. I am now working to finish my own schooling and I'm doing a project which I hope will lead to better ways of teaching for children who are having trouble learning in school, and also for children with no problems. I now have to test some children who are having difficulty in school, and are in special classes such as your child. I would like to work with some children from your child's school. The tests do not take long and the children usually find them fun to take. I have the school's permission to write this letter to you, but cannot test any children without the parent's consent. If you would like to take part in this study, please sign the enclosed waiver and return it to the school with your child. I'd be glad to talk to any parents who have questions at any time. I can be reached Monday through Friday, 9-5, at 960-2991. Thank you very much for your cooperation,

Sincerely,

Raymond Pass

Appendix B. (cont.)

Estimados Padres,

Estoy escribiendole esta carta para pedir su ayuda. Soy un psicologo trabajando con el Center for Child Development en el Morrisania Neighborhood Family Care Center que queda en la calle 168 y Gerard Ave., Bronx, N.Y., 10452. Quisas Ud. ya conoce el NFCC y ha venido para su cuido medico. El CCD ha trabahado con ninos en este distrito por cinco anos, ayudando mas de 1000 estudiantes. Mi trabajo ha sido evaluar ninos que tienen dificultades en el aprender para ayudarles aprender mejor. Yo estoy terminando mi educacion y estoy planeando un estudio que yo espero que nos de mejores metodos para la ensenanza del nino con problemas escolares, como tambien para la ayuda de los ninos sin problemas. Ahora to tengo que evaluar ninos que tienen problemas en el aprender y estan en clases especiales como su nino. Me gustaria trabajar con algunos ninos de la escuela que su nino asiste. Los examenes no toman mucho tiempo y usualmente los ninós se divierten mucho con los examenes. Yo he obtenido el permiso de la escuela para mandarles esta carta, pero no puedo evaluar los ninos sin su permiso. Si Ud. le gustaria tomar parte en este estudio, por favor firme el permiso incluido con esta carta y devuelvalo a la escuela con su nino. Yo estoy dispuesto hablar con cualquier padre que tenga alguna pregunta. Se puede comunicar conmigo de 9 a 5, lunes a viernes llamando al 960-2991. Muchas gracias por su cooperacion.

Sinceramente,

Raymond Pass

Appendix B, (cont.)

Dear Parent,

I am writing this letter to ask for your assistance. I am a psychologist with the Center for Child Development at the Morrisania Neighborhood Family Care Center, 168 St. and Gerard Ave., Bronx, N.Y. 10452. Most probably you are aware of the NFCC and have used it in the past for regular medical care. The CCD has been working with the schools in this district for over five years, helping over 1000 students. In my job there, I test children who are having trouble learning at school and try to find ways to help the children learn. I am now working to finish my own schooling and I'm doing a project which I hope will lead to better ways of teaching for children who are having problems learning in school, and also for children with no problems. I now have to test some children who are learning normally, with no difficulty. I would like to work with some children from your child's school. The tests do not take long and the children usually find them fun to take. I have the school's permission to write this letter to you, but cannot test any children without the parent's consent. If you would like to take part in this study, please sign the enclosed waiver and return it to the school. I'd be glad to talk to any parents who have questions at any time. Thank you very much for your cooperation. I can be reached Monday through Friday 9-5 at 960-2991.

Sincerely,

Raymond Pass

Appendix B. (cont.)

Estimados Padres,

Estoy escribiendole esta carta para pedir su ayuda. Soy un psicologo trabajando con el Center for Child Development en el Morrisania Neighborhood Family Care Center que queda en la calle 168 y Gerard Ave, Bronx, N.Y. 10452. Muy probable Ud. ya conoce el NFCC y ha venido para su cuido medico. El CCD ha trabajado con ninos en este distrito por cinco anos, ayudando mas de 1000 estudiantes. Mi trabajo ha sido evaluar ninos que tienen dificultades en el aprender para ayudarles aprender mejor. Yo estoy terminando mi educacion y estoy planeando un estudio que yo espero que nos de mejores metodos para la ensenanza del nino con problemas escolares, como tambien para la ayuda de los ninos sin problemas. Ahora yo tengo que evaluar ninos que no tienen problemas en el aprender. Me gustaria trabajar con algunos ninos de la escuela que su nino asiste. Los exames no toman mucho tiempo y usualmente los ninos se divierten mucho con los examenes. Yo he obtenido el permiso de la escuela para mandarles esta carta, pero no puedo evaluar los ninos sin su permiso. Si Ud. le gustaria tomar parte en este estudio, por favor firme el permiso incluido con esta carta y devuelvalo a la escuela. Yo estoy dispuesto hablar con cualquier padre que tenga alguna pregunta. Muchas gracias por su cooperacion. Se puede comunicar conmigo de 9 a 5, lunes a viernes llamando al 960-2991.

Sinceramente,

Raymond Pass

Appendix B. (cont.)

Dear ____________________,

I am writing this letter to ask for your assistance. I am a psychologist with the Center for Child Development at the Morrisania Neighborhood Family Care Center where your child ____________________ ____________________ was evaluated in ____________________. Either myself or one of the other psychologists here at the CCD tested ______________. I am now doing a project which I hope will lead to better ways of teaching for children who are having trouble learning, as ____________________ is. The project involves giving some tests for a second time to some of the children who were seen here, and possibly then/referred for special classes. If you are interested in participating in this study, or just in finding out more about it, please call me at 960-2991, Monday through Friday from 9 to 5. I very much appreciate your help and look forward to speaking with you.

Sincerely,

Raymond Pass

Appendix B. (cont.)

Estimado/a ______________________,

Escribo esta carta para pedirle su ayuda. Yo soy un sicologo con el Center for Child Development en el Morrisania Neighborhood Family Care Center, adonde su nino/a __________________________________ fue evaluada __________________. Yo o quisas uno de los otros sicologos aqui en CCD evaluo a ____________________. Yo ahora estoy haciendo un estudio que yo espero tenga resultados en como mejor ensenar a los ninos con problemas en el aprender, igual a __________________. Este estudio requiere la administracion por segunda vez de algunos de los examenes ya dado a algunos de los ninos que hemos visto aqui en el Centro, y que posiblemente han sido referido para una clase especial. Si Ud. le gustaria tomar parte en este estudio, o si quisiera saber mas sobre ests estudio, por favor llamar a este numero 960-2991, lunes a viernes de 9 a 5. Estoy muy agradecido por su ayuda y espero anciosamente poder hablar con Ud.

Sinceramente,

Raymond Pass

Raymond Pass

Appendix B. (cont.)

I ____________________________, hereby give permission to have

my child __________________________take part in the study being

conducted by Mr. Raymond Pass. I understand that this will involve my child taking a number of tests to be given by Mr. Pass. Although the tests will be given in my child's school, I understand that the school,____________________, is not responsible for the design or running of the study, or the analysis of the results. These responsibilities are entirely that of Mr. Pass.

_____________ Date

__________________________ Signature

Yo ___________________________, doy mi permiso par que mi nino/a

____________________________participe en un estudio conducido por el Sr. Raymond Pass. Yo comprendo que esto significa que mi nino/a participara en una series de examenes administrado por el Sr. Pass. Aunque los examenes seran administrados en la escuela, yo comprendo que la escuela _________________, no es responsable por la

administracion del estudio, ni por los analisis de sus resultados. La responsabilidad de este estudio sera enteramente del Sr. Pass.

_______________ Fecha

__________________________ Firma

Appendix B. (cont.)

I, ________________________________, hereby give permission to have my child, ________________________________, take part in the study being conducted by Mr. Raymond Pass. I understand that this will involve my child taking a number of tests to be given by Mr. Pass. Although the tests will be given at the Morrisania Center for Child Development, I understand that neither the Center for Child Development, nor the Morrisania Neighborhood Family Care Center, is responsible for the design or runing of the study, or the analysis of the results. These responsibilities are entirely that of Mr. Pass.

____________________ Date

____________________________________ Signature

Yo, ______________________________, doy mi permiso para que mi nino/a, ______________________________ participe en el estudio conducido por el Sr. Raymond Pass. Yo comprendo que esto significa que mi nino/a participara en una series de examenes administrado por el Sr. Pass. Aunque los examenes seran administrados en el Center for Child Development, yo comprendo que ni el Center for Child Development, ni el Morrisania Neighborhood Family Care Center, es responsable por la administracion del estudio o por los analisis de sus resultados. La responsabilidad de este estudio sera enteramente del Sr. Pass.

____________________ Fecha

____________________________________ Firma

Appendix C. N.Y.C. Board of Education Permission Letter

BOARD OF EDUCATION OF THE CITY OF NEW YORK
OFFICE OF EDUCATIONAL EVALUATION
110 LIVINGSTON STREET, BROOKLYN, N. Y. 11201

ALAN S. BLUMNER, PH.D.
ACTING DIRECTOR

RICHARD T. TURNER, PH.D.
ASST. ADMIN. DIRECTOR

January 12,1979

Mr. Raymond Pass
115 DeHaven Drive
Yonkers, New York 10703

Dear Mr. Pass:

I am happy to inform you that your proposed study entitled, "AN INVESTIGATION OF INTERNAL VERBAL MEDIATION DURING THE SOLUTION OF THE SURFACE NON-VERBAL VISUAL PERCEPTION PROBLEMS" has been approved by the Office of Educational Evaluation, with the following conditions:

1. Before involving any child in your study, you must obtain written parental consent. (I have enclosed a form which you may follow in drawing up your own Parental Permission Form.)

2. Your report of the study should not include identification of any school or school personnel. A code system should be used.

3. You must make it very clear to your prospective respondents that their cooperation is on a purely voluntary basis.

Whenever your report is ready, I would be interested in receiving a copy.

Best wishes in this endeavor.

Sincerely yours,

Alan S. Blumner
Acting Director

ASB:gew
Encls.

P.S. You may duplicate this letter in any quantity you need in order to inform cooperating principals and community superintendents that you have received approval from the Office of Educational Evaluation.

Appendix D. Score Sheet for Mattis Naming Test

MATTIS NAMING TEST

Name__________ Date________ No.____ -

OBJECTS

Cup ____ __________

Spoon ____ __________

Comb ____ __________

Ashtray ____ __________

Ring ____ __________

Fork ____ __________

Matches ____ __________

Jar ____ __________

Light bulb ____ __________

Pen ____ __________

Shoe lace ____ __________

Bottle ____ __________

Envelope ____ __________

Spring ____ __________

COLORS

Red ____ __________

Green ____ __________

Blue ____ __________

Yellow ____ __________

Pink ____ __________

Orange ____ __________

White ____ __________

BODY PARTS

Nose ____ __________

Mouth ____ __________

Chin ____ __________

Thumb ____ __________

Shoulder ____ __________

Wrist ____ __________

Elbow ____ __________

Knee ____ __________

Ankle ____ __________

Σ ____

Appendix E. Score Sheet for Sentence Repetition Test

NEUROSENSORY CENTER COMPREHENSIVE EXAMINATION FOR APHASIA

TEST 5 Sentence Repetition

		I	II	III	IV
1.	Look				
2.	Come here.				
3.	Help yourself.				
4.	Bring the table.				
5.	Summer is coming.				
6.	The iron was quite hot.				
7.	The birds were singing all day.				
8.	The paper was under the chair.				
9.	The sun was shining throughout the day.				
10.	He entered about eight o'clock that night.				
11.	The pretty house on the mountain seemed empty.				
12.	The lady followed the path down the hill toward home.				
13.	The island in the ocean was first noticed by the young boy.				
14.	The distance between these two cities is too far to travel by car.				
15.	A judge here knows the law better than those people who must appear before him.				
16.	There is a new method in making steel which is far better than that used before.				
17.	This nation has a good government which gives us many freedoms not known in times past.				
18.	The friendly man told us the directions to the modern building where we could find the club.				
19.	The king knew how to rule his country so that his people would show respect for his government.				
20.	Yesterday he said he would be near the village station before it was time for the train to come.				
21.	His interest in the problem increased each time that he looked at the report which lay on the table.				
22.	Riding his black horse, the general came to the scene of the battle and began shouting at his brave men.				

Appendix F. Score Sheet for Token Test

TOKEN TEST

Present tokens in random order. Instructions may be repeated once:

1. Show me a circle
2. Show me a square
3. Show me a yellow one
4. Show me a red one
5. Show me a blue one
6. Show me a green one
7. Show me a white one

Total A (7)

Present only large tokens in random order. Instructions may be repeated once:

8. Show me the yellow square
9. Show me the blue circle
10. Show me the green circle
11. Show me the white square

Total B (8)

Present all tokens in random order. Do not repeat instructions:

12. Show me the small white circle
13. Show me the large yellow square
14. Show me the large green square
15. Show me the small blue square

Total C (12)

Present large tokens only in random order. Do not repeat instructions:

16. Take the red circle and the green square
17. Take the yellow square and the blue square
18. Take the white square and the green circle
19. Take the white circle and the red circle

Total D (16)

Present all tokens in random order. Do not repeat instructions:

20. Take the large white circle and the small green square
21. Take the small blue circle and the large yellow square
22. Take the large green square and the large red square
23. Take the large white square and the small green circle

Total E (24)

/mc

Appendix F. (cont.)

TOKEN TEST

Present large squares in first and large circles in second row only. Green and yellow colors should be adjacent.						
24. Put the red circle on the green square.						
25. Put the white square behind the yellow circle.						
26. Touch the blue circle with the red square.						
27. Touch the blue circle and the red square.						
28. Pick up the blue circle or the red square.						
29. Move the green square away from the yellow square.						
30. Put the white circle in front of the blue square.						
31. If there is a black circle, pick up the red square.						
32. Pick up all squares except the yellow one.						
33. Put the green square beside the red circle.						
34. Touch the squares slowly and the circles quickly.						
35. Put the red circle between the yellow square and the green square.						
36. Touch all circles, except the green one.						
37. Pick up the red circle - no - the white square.						
38. Instead of the white square, pick up the yellow circle.						
39. Together with the yellow circle, pick up the blue circle.						

/cr

Total F (96)

Appendix G. Order of Presentation of Answer Choices in "Focus" Condition

	Scale		
Item	A	Ab	B
1	1 2 3 6 5 4	5 2 4 3 1 6	3 1 5 2 4 6
2	6 3 4 1 5 2	5 6 1 2 3 4	4 6 3 5 1 2
3	5 6 1 2 3 4	2 4 6 1 3 5	4 1 2 5 6 3
4	2 3 1 4 6 5	4 1 2 5 6 3	6 4 5 3 2 1
5	5 2 4 3 1 6	2 3 1 4 6 5	1 2 3 6 5 4
6	4 6 3 5 1 2	3 1 5 2 4 6	1 5 6 4 2 3
7	6 4 5 3 2 1	1 5 6 4 2 3	2 3 1 4 6 5
8	3 1 5 2 4 6	6 4 5 3 2 1	3 5 2 6 4 1
9	4 1 2 5 6 3	3 5 2 6 4 1	6 3 4 1 5 2
10	2 4 6 1 3 5	1 2 3 6 5 4	2 4 6 1 3 5
11	1 5 6 4 2 3	6 3 4 1 5 2	5 2 4 3 1 6
12	3 5 2 6 4 1	4 6 3 5 1 2	5 6 1 2 3 4

Appendix H. Statistics Used in this Study

Statistic	Computer Package	Sub-Program
Descriptive data - means, s.d.	SPSS	Breakdown
Descriptive data - adjusted means, DELTA data	DATATEXT	Anova
t-tests	SPSS	T-Test
Homogeneity of variance tests	SPSS	T-Test
Pearson correlation coeffs.	SPSS	Pearson Corr
Trend analyses	SPSS	Oneway
ANOVA, ANOCOVA	DATATEXT	Anova
Homogeneity of regression coeffs.	BMDP	P1V
Multiple correlation coeffs.	calculated by hand	
Neuman-Keuls analyses	calculated by hand	
Chi-Square	calculated by hand	
z tests for difference between Pearson Correlation coeffs.	calculated by hand	

Reference Notes

1. Court, J. H. (compiler). Researcher's bibliography for Raven's Progressive Matrices and Mill Hill Vocabulary Scales. (4th. ed.) Adelaide, Australia: 1977. (available from Dr. J. H. Court, Social Sciences, Flinders University of South Australia, Bedford Park, South Australia, 5042)

2. Costa, L. D. Personal communication, 1976.

3. Mattis, S. Personal communication, 1974.

4. Spreen, O., & Benton, A. L. Neurosensory Center Comprehensive Examination for Aphasia (NCCEA) (edition A). 1969. (published and distributed by Neuropsychology Laboratory, Department of Psychology, University of Victoria, British Columbia, Canada)

Bibliography

Aaronson, D., & Rieber, R. W. (Eds.). Annals of the New York Academy of Sciences (Vol. 263, Developmental psycholinguistics and communication disorders - part IV. The relationship between linguistic competence and linguistic performance). New York: New York Academy of Sciences, 1975.

Alajouanine, T., & Lhermitte, F. Acquired aphasia in children. Brain, 1965, 88, 653-662.

Alberts, E., & Ehrenfreund, D. Transposition in children as a function of age. Journal of Experimental Psychology, 1951, 41, 30-38.

American Psychological Association, Committee on Ethical Standards in Psychological Research. Ethical principals in the conduct of research with human participants. Washington, D. C.: Author, 1973.

Archibald, Y. M., Wepman, J. M., & Jones, L. V. Nonverbal cognitive performance in aphasic and nonaphasic brain-damaged patients. Cortex, 1967, 3, 275-294.

Arrigoni, G., & De Renzi, E. Constructional apraxia and hemispheric locus of lesion. Cortex, 1964, 1, 170-197.

Basso, A., De Renzi, E., Faglioni, P., Scotti, G., & Spinnler, H. Neuropsychological evidence for the existence of cerebral areas critical to the performance of intelligence tasks. Brain, 1973, 96, 715-728.

Belmont, J. M., & Butterfield, E. C. The instructional approach to developmental research. In R. V. Kail, Jr., & J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977.

Bender, L. A. Psychopathology of children with organic brain disorders. Springfield, Illinois: Charles C. Thomas, 1956.

Bender, L. A. Specific reading disability as a maturational lag. Bulletin of the Orton Society, 1957, 7, 9-18.

Bender, L. A. A fifty-year review of experiences with dyxlexia. Bulletin of the Orton Society, 1975, 25, 5-23.

Berger, M., Yule, W., & Rutter, M. Attainment and adjustment in two geographical areas: II. the prevalence of specific reading retardation. British Journal of Psychiatry, 1975, 126, 510-519.

Bever, T. G. Cerebral assymetries in humans are due to the differentiation of two incompatible processes: holistic and analytic. In D. Aaronson & R. W. Rieber (Eds.), Annals of the New York Academy of Sciences (Vol. 263, Developmental Psycholinguistics and communication disorders). New York: New York Academy of Sciences, 1975.

Bingham, W. C., Burke, H. R., & Murray, S. Raven's Progressive Matrices: construct validity. The Journal of Psychology, 1966, 62, 205-209.

Bourne, L. E., Jr., Ekstrand, B. R., & Dominowski, R. L. The psychology of thinking. Englewood Cliffs, New Jersey: Prentice-Hall, 1971.

Broca, P. Nouvelle observation d'aphemie produite par une lesion de la moitie posterieure des deuxieme et troisieme circonvolutions frontales. Bulletin de la Societe Anatomique, 1861, 6, 398-407. (as cited in H. Head, Aphasia and kindred disorders of speech. New York: The Macmillan Company, 1926.)

Bromley, D. B. Primitive forms of response to the Matrices Test. Journal of Mental Science, 1953, 99, 374-393.

Brown, R. W., & Lenneberg, E. H. A study in language and cognition. Journal of Abnormal and Social Psychology, 1954, 49, 454-462.

Burke, H. R. Raven's Progressive Matrices: a review and critical evaluation. The Journal of Genetic Psychology, 1958, 93, 199-228.

Burke, H. R. Raven's Progressive Matrices: validity, reliability, and norms. The Journal of Psychology, 1972, 82, 253-257.

Burke, H. R., & Bingham, W. C. Raven's Progressive Matrices: more on constuct validity. The Journal of Psychology, 1969, 72, 247-251.

Buss, A. H. Rigidity as a function of reversal and nonreversal shifts in the learning of successive discriminations. Journal of Experimental Psychology, 1953, 45, 75-81.

Byrt, E., & Gill, P. E. The standardization of Raven's Progressive Matrices and Mill Hill Vocabulary Scales for Irish school children aged six to twelve years. Unpublished M.A. thesis, National University of Ireland (University College, Cork), 1973.

Cantwell, D. P. A medical model for research and clinical use with hyperactive children. In D. P. Cantwell (Ed.), The hyperactive child: diagnosis, management, current research. New York: Spectrum Publications, Inc., 1975.

Carmichael, L. A., Hogan, H. P., & Walter, A. A. An experimental study of the effect of language on the reproduction of visually perceived form. Journal of Experimental Psychology, 1932, 15, 73-86.

Cassel, R. H. Qualitative evaluation of the Progressive Matrices Tests. Educational and Psychological Measurements, 1949, 9, 233-241.

Cohen, J. The factorial structure of the WISC at ages 7-6, 10-6, and 13-6. Journal of Consulting Psychology, 1959, 23, 285-299.

Colombo, A., De Renzi, E., & Faglioni, P. The occurrence of visual neglect in patients with unilateral cerebral disease. Cortex, 1976, 12, 221-231.

Colonna, A., & Faglioni, P. The performance of hemisphere-damaged patients on spatial intelligence tests. Cortex, 1966, 2, 293-307.

Conners, C. K. (Ed.) Clinical use of stimulant drugs in children. Amsterdam: Excerpta Medica, 1974. (distributed by Abbott Laboratories, North Chicago, Illinois).

Corsini, D. A., Pick, A. D., & Flavell, J. H. Production of nonverbal mediation in young children. Child Development, 1968, 39, 53-58.

Costa, L. D. Interset variability on the Raven Coloured Progressive Matrices as an indicator of specific ability deficit in brain-lesioned patients. Cortex, 1976, 12, 31-40.

Costa, L. D., & Vaughan, H. G., Jr. Performance of patients with lateralized cerebral lesions. I: verbal and perceptual tests. Journal of Nervous and Mental Disease, 1962, 134, 162-168.

Costa, L. D., Vaughan, H. G., Jr., Horwitz, M., & Ritter, W. Patterns of behavioral deficit associated with visual spatial neglect. Cortex, 1969, 5, 242-263.

Costello, C. G. Aphasic cerebral palsied children's wrong answers on Raven's "Progressive Matrices". Journal of Clinical Psychology, 1959, 15, 76-77.

Cromer, R. F. The cognitive hypothesis of language acquisition and its implications for child language deficiency. In D. M. Morehead & A. E. Morehead (Eds.), _Normal and deficient child language_. Baltimore: University Park Press, 1976.

Cronbach, L. J. _Essentials of psychological testing_ (3rd. ed.). New York: Harper and Row, 1970.

Daehler, M. W., Horowitz, A. B., Wynns, F. C., & Flavell, J. H. Verbal and nonverbal rehearsal in children's recall. _Child Development_, 1969, _40_, 443-452.

Das, J. P., Kirby, J., & Jarman, R. F. Simultaneous and successive synthesis: an alternative model for cognitive abilities. _Psychological Bulletin_, 1975, _82_, 87-103.

Denckla, M. B. Language disorders. In J. A. Downey, & N. L. Low (Eds.), _The child with disabling illness: principals of rehabilitation_. Philadelphia: W. B. Saunders Co., 1974.

Denckla, M. B. Minimal brain dysfunction and dyslexia: beyond diagnosis by exclusion. In M. E. Blaw, I. Rapin, & M. Kinsbourne (Eds.), _Topics in child neurology_. New York: Spectrum Publications, Inc., 1977.

Denckla, M. B. Childhood learning disabilities. In K. M. Heilman & E. Valenstein (Eds.), _Clinical neuropsychology_. New York: Oxford University Press, 1979.

Denckla, M. B., & Rudel, R. G. Naming of object-drawings by dyslexic and other learning disabled children. _Brain and Language_, 1976, _3_, 1-15. (a)

Denckla, M. B., & Rudel, R. G. Rapid 'automitized' naming (R.A.N.): dyslexia differentiated from other learning disabilities. _Neuropsychologia_, 1976, _14_, 471-479. (b)

De Renzi, E., & Faglioni, P. The comparative efficiency of intelligence tests and vigilance tests in detecting hemispheric cerebral damage. _Cortex_, 1964, _1_, 410-433.

De Renzi, E., Pieczuro, A., & Vignolo, L. A. Ideational apraxia: a quantitative study. _Neuropsychologia_, 1968, _6_, 41-52.

Dils, C. W. The Coloured Progressive Matrices as an indicator of brain damage. _Journal of Clinical Psychology_, 1960, _16_, 414-416.

Dimond, S. J., & Beaumont, J. G. _Hemisphere function in the human brain_. New York: Halstead Press, 1974.

Douglas, V. I. Stop, look and listen: the problem of sustained attention and impulse control in hyperactive and normal children. Canadian Journal of Behavioral Science, 1972, 4, 259-282.

Douglas, V. I. Differences between normal and hyperkinetic children. In C. K. Connors (Ed.), Clinical use of stimulant drugs in children. Amsterdam: Excerpta Medica, 1974. (distributed by Abbott Laboratories, North Chicago, Illinois).

Douglas, V. I. Perceptual and cognitive factors as determinants of learning disabilities: a review chapter with special emphasis on attentional factors. In R. M. Knights, & D. J. Bakker (Eds.), The neuropsychology of learning disorders: theoretical approaches. Baltimore: University Park Press, 1976.

Dykman, R., Ackerman, P. T., Clements, S. D., & Peters, J. E. Specific learning disabilities: an attentional deficit syndrome. In H. R. Mykelbust (Ed.), Progress in learning disabilities (Vol. 2). New York: Grune & Stratton, 1971.

Dykman, R., Ackerman, P. T., Peters, J. E., & McGrew, J. Psychological tests. In C. K. Conners (Ed.), Clinical use of stimulant drugs in children. Amsterdam: Excerpta Medica, 1974. (distributed by Abbott Laboratories, North Chicago, Illinois).

Edwards, S., Ellams, J., & Thompson, J. Language and intelligence in dysphasia: are they related? British Journal of Disorders of Communication, 1976, 11, 83-94.

Eisenberg, L. The epidemiology of reading retardation and a program for preventive intervention. In J. Money (Ed.), The disabled reader - education of the dyslexic child. Baltimore: Johns Hopkins Press, 1966.

Evans, R. B., & Marmorstan, J. Scoring Raven's Coloured Progressive Matrices to differentiate brain damage. Journal of Clinical Psychology, 1964, 20, 360-364.

Eysenck, H. J. Dimensions of personality. London: Kegan Paul, 1948.

Farley, F. H. Further data on multiple-choice verses open-ended estimates of vocabulary. British Journal of Social and Clinical Psychology, 1969, 8, 67-68.

Fish, B. Stimulant drug treatment of hyperactive children. In D P. Cantwell (Ed.), The hyperactive child: diagnosis, management, current research. New York: Spectrum Publications, Inc., 1975.

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

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

Gaddes, W. H., & Crockett, D. J. The Spreen-Benton aphasia tests, normative data as a measure of normal language development. Brain and Language, 1975, 2, 257-280.

Gainotti, G., Caltagirone, C., & Miceli, G. Poor performance of right brain-damaged patients on Raven's Coloured Matrices: derangement of general intelligence or of specific abilities? Neuropsychologia, 1977, 15, 675-680.

Gardner, R. A. The objective diagnosis of minimal brain dysfunction. Cresskill, New Jersey: Creative Therapeutics, 1979.

Gazzaniga, M. S. The bisected brain. New York: Appleton-Century-Crofts, 1970.

Geschwind, N. Neurological foundations of language. In H. R. Mykelbust (Ed.), Progress in learning disabilities. New York: Grune & Stratton, 1968.

Ghiselin, B. The creative process. New York: Mentor Books, 1955.

Glasser, A. J., & Zimmerman, I. L. Clinical interpretation of the Wechsler Intelligence Scale for Children. New York: Grune and Stratton, 1967.

Glucksberg, S., & Weisberg, R. W. Verbal behavior and problem solving: some effects of labelling in a functional fixedness problem. Journal of Experimental Psychology, 1966, 71, 659-664.

Harrow, M., & Friedman, G. B. Comparing reversal and nonreversal shifts in concept formation with partial reinforcement controlled. Journal of Experimental Psychology, 1958, 55, 592-597.

Hays, W. L. Statistics for the social sciences (2nd. ed.). New York: Holt, Rinehart and Winston, 1973.

Head, H. Aphasia and kindred disorders of speech (Vol. 1). New York: The Macmillan Company, 1926.

Hecaen, H., & Albert, M. L. Human Neuropsychology. New York: John Wiley & Sons, 1978.

Heim, A. W., & Watts, K. P. An experiment on multiple-choice verses open-ended answering in a vocabulary test. British Journal of Educational Psychology, 1967, 37, 339-346.

Hermann, K. Reading disability: a medical study of word-blindness and related hanicaps. Copenhagen: Munkgaard, 1959.

Heron, A., & Chown, S. Age and function. London: Churchill, 1967.

Huttenlocher, J. Language and thought. In G. A. Miller (Ed.), Communication, language, and meaning: psychological perspectives. New York: Basic Books, Inc., 1973.

Jacobs, P. I., & Vandeventer, M. Information in wrong answers. Psychological Reports, 1970, 26, 311-315.

James, W. Psychology: briefer course. New York: Henry Holt & Co., 1892.

Jastak, J. Problems of psychometric scatter analysis. Psychological Bulletin, 1949, 46, 177-199.

Jensen, A. R. Social class and verbal learning. In M. Deutsch, I. Katz, & A. Jensen (Eds.), Social class, race, and psychological development. New York: Holt, Rinehart and Winston, 1968.

Jordan, T. E., & Bennett, C. M. An item analysis of the Coloured Progressive Matrices (1947). Journal of Consulting Psychology, 1957, 21, 222.

Kaufman, A. S. Factor analysis of the WISC-R at 11 age levels between 6 1/2 and 16 1/2 years. Journal of Consulting and Clinical Psychology, 1975, 43, 135-147.

Kaufman, A. S. Verbal-performance IQ discrepancies on the WISC-R. Journal of Consulting and Clinical Psychology, 1976, 44, 739-744.

Kaufman, A. S. Intelligent testing with the WISC-R. New York: John Wiley & Sons, 1979.

Keeney, T. J., Cannizzo, S. R., & Flavell, J. H. Spontaneous and induced verbal rehearsal in a recall task. Child Development, 1967, 38, 953-966.

Keir, G. The Progressive Matrices as applied to school children. British Journal of Psychology - Statistical Section, 1949, 2, 140-150.

Kelleher, R. T. Discrimination learning as a function of rehearsal and nonrehearsal shifts. Journal of Experimental Psychology, 1956, 51, 379-384.

Kendler, H. H., & D'Amato, M. F. A comparison of reversal shifts and nonreversal shifts in human concept formation behavior. Journal of Experimental Psychology, 1955, 49, 165-174.

Kendler, H. H., & Kendler, T. S. Effects of verbalization on discrimination reversal shifts in children. Science, 1961, 134, 1619-1620.

Kendler, T. S. Development of mediating responses in children. Monographs of the Society for Research in Child Development, 1963, 28(2, serial No. 86).

Kendler, T. S. Verbalization and optional reversal shifts among kindergarten children. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 428-436.

Kendler, T. S., & Kendler, H. H. Reversal and nonreversal shifts in kindergarten children. Journal of Experimental Psychology, 1959, 58, 56-60.

Kendler, T. S., Kendler, H. H., & Learnard, B. Mediated responses to size and brightness as a function of age. American Journal of Psychology, 1962, 75, 571-586.

Kendler, T. S., Kendler, H. H., & Wells, D. Reversal and nonreversal shifts in nursery school children. Journal of Comparative and Physiological Psychology, 1960, 53, 83-87.

Kertesz, A., & McCabe, P. Intelligence and aphasia: performance of aphasics on Raven's Coloured Progressive Matrices (RCPM). Brain and Language, 1975, 2, 387-395.

Kirk, R. E. Experimental design: procedures for the behavioral sciences. Belmont, California: Brooks/Cole Publishing Company, 1968.

Knehr, C. A. Progressive Matrices findings associated with cerebral histopathology. Perceptual and Motor Skills, 1956, 6, 249-254.

Knehr, C. A. Revised approach to detection of cerebral damage: Progressive Matrices revisited. Psychological Reports, 1965, 17, 71-77.

Kuenne, M. R. Experimental investigation of the relation of language to transposition behavior in young children. Journal of Experimental Psychology, 1946, 36, 471-490.

Lezak, M. D. Neuropsychological assessment. New York: Oxford University Press, 1976.

Liberman, A. M., Cooper, F. S., Shankweiler,D. P., & Studdert-Kennedy, M. Perception of the speech code. Psychological Review, 1967, 74, 431-461.

Luria, A. R. The role of speech in child development. In The central nervous system and behavior: translations from the Russian medical literature (collected for the participants of the Third Macy Conference on the Central Nervous System and Behavior). Bethesda, Maryland: U. S. Department of Health, Education, and Welfare: Public Health Service, National Institutes of Health, 1960. (a)

Luria, A. R. The role of speech in the regulation of normal and abnormal behavior. Bethesda, Maryland: U. S. Department of Health, Education, and Welfare: Public Health Service, National Institutes of Health, 1960. (b)

Luria, A. R. Higher cortical function in man. New York: Basic Books, 1966.

Maccoby, E. E. Developmental psychology. Annual Review of Psychology, 1964, 15, 203-250.

Maher, B. A. Position errors and primitive thinking in the Progressive Matrices Test. American Journal of Mental Deficiency, 1960, 64, 1016-1020.

Mattis, S., French, J. H., & Rapin, I. Dyslexia in children and young adults: three independent neuropsychological syndromes. Developmental Medicine and Child Neurology, 1975, 17, 150-163.

Miller, F. M., & Raven, J. C. The influence of positional factors on the choice of answers to perceptual intelligence tests. British Journal of Medical Psychology, 1939, 18, 35-39.

Moely, B. E., Olson, F. A., Halwes, T. G., & Flavell, J. H. Production deficiency in young children's clustered recall. Developmental Psychology, 1969, 1, 26-34.

Nation, J. E., & Aram, D. M. Diagnosis of speech and language disorders. Saint Louis: The C. V. Mosby Company, 1972.

Noton, D., & Stark, L. Eye movements and visual perception. Scientific American, 1971, 224(6), 34-43.

Orme, J. E. Hypothetically true norms for the Progressive Matrices Test. Human Development, 1966, 9, 222-230.

Orton, S. T. "Word-blindness" in school children. Archives of Neurology and Psychiatry, 1925, 14, 581-615.

Orton, S. T. Reading, writing and speech problems in children. New York: Norton, 1937.

Owen, F. W., Adams, P. A., Forrest, T., Stolz, L. M., & Fisher, S. Learning disorders in children: sibling studies. Monographs of the Society for Research in Child Development, 1971, 36(4, Serial No. 144).

Penrose, L. S., & Raven, J. C. A new series of perceptual tests: preliminary communication. British Journal of Medical Psychology, 1936, 16, 97-104.

Peters, J. E. Minimal brain dysfunction in children. Archives of General Practice, 1974, 10, 115-123.

Peters, J. E., Davis, J. S., Goolsby, C. M., Clements, S. D., & Hicks, T. J. Physician's handbook: screening for MBD. Summit, New Jersey: CIBA Pharmaceuticals, Inc., 1973.

Pick, H. L., Jr., & Pick, A. D. Sensory and perceptual development. In P. H. Mussen (Ed.), Carmichael's manual of child psychology (3rd ed., Vol. 1). New York: John Wiley & Sons, Inc., 1970.

Piercy, M., & Smyth, V. O. G. Right hemisphere dominance for certain non-verbal intellectual skills. Brain, 1962, 85, 775-790.

Ranken, H. B. Language and thinking: positive and negative effects of naming. Science, 1963, 141, 48-50.

Rapin, I. Language disability in children. In M. E. Blaw, I. Rapin, & M. Kinsbourne (Eds.), Topics in child neurology. New York: Spectrum Publications, Inc., 1977.

Rapoport, J. L., Buchsbaum, M. S., Zahn, T. P., Weingartner, H., Ludlow, C., & Mikkelsen, E. J. Dextroamphetamine: cognitive and behavioral effects in normal prepubertal boys. Science, 1978, 199, 560-563.

Raven, J. C. The R. E. C. I. series of perceptual tests: an experimental survey. British Journal of Medical Psycology, 1939, 18, 16-34.

Raven, J. C. Standardization of Progressive Matrices 1938. British Journal of Medical Psychology, 1941, 19, 137-150.

Raven, J. C. Coloured Progressive Matrices: Sets A, Ab, B. London: H. K. Lewis & Co. Ltd., 1956 (a) - (also 1949).

Raven, J. C. Standard Progressive Matrices: Sets A, B, C, D and E. London: H. K. Lewis & Co. Ltd., 1956. (b) - (also 1938).

Raven, J. C. Guide to the Standard Progressive Matrices, Sets A, B, C, D, and E. London: H. K. Lewis & Co. Ltd., 1960.

Raven, J. C. Advanced Progressive Matrices: Sets I, II. London: H. K. Lewis & Co. Ltd., 1962. - (also 1947).

Raven, J. C. Advanced Progressive Matrices, Sets I and II, plan and use of the scale with a report of experimental work. London: H. K. Lewis & Co. Ltd., 1965.(a) - (also 1947, 1962).

Raven, J. C. Guide to using the Coloured Progressive Matrices, Sets A, Ab, B. London: H. K. Lewis & Co. Ltd., 1965.(b) - (also 1949, 1951, 1956, 1958, 1960).

Raven, J. C., Court, J. H., & Raven, J. Manual for Raven's Progressive Matrices and vocabulary scales. London: H. K. Lewis & Co. Ltd., 1976.

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

Reese, H. W. Verbal effects in the intermediate-size transposition problem. Journal of Experimental Child Psychology, 1966, 3, 123-130.

Ross, D., & Ross, S. Hyperactivity: research, theory, and action. new York: John Wiley & Sons, 1976.

Semmes, J. Hemispheric specializaton: a possible clue to mechanism. Neuropsychologia, 1968, 6, 11-26.

Silverstein, A. B. Reappraisal of the validity of WAIS, WISC, and WPPSI short forms. Journal of Consulting and Clinical Psychology, 1970, 34, 12-14.

Silverstein, A. B. Validity of WISC-R short forms. Journal of Clinical Psychology, 1975, 31, 696-697.

Slobin, D. I. Psycholinguistics. Glenview, Illinois: Scott, Foresman and Company, 1971.

Smith, E. M., Brown, H. O., Toman, J. E. P., & Goodman, L. S. The lack of cerebral effects of d-tubocurarine. Anesthesiology, 1947, 8, 1-14.

Spearman, C. Theory of a general factor. British Journal of Psychology, 1946, 36, 117-131.

Spearman, C., & Jones, L. L. W. Human ability. London: Macmillan, 1950.

Spiker, C. C., Gerjuoy, I. R., & Shepard, W. O. Children's concept of middle-sizedness and performance on the intermediate size problem. Journal of Comparative and Physiological Psychology, 1956, 49, 416-419.

Stevenson, H. W. Children's learning. New York: Appleton-Century-Crofts, 1972.

Stevenson, H. W., & McBee, G. The learning of object and pattern discrimination by children. Journal of Comparative and Physiological Psychology, 1958, 51, 752-754.

Sykes, D., Douglas, V. I., & Morgenstern, G. The effect of methylphenidate on sustained attention on hyperactive children. Psychopharmacologia, 1972, 5, 262-274.

Urmer, A. H., Morris, A. B., & Wendland, L. V. The effects of brain damage on Raven Progressive Matrices. Journal of Clinical Psychology, 1960, 16, 182-185.

Vellutino, F. R. Towards an understanding of dyslexia: psychological factors in specific reading disability. In A. L. Benton, & D. Pearl (Eds.), Dyslexia: an appraisal of current knowledge. New York: Oxford University Press, 1978.

Vernon, P. E., & Parry, J. B. Personnel selection in the British forces. London: University of London Press, 1949.

Vernon, P. E. The variations of intelligence with occupation, age, and locality. British Journal of Psychology - Statistical Section, 1947, 1, 52-63.

Vernon, P. E. An application of factor analysis to the study of test items. British Journal of Psychology - Statistical Section, 1950, 3, 1-15.

Vincent, D. V. The linear relationship between age and score of adults in intelligence tests. Occupational Psychology, 1952, 26, 243-249.

Vygotsky, L. S. Thought and language (E. Hanfmann, & G. Vakar, Eds. and trans.). Cambridge, Massachusetts: The M. I. T. Press, and New York: John Wiley & Sons, Inc., 1962. (Originally published, 1934.)

Wamba, D. E., & Marzolf, S. S. Use of eye movements as a response indicator in testing the physically handicapped. Journal of Clinical Psychology, 1955, 11, 405-407.

Ward, J., & Fitzpatrick, T. F. Characteristics of matrices items. Perceptual and Motor Skills, 1973, 36, 987-993.

Watson, J. B. Psychology as the behaviorist views it. Psychological Review, 1913, 20, 158-177.

Wechsler, D. Wechsler Intelligence Scale for Children (WISC). New York: The Psychological Corporation, 1949.

Wechsler, D. Wechsler Intelligence Scale for Children - Revised (WISC-R). New York: The Psychological Corporation, 1974.

Wetherick, N. E. The responses of normal adult subjects to the Matrices Test. British Journal of Psychology, 1966, 57, 297-300.

Whitaker, H. A., & Ojemann, G. A. Lateralization of higher cortical functions: a critique. In S. J. Dimond & D. A. Blizard (Eds.), Annals of the New York Academy of Sciences (Vol. 299, Evolution and lateralization of the brain). New York: New York Academy of Sciences, 1977.

Wiig, E. H., & Semel, E. M. Language disabilities in children and adolescents. Columbus, Ohio: Charles E. Merrill Publishing Company, 1976.

Winer, B. J. Statistical principals in experimental design (2nd ed.). New York: McGraw-Hill Book Company, 1971.

Yates, A. J. Item analyses of Progresive Matrices (1947). British Journal of Educational Psychology, 1961, 31, 152-157.

Zaidel, D., & Sperry, R. W. Performance on the Raven's Coloured Progressive Matrices test by subjects with cerebral commisurotomy. Cortex, 1973, 9, 34-39.

Zangwill, O. Intelligence in aphasia. In A. V. S. De Rueck & M. O'Connor (Eds.), Disorders of Language. London: Churchill, 1964.