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ABSTRACT

To test whether training in logical multiplication would improve the reading skills of "retarded readers" (children with specific language disability, minimal brain damage, dyslexia, psycho-neurological learning disability, or perceptual handicaps), this study (1) elaborated a theoretical approach to reading based on Piaget's theory of cognitive development, (2) conducted an intensive diagnostic study of four reading-retarded children, and (3) administered to these subjects an eleven-week logical training program. The Durrell Listening-Reading Tests were administered on a pre- and post-test basis to assess the program's effect on reading. The findings of the study indicated that some reading retardation is related to problems of a logical nature, and that even when the source of reading difficulty is perceptual or emotional, the child's progress can be furthered by strengthening logical abilities in the word attack process. (Included in this document are a bibliography of sources consulted, diagnostic information on the subjects, and the basic content of the logical training program itself.) (MF)

FINAL REPORT
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DIAGNOSIS AND REMEDIATION OF READING RETARDATION: A FOCUS ON THE DEVELOPMENT OF LOGICAL THINKING

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U. S. Department of
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U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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I want to express my special gratitude to Dr. Alvin Collins, principal of the Bennett-Hemingway Elementary School in Natick, Massachusetts. His friendship and assistance have been invaluable from the beginning of my doctoral research to the completion of the present study. Appreciation also goes to Mrs. Bickley Simpson for helping to inspire my research into the nature of reading and to Dr. Freda Rebelsky for her comments on the research proposal. Finally, I want to thank the four children, their parents, and their teachers for their cooperation in this research effort.

Summary

The present study explored a theoretically-based approach to reading retardation. A three-pronged attack on the problem was followed. First, a logicodeductive analysis of the cognitive requirements of reading was formulated. The focus was on the Piagetian concepts of logical multiplication, class inclusion and shift. Second, an intensive diagnostic examination of four reading retarded children was conducted. Both perceptual and conceptual processes were studied. Third, an eleven-week logical training program was administered to the same children. The Durrell Listening-Reading Tests were administered on a pre- and post-test basis to assess the program's effect on reading.

The analysis of the logical requirements of reading is derived from Piaget's theory of cognitive development. It shares some commonalities with Elkind's application of Piaget's perceptual theory to reading, but rejects Elkind's emphasis on perceptual rather than logical activity.

The present analysis can be summarized briefly as follows. English sound-symbol relationships are complex. To develop satisfactory word-attack skills, the child must realize three things: a) one letter can represent several sounds, and one sound can be represented by several letters; b) the class of sounds is larger than the class of letters; and c) correct pronunciation of letters changes as a function of their context. These abilities seem to reflect multiplicative classification, class inclusion, and shift, respectively--abilities identified by Piaget as achievements of concrete, logical thought operations.

Four children were selected for diagnosis and training. All four were underachievers in reading, but seemed to be at different levels in their cognitive development. It was hoped that intensive study would clarify the relationship between their logic and their reading.

The diagnostic testing suggested that the reading retardation of one child, T.F., was due primarily to perceptual problems rather than conceptual ones. Another child, D.M., showed strong evidence of a wide range of

logical problems. A third child, K.C., seemed to have impairments of both a logical and perceptual nature. Finally, the fourth child, L.M., seemed to have perceptual difficulties complicated by emotional and logical involvements.

The results of the training program were mixed, but not incompatible with the theoretical model. D.M. consistently had difficulty with the logical exercises. Her failure to improve significantly in her logical skills was paralleled by a failure to show improvement on the Durrell Listening-Reading Tests. It seems likely that she needed a more frequent and paced involvement with the program materials.

L.M., a highly distractible and emotive child, also failed to show significant progress in the program. His difficulties in remaining attentive to any problem and his tendency to focus on idiosyncratic cues interfered in the successful completion of most tasks.

T.F., who began with nearly operational logical processes but definite visual perceptual problems, seemed to benefit from the program. She showed great improvement on the listening subtests of the Durrell, less improvement on the reading subtests. This suggests that training led to a more effective use of unimpaired perceptual areas--the auditory--but not impaired areas--the visual.

Finally, the program seemed to fit K.C.'s needs most clearly. K.C. showed the steadiest improvement during the course of the program. This improvement was reflected by her increased success on the logical screening task. She also showed considerable improvement on the reading portions of the Durrell, and a diminished gap between potential and actual reading scores. She was the only child whose potential and actual reading scores were both on grade level (according to Durrell norms) at the end of the program. In addition, her mother reported that K.C. had developed a new and exciting interest in reading on her own.

The findings of the study seemed to indicate both some applications and limitations of the theoretical model. It became my firm conviction that no single theoretical or diagnostic framework can encompass all reading disability. Individual differences in cognitive style seem to make a definite, if elusive, contribution to all cognitive activities. Furthermore, there seem to be important weaknesses in the short-term, one-shot type of intervention. Nevertheless, I believe the findings support at least two conclusions.

1. Some reading retardation is related to problems of a logical nature--that is, inability to deal with multiplicative classification, class inclusion and shift.

2. Children can be generally adequate in logical development and still have difficulty with sound-symbol relationships. This difficulty may be related to or aggravated by perceptual impairments or mild emotional disturbance. Nevertheless, children with such problems can benefit from logical training exercises designed to capitalize on their logical abilities in the word attack process.

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Introduction

There has been widespread agreement that reading and reading difficulties have been extensively--if not excessively--researched. Yet there is also widespread agreement that at least 5-25% of American school children are sufficiently retarded in reading to warrant the invention of new diagnostic categories--specific language disability, minimal brain damage, dyslexia, psychoneurological learning disability, perceptual handicap. (While the term "reading retardation" summarizes the presenting problem, the other terms express some assumptions about the causes or nature of the difficulty). The terms may reflect different--but certainly overlapping--subsamples, but all are applied to that population of children who have reading difficulties which cannot be attributed to inferior intelligence, sensory or motor deficit, lack of educational opportunity, or primary emotional disturbance. If reading problems have been so widely studied, why does there continue to be such a large population of reading retarded children?

Obviously one small study cannot presume to answer such a major question. Nevertheless, the present study attempts to throw some light on the problem by pursuing three avenues of approach: 1) elaborating a theoretical approach to reading based on Piaget's theory of cognitive development; 2) conducting an intensive diagnostic study of four reading retarded children; and 3) carrying through an intervention with these same four children. The background for each of these avenues is discussed below.

Towards a Cognitive Model of Reading

Elkind (Elkind & Deblinger, 1969) has suggested that the great failing of much reading research has been a pragmatic orientation with no underlying theoretical foundation. Elkind has attempted to formulate such a theoretical foundation himself, utilizing what he calls "Piaget's developmental theory of perception" (1967). In analyzing reading, Elkind focuses on the Piagetian notion of decentration and the perceptual activities of reorganization (involved in figure-ground relations) and schematization (involved in part-whole relations) which underly decentration. According to Elkind,

> In Piaget's (1961) view, the perception of the young child is <u>centered</u> in the sense that it is caught and held by the dominant aspects of the

visual field.... With increasing age, however, and the development of perceptual activities (internalized actions), perception becomes increasingly decentered in the sense that it is progressively freed from its earlier domination by the field effects (1967, p. 358, italics Elkind's).

Elkind suggests that two perceptual activities have particular implications for reading--schematization and reorganization. He explains that Piaget's notion of schematization involves a coordination between parts and wholes such that both their separate identities and interdependence are recognized. This type of coordination may, Elkind believes, be involved in successful reading, where the child must understand the relationships between letters and words--particularly if he is to analyze new words successfully. Elkind argues that look-say reading methods may militate against successful schematization, and suggests that it may be helpful to train children directly in that activity.

Elkind explains Piaget's notion of perceptual reorganization as perceptual action upon a given configuration to produce a new organization without modifying the stimulus, and gives the example of figure-ground reversals. Elkind agrees with Piaget that such perceptual activity is similar to the process of logical multiplication on the plane of conception. Perceptual reorganization is relevant to English phonics, Elkind believes, because one letter can represent several sounds, one sound can be represented by several letters, and the same element can be represented by both upper-case and lower case, script and printed letters. Elkind believes that the child's problem in recognizing these relationships is directly analogous to that of reversing figure and ground while viewing an ambiguous figure.

It was the present writer's conviction in undertaking this research that Elkind's analysis was limited by a traditional emphasis on reading as a perceptual activity. It seems clear to me that reading is always conceptual also. The very act of "sounding out" c-a-t, saying "cat", and recognizing that the word--written and spoken--represents a common four-legged animal, must be at least in part a cognitive act. This assumption is supported by Henderson and Green's assertion (1969, p. 14) that "Reading is the process of taking meaning to, in order to construct meaning from, language in print."

Elkind suggests that the child's recognition of the somewhat complicated relationship between sound and symbol in English is a perceptual process partly analogous to the logical process of class multiplication. By contrast, it was my own contention that it is precisely logical multiplication which is involved, along with some understanding of class inclusion relations and the ability to shift (to be discussed below). That is, if the child looks at the letter A, he does not see it first as an ā and then as an ă, the way he may see first the vase and then the profiles in the Rubin Vase-Profile figure. Rather, because he has come to understand that the letter A represents several sounds, he experiments (mentally or orally) with those sounds until he diciphers a new word. He does not attach or detach the contour lines of the letter to do this, as one does in reversing figure and ground in an ambiguous figure.

Despite my criticism of Elkind's emphasis, I undertook this research accepting his insistence on the need for theoretical frameworks and his choice of Piaget as a model. Consequently the following conceptual analysis of reading as a logical process owes much to Elkind as well as to Piaget.

In Piaget's theory of cognitive development, preoperational thought, the thought of the young child, is specific, immediate and irreversible. It is characterized by egocentricity--the child is not able to put himself in the place of others or make judgments about characteristics of objects on the basis of anything except superficial attributes. In the area of classifying, the child lacks an understanding of class inclusion--for example, that "all boys = some children" means that boys are a subgroup of a larger group of children. Preoperational children also have difficulty shifting the criterion by which they classify--e.g., from form to color.

Reading for the preoperational child is probably a matter of recognizing the global configuration of certain words. This reading technique may be adequate when the child is dealing with a small vocabulary, but it isn't sufficient for learning large numbers of words and doesn't help in the analysis of new and unfamiliar words. These latter undertakings are facilitated by the learning of phonetic rules. If it were always true that A says "ă", B says "b", C says "k", etc., the preoperational child might not have any difficulties with reading except those imposed by such limitations as memory and the learning of rules. As it is, A sometimes says "ā" and C sometimes says "s", distinctions which involve more complex--and probably operational--thought.

In Piaget's view, operational thought is systematic, logical and generalized. Most important, it is reversible--that is, the child can anticipate the inverse or negation of a series of actions and comprehend the relationships between subclasses and superordinate classes. He can coordinate intension and extension--that is, he can correctly define a class with a superordinate label and extend it to all appropriate stimuli. He is becoming adept at handling additive and multiplicative classes, which involves keeping more than one set of characteristics in mind at once. He can also shift the criterion by which he classifies, e.g., from form to color.

Although all the operations essential to classification originate in preverbal sensorimotor habits and perceptions, a grouping is not a true or logical class until the child is able to distinguish and to coordinate its intensive and extensive contents. It would seem possible to talk of logical classes of sounds as well as logical classes of objects like fruit and clothes. If the child correctly makes a "k" sound whenever it appears in a word, and if he knows that the letters C, K and Q can all make the "k" sound, he could be said to have a true class of "k" sounds.

Multiplicative class membership is determined by the coincidence of two or more sets of properties. It is not until the operational stage of thought that a child can understand that a box may belong simultaneously to classes of boxes, square things, and even brown things or small things. Similarly, it is not until the operational stage that he can consistently form classes that require the coincidence of two properties, e.g., a class of small round objects, a class of red fruit, etc. Of particular interest to the present investigator is the fact that sounds and letters, like objects and people, are polydimensional, that the letter A, for example, may represent several different classes of sounds. It might even be argued that the concepts of "short vowels" and "long vowels" represent multiplicative classes where two attributes, shortness or longness, and vowelness coincide.

Class inclusion refers to the hierarchial nature of item classification and presupposes understanding of two propositions: (a) All A are some B (e.g., all children are people); (b) $A < B$ (there are fewer children than people). In relationship to reading, this principle would involve the implicit realization that, for example, only some "k" sounds are made by the letter C.

Shift involves the ability to focus successively on different aspects of a set of stimuli. Thus, a child may sort things first by form and then by color, or he may classify an apple first as a fruit and then as a round object. In reading, he may pronounce the letter C first as "s" and then as "k" as a function of its context.

Operationality is not achieved in all areas of cognitive functioning at once, but is directly related to the child's familiarity with the stimuli and processes involved. Inhelder and Piaget found that Viennese children demonstrated understanding of class inclusion with flowers earlier than with animals, and interpreted this finding in terms of a greater familiarity with the flowers. It is possible that the same rule applies to reading, that children learn some phonetic rules faster than others because of their more frequent occurrence in reading. This relationship undoubtedly would be complicated by other factors such as the number of sounds a given letter makes.

<u>Diagnosing the Factors in Reading Retardation</u>

It is possible to identify at least three major diagnostic emphases in the reading retardation literature: a) perceptual dificiencies; b) linguistic-syntactic problems; and c) various kinds of intellectual-cognitive-involvement. There is also some interest in the effect of cognitive style on reading difficulty. Each of these areas was investigated in the diagnostic part of the present study. Some of the major related literature is summarized in the following pages.

Current research into reading disabilities frequently concentrates on specific aspects of perceptual performance. According to Zigmond (1969), dyslexia (so-called neurogenic reading disability) has been attributed to auditory intrasensory disorders, visual intrasensory disorders, and to intersensory failures of integration between auditory and visual systems. Zigmond herself (1969) assessed four kinds of auditory and visual sensory integrations (intra- and intersensory) and their relationship to reading and intelligence scores in dyslexic and normal boys (CA's 9-0 to 12-11 years). She found that the dyslexics were deficient on several auditory intrasensory and auditory visual intersensory measures, but average on the visual intrasensory measures. In addition, as compared with their normal controls, the dyslexic boys showed different patterns of relationship between sensory integration scores and reading and intelligence scores. On the basis of these data, Zigmond suggests that learning in dyslexics is not as well integrated as it is in normal children. She concludes that the organization and use of perceptual and intellectual abilities is different in normal and dyslexic boys.

McGrady & Olson (1970) arrived at very different conclusions after also assessing various intra- and intersensory functions in 99 learning disability and normal children (aged 8 and 9) with a battery of 13 tests. They found that the children with learning disabilities tended to perform more poorly on tasks which utilized verbal stimuli, regardless of psychosensory modality. Consequently, the authors argue that a focus on sensory channels is not useful in distinquishing between normal and learning disabled children. Rather, the parameter of significance was the distinction between verbal and non-verbal stimuli. This suggests that the nature of the reading problems was linguistic rather than perceptual. McGrady & Olson conclude that remediation of learning disabilities through perceptual training alone is unwarranted.

A rather different approach to linguistic-syntactic variables underlying the ability to read has been taken by Farnham-Diggory (1970). In study comparing learning patterns in normal and brain-damaged children, Farnham-Diggory hypothesized that learning the units to be synthesized (e.g., words) might be a necessary but not sufficient condition for the integration of ideas which is involved in reading. Farnham-Diggory found no significant differences between normal and brain-damaged children in the ability to act out simple commands presented orally or pictorally. However, brain-damaged children were delayed in the ability to learn symbolic forms of the commands (logographs) and even by age 13 were not performing on a synthesis task (two- and three-word sentences constructed with logographs) with the proficiency of seven-year-old normal children. Farnham-Diggory concludes that brain-damaged children may have difficulty with the conceptual synthesis underlying adult syntax even when they can process the individual symbols.

Support for an emphasis on the linguistic rather than perceptual aspects of the reading task comes also from another direction. A substantial research effort has been made to use the Wechsler Intelligence Scale for Children as a diagnositc tool for analyzing intellectual profiles of retarded readers. Belmont and Birch (1966) studied 150 retarded and 50 normal readers matched for age, school grade and WISC Full Scale IQ. The findings revealed that in general the retarded readers were characterized by better functioning on the Performance Scale and poorer functioning on the Verbal Scale. Further evaluation of the use of language in both groups supported Belmont & Birch's conclusion that retarded readers are deficient primarily in language functioning rather than in perceptual or motor skills.

Huelsman (1970) reviewed 23 studies investigating the usefulness of WISC subtest patterns in the diagnosis of reading disability. He found that 20 of the studies lent themselves to pattern analysis. These studies indicated that the disabled reader pattern includes low scores in Information, Arithmetic and Coding. (Low scores in Picture Completion were reported in 10 of the studies). Huelsman notes that in all cases this pattern was extracted from group data with no indication of how often, if ever, it represented the performance of individuals. In his own study of reading retarded fourth graders, Huelsman made note of all weighted subtest scores falling three points or more above or below the subject's own mean weighted subtest score. He found that not one of the 101 underachievers were low on all three of the subtests, Information, Arithmetic and Coding. Furthermore, only 6% were low on two tests and only 30% low on 1 test.

Huelsman concludes that the WISC pattern of low scores in Information, Arithmetic and Coding may be applicable to groups but is not true of individuals. He suggests that future research be directed toward investigating the possible significance of particular subtest scores rather than toward pattern identification.

Most approaches to intellectual-cognitive factors in reading retardation have focused on the WISC or other standardized instruments. Dudek et al (1969) found that performance on Piagetian tasks was highly correlated with performance on the WISC and that both are effective in predicting academic success as early as the first grade. Other studies are beginning to examine the relationship between success on Piagetian types of tasks and success in reading. In a pilot study of 14 fourth and fifth grade retarded readers diagnosed as perceptually handicapped, Simpson[1] found that none of the children were successful with Pinard and Laurendeau's class inclusion task. White & Simpson (unpublished research) found a correlation of .34 ($.01 < p < .05$) between reading achievement scores in 56 normal second- and fourth-graders and the occurrence of additive and multiplicative classifications in a free-sorting task. When a smaller sample ($n = 20$) of these same children were administered a structured classification task (testing logical multiplication, shift and class inclusion), the relationship with reading comprehension rose to .61 ($p < .01$) and with vocabulary skills to .51 ($p < .05$).

The relationship between cognitive style and such other variables as IQ, reading achievement, and personality traits has attracted attention in recent years. Sigel describes cognitive styles as the "modes" an individual uses in perceiving, organizing and labeling his environment. He believes that individuals acquire predispositions to respond to particular kinds of cue, and that these predispositions are reflected in personal use of language.

Sigel has focused on age, sex and personality correlates of different stylistic predispositions. Belmont & Birch (1966) have looked directly at the

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[1] Personal communication

relevance of style for reading retardation. Their analysis of answers to the first five words on the WISC Vocabulary subtest revealed that normal and retarded readers did not differ significantly in reliance on functional definitions ("bicycles are for riding"). However, retarded readers defined words descriptively ("bicycles have wheels and handlebars") significantly more often than categorically ("bicycles are a kind of vehicle"), whereas the reverse tended to be true for normal readers. Belmont & Birch believe these findings support their view of reading retardation as primarily a language problem. If one wants to argue (as Sigel does) that language use reflects broader stylistic predispositions, another conclusion can be reached. That is, the way the individual perceives and organized his environment affects a variety of performances, including such verbal ones as success in defining words and learning to read.

Remediation of Reading Difficulties

Emphasis on specific perceptual deficits in reading disability has led to the development of programs aimed at remedying or circumventing these deficits (e.g., Frostig and Horne, 1964). Johnson (1967) has pointed out the dangers of gearing remediation programs to such isolated problems:

> if only symptoms such as visual-perceptual impairment or an auditory memory problem are delineated, there is a tendency to teach "dead-end" skills without relating them to basic areas of language, communication and learning (p. 320).

Blom similarly points out that remedial programs "have yet to demonstrate satisfactorily that training in perceptual-cognitive-motor skill areas have generalizability and transferability to academic learning areas (1969, p. 254)."

There has been very little research into the use of conceptually-oriented remedial programs with reading-disabled children. However, Caldwell and Hall (1969) have presented evidence that conceptual training (concerning concepts of "same" and "different") resulted in improved scores on a perceptual discrimination task in kindergarteners. In addition, there is evidence that conceptual training can improve reading skills in disadvantaged children (Blank, 1968; Elkind and Deblinger, 1969).

In the Elkind and Deblinger study, an experimental group of second grade inner-city black children trained with "nonverbal perceptual exercises" for 15 weeks made significantly greater improvement on word form and word recognition tasks than did control groups trained with a commercial reading program. Elkind and Deblinger interpret the results as demonstrating the relation of perceptual activity (as defined in terms of Piagetian theory) to reading skills. It can be argued, however, that the training program, which involved anagrams, symbolic transformations and coding exercises, did not emphasize purely perceptual processes at all, but logical processes also.

Purposes of Present Study

The present study is a model-building investigation endeavoring to explore the relevance of the Piagetian notion of logical operations to problems in reading. The basic hypothesis is a logicodeductive one, based on a conceptual analysis of the logical requirements of reading. It is argued that if a child cannot handle problems of logical multiplication (understanding, for example, that the letter A can be associated with the sound ă as well as ā), then he will have difficulty reading beyond a primer level. Preliminary research (White, Simpson, unpublished papers) provides some support for this hypothesis.

If the relationship between logical multiplication and reading holds, the question becomes: will training in logical multiplication help to improve reading skills? The prior question of whether logical training can accelerate the achievement of operational thinking at all has been the subject of some research and debate (Kohnstamm, 1967; Morf, reported in Flavell, 1963; Sigel, 1964; Smedslund, reported in Flavell, 1963; Wohlwill and Lowe, 1962).

Although there are inconsistencies, the findings of the training studies seem to suggest that if a child is transitional in his thinking, if he already has some areas of logical thought, if he can solve even one operational problem, then training can help to improve, or at least consolidate, his level of cognitive functioning (Ginsburg and Opper, 1969). There is, additionally, already some evidence that training in symbolic processes can improve such reading-related skills as word recognition and word form (Elkind & Deblinger, 1969).

Even if the hypothesized relation does hold, there may be some children who can handle certain concrete problems of logical multiplication but who nevertheless have problems with reading. As already noted, McGrady & Olson (1970) have emphasized that children with learning disabilities have their greatest difficulties with verbal tasks, independent of some other variables. Nevertheless, it is possible that the "causal" factors may be "emotional" (Bernstein, 1969, Blom, 1969) or "perceptual" (Sparrow, 1969). It is also possible that whatever other factors may be involved, these children have not realized the connection between their incipient logical abilities and the process of reading. If this is so, then it is possible that the children may be trained to apply their evolving logical thinking abilities to reading.

The present study attempts through both diagnostic and remedial efforts to discover just which, if any, reading retarded children can benefit from a logical training program.

Methodology

Evolution of Study

The present study is a logical extension of my doctoral research. For my thesis, I studied children's free classification responses. I was particularly interested in whether the same responses (i.e., justifications for grouping) could be scored both for cognitive style (cf. Sigel) and for cognitive ability (cf. Inhelder and Piaget). My sample consisted of 150 children--15 boys and 15 girls randomly selected in the spring of 1969 from each of grades K, 2, 4, 6, and 8 at the Bennett-Hemingway Elementary School in Natick, Mass. The results of the study (White, 1971) were favorable--that is, the same grouping response (e.g., "They're fruits and vegetables") could be scored both for cognitive style and for cognitive ability (e.g., presence or absence of logical multiplication, additive classification, etc.).

I next investigated the relationship between the indices of cognitive ability and reading achievement scores in the second, fourth, and sixth graders. The correlation between multiplicative classifications and both reading achievement and vocabulary scores (Iowa Tests of Basic Skills) proved to be positive and statistically significant, although somewhat small ($r = .34$, $p < .05$). This relationship held even with IQ factored out.

Finding a statistically significant relationship was encouraging in view of the fact that the original classification task had been a free-sorting one. The children had in no way been constrained to make multiplicative classifications. The next step was to develop a structured classification task, in which multiplicative classification and other logical abilities were put to a more stringent test, (see appendix A). This new task was administered to 40 third graders (from the original second grade sample of 60) in the spring of 1970. The relationship of logical thinking with reading comprehension rose to .61 ($p < .01$) and with vocabulary to .51 ($p < .05$).

This relationship seemed relatively substantial. Moreover, there were children who clearly fit the model proposed earlier in this paper--that is, they were either good in both classifying and reading, or poor in both. On the other hand, there were also children who did not fit the model--they were low in reading achievement but seemed adequate in their classifying skills. This would suggest that the ability to handle multiplicative classification, class inclusion and shift may be necessary but not sufficient for the development of reading skills.

Further investigation of the relationships between logical abilities and reading seemed in order. Four children were selected for intensive study. All four children are considered to be underachievers in reading. Their scores on the structured classification task range from 10 to 15 (out of a possible 26 or more), indicating that none of them are completely operational in logical classification skills.

Rationale for Sample

The sample for this study deliberately was kept small and highly selected. In this aspect of my research, I am adopting the position of Sidman (1960).

Sidman does not believe that science is effectively furthered by the traditional insistence on group designs, by the assumption that the more (subjects), the better. Use of larger and larger groups of subjects does not, he believes, make it more likely that the findings can be generalized to other subjects.

> We cannot dispose of the problem of subject generality by employing large groups of subjects and using statistical measures such as the mean and analysis of variance. It is not true that the larger the group, the greater is the generality of the data (p. 47).

Sidman, following Skinner, prefers to see data presented in terms of individual subjects rather than groups. "Individual data are capable of revealing the effects of variables that group data might hide (p. 164)." He disputes the popular notion that in group designs, sources of unwanted variability tend to cancel each other out. He holds

> ...it is unlikely that any behavioral measure can be freed of the effects of uncontrolled variables simply by taking an average over a group of subjects. The average will be composed of individual measures which reflect non-random differential effects of all the uncontrolled factors in the situation. The uncontrolled variability, although submerged from view, remains present in the data....Unfortunately, since the grouping of data hides such variability, it cannot adequately be evaluated (p. 164).

It is hoped that the present design will avoid some of the pitfalls with which Sidman is concerned. Some effort will be made to summarize the similarities and differences among the subjects. Data will also be presented by individual subject in case study form.

The Sample

Table 1 summarizes sex, age, second grade reading percentile (Ginn) and structured classification task data for the four children selected for intensive study. The sample probably is not representative of the general population of retarded readers as three of the four are girls. (Generally, boys outnumber girls in such populations).

TABLE 1

SEX, DATE OF BIRTH, AGE, SECOND GRADE READING PERCENTILE AND STRUCTURED CLASSIFICATION TASK SCORES OF SAMPLE CHILDREN

Child	Sex	Date of Birth	Age	Reading %	SCT*
K.C.	F	63-9-12	7-8	37	10
T.F.	F	63-3-13	8-2	50	15
D.M.	F	68-8-6	7-9	48	10
L.M.	M	62-12-30	8-9	--	12

*Score represents the number of items answered operationally. A score of 26 or more is possible.

The chronological ages given for each child represent age at the time of diagnostic testing. The girls, K.C., T.F., and D.M. were tested over a period of about four weeks in the spring of 1971, when they were still in the second grade. The boy, L.M. was tested over a longer period in the fall of 1971, when he was in third grade. (He was selected to replace another boy dropped from the study because of a remarkable improvement in reading performance). All four children were in the third grade at the time of the logical training program. There is no second grade reading percentile recorded for L.M. because he was not yet enrolled in the school at the time the yearly tests were given.

Diagnostic Testing

Each child was administered an extensive battery of tests to assess his visual, auditory, intersensory and cognitive functioning. These tests and the specific functions they are assumed to tap are summarized in Table 2.

In addition, each child was pretested on the Durrell Listening-Reading Series test in September 1971, before the beginning of the logical training program. The children were post-tested on the same instrument and on the structured classification task in January 1972. The Durrell test yields both a potential reading grade and age level (based on the listening score) and an actual reading grade and age level (based on the reading score). It is thus a helpful index to the gap between potential and performance, to the extent of underachievement.

TABLE 2

MEASURES OF VISUAL, AUDITORY, INTERSENSORY AND COGNITIVE ABILITIES

Ability	Test
Visual Measures	
Discrimination	Slingerland Tests 1-4, Frostig Test 4 (Position in Space).
Constancy	Frostig Test 3 (Form Constancy).
Analysis & Synthesis	WISC Picture Completion; Detroit Picture Completion
Figure-ground	Frostig Test 2 (Figure Ground).
Memory	Detroit Visual Attention Span for Objects: Detroit Visual Attention Span for Letters.
Integration	WISC Block Design Test.
Visual-motor	Beery Visual-Motor Integration Test; Frostig 5 (Spatial Relations).
Auditory Measures	
Discrimination	Slingerland 7
Memory	Detroit Attention for Unrelated Words: Slingerland 6, 8.
Integration	Detroit Attention Span for Related Syllables.
Blending	Roswell-Chall Sound Blending Test.
Intersensory Measures	Slingerland 6, 7, 8.
Cognitive Measures	
IQ	WISC
Reasoning	Raven's Colored Progressive Matrices.
Conservation	Goldschmid-Bentler Conservation Tasks.
Class Inclusion	Pinard-Laurendeau Class Inclusion Task.
Logical Classification	Structured Classification Task.

Logical Training Program

All four children participated in an eleven week logical training program from October 5 to December 16. The children met with me individually for 30-40 minutes each on Tuesdays, and for 40 minutes as a group on Thursdays. In general, the individual meetings on Tuesdays were held in a large supply closet and the group meetings were held in a reading room next to the school library.

The basic content of the logical training program can be found in Appendix B. As noted in that appendix, the overall purpose of the program was two-fold. First, it aimed at developing the child's mastery of and confidence in the application of logic to various kinds of problems. This included the encouragement of good guessing--that is the making of predictions, forming of inferences and testing of hypotheses based on the implications of both the properties of and the relationships among stimuli. Second, the program aimed at teaching the child to apply his logical skills to the process of reading. It was assumed that letters and words are tools and that (despite the phonetic complexities of English) there are, ultimately, rules that bind the relationships between letters and sounds. The same reasoning that the child uses to simplify and classify the objects and events in his world may be applicable to the coding process involved in reading. For example, experimenting with possible pronunciations of the letter A in an unfamiliar word may not be logically different from deciding to which of a group of subsets a given block belongs. Both types of activity were used in the training program.

The training program consisted of two major types of exercise. There were, first, activities involving Atttribute Blocks and People Pieces. These were taken rather directly, although selectively, from the <u>Teacher's Manual for Attribute Games and Problems</u> (Elementary Science Study, 1968). There were also verbal activities, derived from the model proposed for this study. These verbal activities called upon the same basic logical processes involved in the concrete activities with attribute Blocks and People Pieces--e.g., multiplicative classification, shifting.

Findings and Analysis

Diagnostic Findings: Sensory Measures

At the time of the progress report for the present study, the most outstanding feature of the diagnostic testing seemed to be a lack of consistent performance on supposedly similar tasks. Since that time I have carefully reviewed all of the data and have discovered that my examiner recorded incorrect age equivalents for all the Beery Visual Motor Integration Tests as well as scoring T.F.'s Detroit subtest 16 incorrectly. This discovery, the correction of the errors, and a task analysis of the different subtests, reveal that there are, after all, identifiable patterns of strength and weakness in each child's performance.

All of the tasks used for assessing visual, auditory and intersensory functioning except the Slingerland and Roswell-Chall yield some sort of test age. On these tasks, a rating of "Low" indicates that the score is 13 months or more below the child's mean mental age on the WISC. "Average" indicates that the score is within one year, plus or minus, of the WISC mental age, and "High" indicates that the score is at least 13 months above the WISC mental age.

On the Roswell-Chall, blending scores can be rated as either adequate or inadequate. All four of the sample children achieved raw scores within the adequate range. Consequently their performance levels on this task have been rated "average".

All scores on the Slingerland are error scores. The Slingerland manual gives no indication of what a superior performance on this test might be. However, it is noted in the manual that the average child makes no more than 12-15 errors on subtest 3-8. A total of more than 12-15 errors on these subtests suggests the possibility of a specific language disability. Since an error score of 2 on each of the six subtests would result in a total error score of 16 (on the high side of normal), errors of 0, 1 or 2 on each subtest are considered "average". Larger error scores are considered to show a "low" performance level.

K. C.

Table 3 summarizes the performance of K.C. on the visual, auditory and intersensory measures. K.C.'s

TABLE 3

SUBJECT K.C.: RAW SCORES, AGE EQUIVALENTS AND PERFORMANCE LEVELS ON VISUAL, AUDITORY, AND INTERSENSORY TASKS

Ability	Task	Raw Score	Age Equiv	Perform Level
Visual Measures				
Discrimination	Slingerland 3	1X	--	Avg.
	Slingerland 4	0X	--	Avg.
	Frostig 4	8	6-3	Low
Constancy	Frostig 3	1	2-0	Low
Analysis & Synthesis	WISC Pic. Completion	9	8-6	Avg.
	Detroit 17	2	5-6	Low
Figure Ground	Frostig 2	14	5-6	Low
Memory	Detroit 9	36	7-3	Avg.
	Detroit 16	5-2	9-9	High
	Slingerland 3	1X	--	Avg.
	Slingerland 5	6X	--	Low
Integration	WISC Block Design	18	10-6	High
Visual-Motor	VMI	11	5-10	Low
	Frostig 5	6	7-6	Avg.
Auditory Measures				
Discrimination	Slingerland 7	8X	--	Low
Blending	Roswell-Chall	28	--	Avg.
Memory	Detroit 6	36	4-9	Low
	Slingerland 6	6X	--	Low
	Slingerland 8	0X	--	Avg.
Integration	Detroit 13	69	9-6	High
Intersensory Measures				
Aud-Vis Integration	Slingerland 6	6X	--	Low
Aud-Vis Integration	Slingerland 7	8X	--	Low
Aud-Vis Integration	Slingerland 8	0X	--	Avg.

total error score of 21 on Slingerland subtests 3-8 suggests the possibility of a specific language disability. An analysis of her errors strongly suggests dysgraphia--that is, "a weakness in Kinesthetic memory of sequential movement patterns" (Slingerland, 1970, p. 107). She made 10 errors (mostly substitutions of upper case for lower case letters) on the preliminary direct copying tasks (not entered into error score) and six errors on a copying from memory task. On this latter subtest (number 5), her greatest difficulty was with the reproduction of designs rather than letters or numbers.

K.C. also had some difficulty with the Slingerland spelling test and auditory sounds task. On the latter, all her errors reflected a failure to shift from the recording of initial sounds (heard in dictated words) to final sounds. According to Slingerland (1970, p. 112) such a failure to shift probably reflects directional confusion. There would also seem to be some possibility of a general inability to shift or perseveration factor, but this is not confirmed by K.C.'s performance on, for example, Raven's Progressive Matrices.

By comparison with her mean WISC M.A. of 7-6, K.C. performed relatively poorly on the Frostig visual figure-ground (P.A.*5-6), form constancy (P.A.=2) and position in space tasks (P.A.=6-3). The only Frostig subtest which she performed on age level was that of spatial relations (P.A.=7-6), which requires copying designs with the aid of dots. K.C.'s difficulty with the Frostig designs parallels her difficulties with the nonsense forms on the Slingerland subtest 5. Her age level performance on the spatial relations task is congruent with her general improved success on items in a context or with supportive visual cues (e.g., dots), and interesting in contrast to her relatively low performance (an age equivalent of 5-10) on Beery's Visual Motor Integration Task. The VMI is similar to the Frostig spatial relations task in requiring the direct copying of designs, but unlike the Frostig, does not supply dots.

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*P.A. = the Perceptual Age equivalents provided in the Frostig manual.

K.C.'s performance on the Detroit seems to highlight effectively some of her important strengths and weaknesses. She had real problems with auditory memory for unrelated words (subtest 6, M.A.=4-9) but a high performance in auditory memory for related words (subtest 13, M.A.=9-6), which involves repeating meaningful sentences. Here we can see her superiority in a task supplying a context for the words to be recalled. She showed average visual memory for objects (subtest 9, M.A.=7-3) and high visual memory for letters (subtest 16, M.A.=9-9) despite several reversals on items even at the easiest level.

K.C. gave a relatively poor performance (M.A.=5-6) on the Detroit Disarranged Pictures (subtest 17), which involves indicating by number how the cut-up sections of a picture should be rearranged to provide a meaningful whole. On the WISC Picture Completion Task, which also involves visual analysis and synthesis, she was more successful (T.A.*=8-6). The Picture Completion task, however, requires a different sort of response--simple recognition of what part is missing from a picture (e.g., a leg from a dog). Visual integration as measured by the WISC Block Design subtest was high (T.A.=10-6).

To summarize, K.C. shows some evidence of dysgraphia, and weaknesses in visual perception, auditory memory for unrelated words and visual-motor integration. She benefits from context cues and is somewhat more successful in dealing with meaningful than nonmeaningful items.

<u>T.F.</u>

Table 4 summarizes the performance of T.F. on the visual, auditory and intersensory measures. Of the four sample children, she received the lowest error score (14) on the Slingerland and is the only one within the normal range. Nevertheless, there is some suggestion of dysgraphia, and of a visual perception problem strengthened by association with the auditory mode. (That is, when faced with a visual array, she makes more errors selecting the correct match to words presented visually than to words presented orally). She also had difficulties with the spelling test, although not as many as might be expected on the basis of teacher reports. (They say her spelling is horrendous).

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*The WISC manual provides Test Age equivalents for each subtest scaled score. The mean of all these Test Ages is the WISC Mental Age.

TABLE 4

SUBJECT T.F.: RAW SCORES, AGE EQUIVALENTS, AND PERFORMANCE LEVELS ON VISUAL, AUDITORY AND INTERSENSORY TASKS

Ability	Task	Raw Score	Age Equiv	Perform Level
Visual Measures				
Discrimination	Slingerland 3	0X	--	Avg.
	Slingerland 4	5X	--	Low
	Frostig 4	7	7-0	Low
Constancy	Frostig 3	14	9-0	Avg.
Analysis & Synthesis	WISC Pic. Completion	12	11-6	High
	Detroit 17	11	7-9	Low
Figure Ground	Frostig 2	12	5-3	Low
Memory	Detroit 9	30	5-3	Low
	Detroit 16	0	0	Low
	Slingerland 3	0X	--	Avg.
	Slingerland 5	3X	--	Low
Integration	WISC Block Design	20	10-6	Avg.
Visual-Motor	VMI	16	8-8	Low
	Frostig 5	6	7-6	Low
Auditory Measures				
Discrimination	Slingerland 7	0X	--	Avg.
Blending	Roswell-Chall	23	--	Avg.
Memory	Detroit 6	35	5-0	Low
	Slingerland 6	5X	--	Low
	Slingerland 8	1X	--	Avg.
Integration	Detroit 13	71	10-6	Avg.
Intersensory Measures				
Aud-Vis Integration	Slingerland 6	5X	--	Low
	Slingerland 7	0X	--	Avg.
	Slingerland 8	1X	--	Avg.

On the Frostig, T.F. had some problem with visual figure-ground perception (P.A.=5-3) and position in space (P.A.=7-0). Her performance on the spatial relations task (P.A.=7-6) was within a year of her chronological age (8-2) but low in relation to her WISC mental age of 10-0. This is true of her performance on another perceptual-motor integration task, the VMI, where she achieved an age equivalent of 8-8. The only Frostig subtest which she performed on her M.A. level was form constancy (P.A.=9-0).

On the Detroit, T.F. had difficulty with auditory memory for unrelated words (M.A.=5-0) but not for related words (M.A.=10-6). She also had problems with visual memory for objects (M.A.=5-3) and completely failed every item on the visual memory for letters task by consistently reversing the letter sequences. Her performance on the disarranged pictures test (M.A.=7-9) was low in comparison with her WISC M.A. By contrast, her performance on the WISC Picture Completion task was high (T.A.=11-6).

On the Raven's Progressive Matrices, T.F. scored in the 80th percentile. This is substantially lower than her WISC percentile of 95. The discrepancy may reflect her disproportionate number of errors reflecting poor perceptual discrimination. Such errors do support the possibility of a visual perception problem interfering with T.F.'s achievement.

To summarize, T.F.'s chief problem seems to be in the area of visual discrimination and visual memory. She reverses letters when recalling a series presented visually, and chooses alternatives with reversed letter sequences when trying to match a word. Although she may have some auditory weakness reflected both in recall and spelling difficulties, her visual discrimination problems seem somewhat alleviated by an association of visual and auditory modes.

D.M.

Table 5 summarizes D.M.'s performance on visual, auditory and intersensory tasks. Her total error score of 19 on the Slingerland indicates the possible presence of a specific language disability. Her 14 errors on the first copying task suggest dysgraphia, a possibility further supported by her four errors on subtest 5 (requiring reproduction from memory of designs, letters, and numbers).

TABLE 5

SUBJECT D.M.: RAW SCORES, AGE EQUIVALENTS, AND PERFORMANCE LEVELS ON VISUAL, AUDITORY AND INTERSENSORY TASKS

Ability	Task	Raw Score	Age Equiv	Perform Level
Visual Measures				
Discrimination	Slingerland 3	0	--	Avg.
	Slingerland 4	6X	--	Low
	Frostig 4	8	8-9	Avg.
Constancy	Frostig 3	7	6-0	Low
Analysis & Synthesis	WISC Pic. Completion	11	10-6	High
	Detroit 17	22	10-6	High
Figure Ground	Frostig 2	12	5-3	Low
Memory	Detroit 9	43	9-6	Avg.
	Detroit 16	5-1	9-0	Avg.
	Slingerland 3	0X	--	Avg.
	Slingerland 5	4X	--	Low
Integration	WISC Block Design	6	7-2	Low
Visual-Motor	VMI	14	7-2	Low
	Frostig 5	7	8-3	Avg.
Auditory Measures				
Discrimination	Slingerland 7	0X	--	Avg.
Blending	Roswell-Chall	28	--	Avg.
Memory	Detroit 6	35	5-3	Low
	Slingerland 6	9X	--	Low
	Slingerland 8	0X	--	Avg.
Integration	Detroit 13	48	6-6	Low
Intersensory Measures				
Aud-Vis Integration	Slingerland 6	9X	--	Low
	Slingerland 7	0X	--	Avg.
	Slingerland 8	0X	--	Avg.

Her six errors on the visual discrimination task (no memory involved) suggest a visual perception problem also. Her absence of errors on the auditory association task indicates that her visual perception problems are strengthened by association with the auditory mode. It also supports the possibility that her poor performance on subtest 5 may be more a problem of dysgraphia than visual perception per se. There is no evidence of any auditory perception problem.

D.M. was low on the Frostig subtests for figure-ground (P.A.=5-3) and form constancy (P.A.=6-0). She had no difficulties with position in space (P.A.=8-9) or spatial relations (P.A.=8-3). She had more difficulty with the VMI (age equivalent = 7-2) which requires visual-motor integration without supplying supportive dots.

On the Detroit, D.M. had some difficulty with auditory memory for both unrelated (M.A. =5-3) and related (M.A.=6-6) words. She had no difficulty with visual memory for objects (M.A.=9-6) or letters (M.A.=9-0). Her analysis and synthesis abilities were high as evidenced by an M.A. of 10-6 on the WISC Picture Completion. Visual integration as assessed by the WISC block design task was low (T.A.=7-2) in relation to her WISC M.A. of 8-6.

D.M, scored around the 85th percentile on the Raven's Progressive Matrices. Unlike K.C. and T.F., her error pattern suggests perseveration rather than difficulties in perceptual discrimination. Such perseveration may be related either to anxiety or to difficulties in shifting--which may be a cognitive problem.

To summarize, D.M. shows evidence of dysgraphia and difficulties in perceptual-motor integration. She may have some visual perceptual problems but shows no evidence of auditory perceptual problems. On the other hand, she may be impaired in auditory memory but not visual memory.

L.M.

Table 6 summarizes L.M.'s performance on the visual, auditory and intersensory tasks. His error score of 21 is beyond the normal range. Analysis of his errors suggests some dysgraphia as well as definite problems in auditory discrimination (partly reflected in spelling errors).

TABLE 6

SUBJECT L.M.: RAW SCORES, AGE EQUIVALENTS, AND PERFORMANCE LEVELS ON VISUAL, AUDITORY AND INTERSENSORY TASKS

Ability	Task	Raw Score	Age Equiv	Perform. Level
Visual Measures				
Discrimination	Slingerland 3	2X	--	Avg.
	Slingerland 4	2X	--	Avg.
	Frostig 4	8	8-9	Low
Constancy	Frostig 3	6	5-6	Low
Analysis & Synthesis	WISC Pic. Completion	12	11-6	High
	Detroit 17	3	5-9	Low
Figure Ground	Frostig 2	14	5-6	Low
Memory	Detroit 9	47	10-10	Avg.
	Detroit 16	4-4	8-9	Low
	Slingerland 3	2X	--	Avg.
	Slingerland 5	6X	--	Low
Integration	WISC Block Design	17	10-6	Avg.
Visual-Motor	VMI	16	8-7	Low
	Frostig 5	7	8-3	Low
Auditory Measures				
Discrimination	Slingerland 7	3X	--	Low
Blending	Roswell-Chall	30	--	Avg.
Memory	Detroit 6	41	6-10	Low
	Slingerland 6	5X	--	Low
	Slingerland 8	3X	--	Low
Integration	Detroit 13	71	10-6	Avg.
Intersensory Measures				
Aud-Vis Integration	Slingerland 6	5X	--	Low
	Slingerland 7	3X	--	Low
	Slingerland 8	3X	--	Low

Compared with a WISC M.A. of 10-0, L.M. is low on all the Frostig subtests, but his performance on position in space (P.A.=8-9) and spatial relations (P.A.=8-3) is relatively better than on form constancy (P.A.=5-6) and figure-ground (P.A.=5-6). His achievement on the VMI (age equivalent =8-7) closely parallels his performance on the Frostig spatial relations task.

On the Detroit, L.M. had difficulty with auditory memory for unrelated words (M.A.=6-10) but not for related words (M.A.=10-6). His visual memory for objects was good (M.A. =10-10) and for letters a little on the low side (M.A.=8-9). He had real difficulties with visual analysis and synthesis as measured by the Detroit Disarranged Pictures (M.A.=5-9) but not as measured by the WISC Picture Completion Task (T.A.=11-6).

Like D.M., and unlike T.F. and K.C., L.M.'s pattern of errors on the Raven's Progressive Matrices indicated perseveration rather than problems with perceptual discrimination. Such a pattern suggests anxiety or an inability to shift. As will be discussed later, he failed all items requiring logic, or reasoning by analogy. Unlike the relatively high scores of the other children, L.M. reached only the 45th percentile--in marked contrast to his 80th percentile rank on the WISC.

In summary, L.M. seems to have perceptual problems in the area of auditory perception and memory, as well as cognitive or emotional difficulties interfering with his ability to shift.

<u>Diagnostic Testing: The WISC</u>

Figure 1 is a graph of each subject's pattern of scaled scores on the WISC subtests. As the figure shows, there are some shared strengths and weaknesses in subtest performance. The patterns also retain highly individualistic features.

The present study adopted Huelsman's procedure (1970) for analysis of WISC subtest scores. That is, all scaled scores falling three points or more above and below the subject's own mean scaled subtest score were noted. Table 7 summarizes the deviant subtests for each child. In this study, as in Huelsman's, none of the subjects fell into the pattern of low Information, Coding, and Arithmetic identified in group studies. D.M. was low on

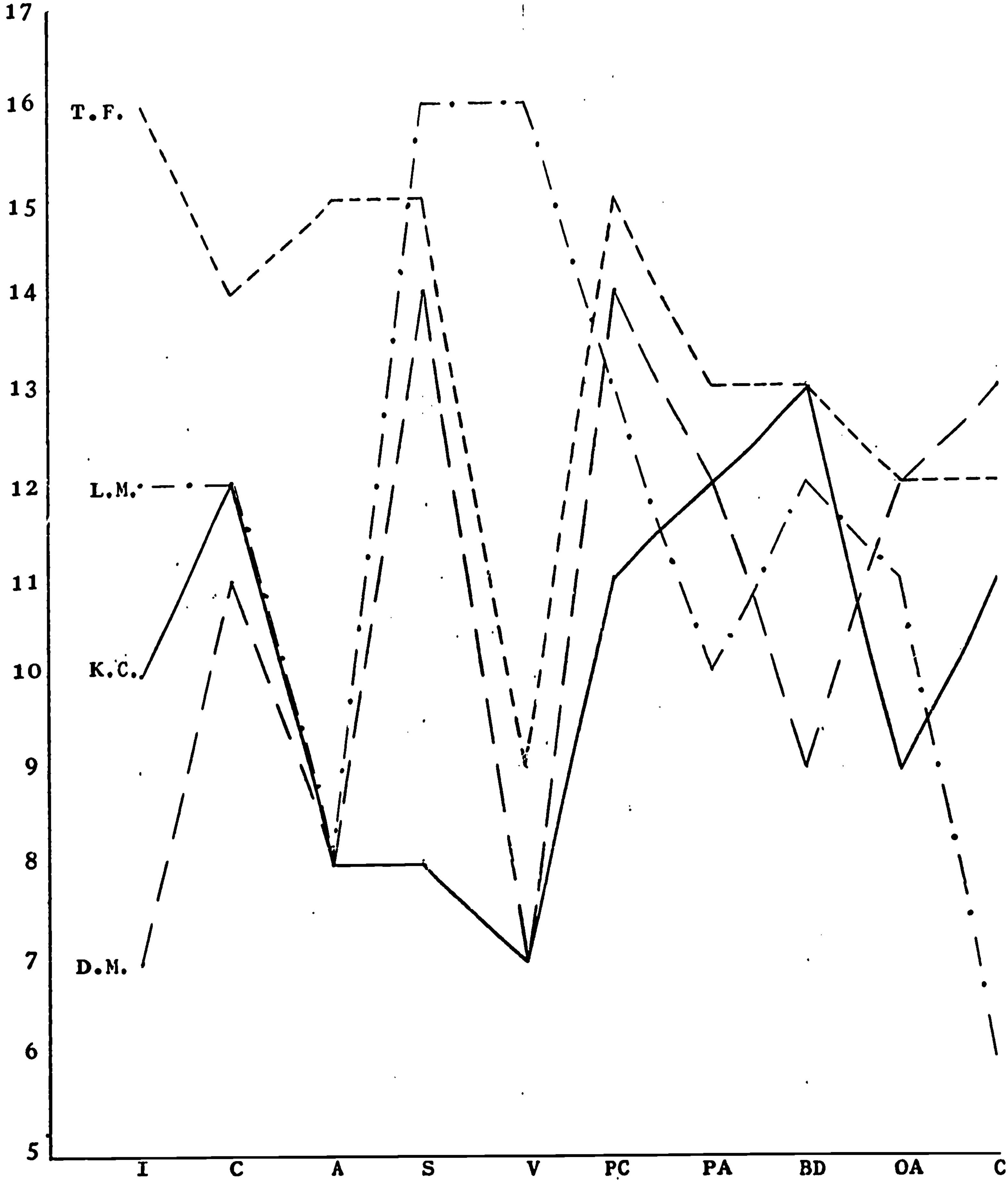


Figure 1. WISC Scaled Subtest Scores of Sample Children

Information and L.M. was low on Coding. The other two subjects did not fall into the group pattern at all.

TABLE 7

SIGNIFICANTLY HIGH AND SIGNIFICANTLY LOW WISC SUBTESTS*

Child	Significantly Low	Significantly High
K. C.	Vocabulary	Block Design
T. F.	Vocabulary	---
D. M.	Vocabulary, Information	Similarities, Picture Completion
L. M.	Coding	Vocabulary, Similarities

*Indicates scaled score 3 points or more above or below S's own mean scaled score (from Huelsman, 1970).

Three subjects, K.C., T.F., and D.M. were low on Vocabulary, while L.M. was high on it. D.M. and L.M. share high scores in Similarities. D.M. is also high in Picture Completion. T.F., who has the highest IQ has the least total scatter--only 1 subtest is deviant (Vocabulary). D.M., by contrast, has considerable scatter, with two significantly high scores (Similarities and Picture Completion) and two significantly low ones (Vocabulary and Information).

The subjects differ among themselves not only in strengths and weaknesses on individual subtests, but also in relative ability on performance vs. verbal scales. Verbal IQ's, Performance IQ's and Full Scale IQ's are given in Table 8. Two subjects, K.C. and D.M., adhere to the "typical" pattern of retarded readers with lower verbal IQ's than performance IQ's. In both cases, the gap is substantial--12 points in the case of K.C. and 19 in the case of D.M.

TABLE 8

VERBAL, PERFORMANCE AND FULL SCALE IQ'S ON THE WECHSLER INTELLIGENCE SCALE FOR CHILDREN

Child	Verbal IQ	Performance IQ	Full Scale IQ
K.C.	96	108	102
T.F.	124	121	125
D.M.	96	115	106
L.M.	118	103	112

A different pattern is revealed by the other two subjects. T.F.'s verbal IQ is superior to her performance IQ by 4 points. L.M.'s verbal IQ exceeds his performance IQ by a more substantial 9 points. These two subjects also have the higher full scale IQ's--125 and 112 as compared with 102 and 106.

The findings from this sample confirm Huelsman's (1970) findings--individual subtest patterns do not conform to the group pattern of low Information, Arithmetic and Coding, nor are all retarded readers superior in performance over verbal IQ. Although there are points of similarity among the subjects, individual differences are striking. Note again, for example, that while three S's are significantly low on Vocabulary, the fourth is not just average but significantly high. I would have to agree with Huelsman that instead of trying to identify a common WISC profile for retarded readers, it would be more profitable to investigate the significance of individual subtest performances for reading achievement.

An investigation of the relevance of WISC subtests for reading might include an error analysis, as recommended by Sigel (1963). Sigel suggests that one of the advantages of Raven's Progressive Matrices (PM) is that it supplies just such an error analysis. In his studies of children's PM scores, Sigel (1963) found that there are certain error patterns which are more typical of younger than of older children, and of girls than of boys. He believes that ultimately error analyses may tell us more about the why and why not of intellectual performance rather than just the what.

Some reference has been made already to the performance of the four sample children on the PM. Table 9 summarizes their raw scores, percentiles (determined partly by their CA) and the deviant portions of their error patterns. Three of the children, K.C., T.F., and D.M. scored at the 80th percentile or above, while L.M. scored at only the 45th percentile. The deviant error patterns of K.C. and T.F. revealed problems with visual discrimination, while for D.M. and L.M. it revealed perseveration. If these error patterns are generalizable to reading, it would suggest that K.C. and T.F. have reading difficulties because of visual perceptual deficiencies, and D.M. and L.M. because of logical (or emotional) involvements. The availability of error analyses at least facilitates the making of such hypotheses and the raising of possibilities which can be investigated.

TABLE 9

RAW SCORES, PERCENTILES AND PREDOMINANT ERROR PATTERNS ON RAVEN'S PROGRESSIVE MATRICES

Child	Raw Score	Percentile*	Type of Error
K.C.	23	90	Discrimination
T.F.	22	80	Discrimination
D.M.	22	85	Perseveration
L.M.	21	45	Perseveration

*Because determination of percentile takes C.A. into account, it is possible for two children to have the same raw scores but different percentiles.

Diagnostic Testing: Cognitive Development

Three Piaget-type tests were used to assess the children's cognitive development--the Goldschmid-Bentler Conservation Test, Pinard-Laurendeau Class Inclusion Test, and my own Structured Classification Task. Raw scores and cognitive levels for each of these tests are presented in Table 10.

TABLE 10

RAW SCORES AND COGNITIVE LEVELS FOR CONSERVATION, CLASS INCLUSION AND CLASSIFICATION TASKS

Child	Conservation		Class Inclusion		Classification	
	Score	Level	Score	Level	Score	Level
K.C.	12	Operational	2	Transitional	10	Preoperational
T.F.	12	Operational	3	Operational	15	Transitional
D.M.	4	Preoperational	2	Transitional	10	Preoperational
L.M.	12	Operational	3	Operational	12	Transitional

There is no necessary contradiction to the fact that the children score at different levels on different tasks. Piaget proposes the notion of "horizontal decalages" (variations in operativity dependent on specific content of items). Kohnstamm (1963) has presented evidence that children can be operational in conservation tasks while still preoperational in classification.

Of the four children, T.F. seems to be the most firmly operational. She performed on an operational level on two of the tasks and close to it on the third. In light of the evidence from her other tests, it seems likely that T.F.'s reading problem is not logical in nature. The evidence favors a diagnosis of perceptual rather than conceptual impairment.

L.M.'s performance is also relatively successful--two of the scores are operational and the third is transitional. Nevertheless, in light of his difficulties on the PM and in the training program (to be discussed later), it seems quite possible that his problems are at least partly logical in nature.

D.M. was the weakest of the four children on the cognitive tasks. She was preoperational in conservation and classification and transitional in class inclusion. These difficulties jibe well with the nature of her errors on the PM and suggest that she may have problems with logic.

K.C.'s scores ranged from preoperational through transitional to operational. In light of her performance on other tasks, it is difficult to come to any firm conclusion that her reading problems stem from logical weakness. There seems to be just as much evidence of a possible perceptual impairment.

<u>Reading: Before the Intervention</u>

In order to be candidates for this study, children had to be rated as underachievers in reading. All four of the sample subjects do appear to fall into this category. Table 11 summarizes their performance on the group-administered Iowa Test of Basic Skills and their actual reading level in September, 1971, before the beginning of the logical training program.

On the basis of national norms, K.C. and D.M. achieved at grade level on the Iowa vocabulary test but not on the comprehension test. But in actual reading performance in school, K.C. was assigned to the next-to-lowest reading group, and began the school year in the first book of the second grade series. D.M. was in the lowest reading group and began the year in a first grade primer. T.F. and L.M. both received lower scores in vocabulary than in comprehension, and in both cases these vocabulary scores were

TABLE 11

IOWA GRADE EQUIVALENTS AND PERCENTILES AND ACTUAL READING LEVELS OF SAMPLE BEFORE INTERVENTION

Child		Iowa Tests of Basic Skills			Actual Reading Level	
	Vocabulary Grade Equiv	Vocabulary Percentile	Comprehension Grade Equiv.	Comprehension Percentile	Group	Reader
K.C.	3.6	67	2.7	38	3	2:1
T.F.	1.6	8	2.1	17	3	2:2
D.M.	3.1	49	1.8	9	4	Primer
L.M.	1.6	8	2.8	41	4	Primer

TABLE 12

DURRELL READING-LISTENING PRETEST: GRADE EQUIVALENTS, AND APPROXIMATE DIFFERENCE IN MONTHS BETWEEN LISTENING AND READING TESTS

Child	Listening Vocabulary	Reading Vocab.	Approximate Diff.	Listening Sentences	Reading Sentences	Approximate Diff.	Listening Total	Reading Total	Approximate Difference
K. C.	3.9	3.0	9 mos.	3.8	2.5	14 mos.	3.6	2.5	13 mos.
T.F.	3.2	2.3	13 mos.	2.9	2.1	8 mos.	3.0	2.3	7 mos.
D.M.	2.7	2.7	0 mos.	2.5	1.8	7 mos.	2.6	2.4	2 mos.
L.M.	3.6	2.6	12 mos.	4.9	2.0	2.0 yrs	3.5	2.5	12 mos.

very low (eighth percentile). Yet of the four, T.F. was actually performing on the highest level in school--she began the year in the second book of the second grade series. L.M., who was on the same low level in vocabulary but had the highest comprehension percentile of the group 41st percentile), began the year in the lowest reading group and in a first grade primer.

The children were also administered the Durrell Listening-Reading Test at the beginning and end of the logical training program. This test helps to clarify the extent of their underachievement by supplying both a potential reading score (based on listening tasks) and an actual reading score (based on reading tasks paralleling the listening tasks). Table 12 presents grade equivalents and the difference in months between listening and reading tests.

Except in the case of D.M., there are rather substantial gaps between potential and actual performance scores for each child. The discrepancy ranges from nine months to 14 months for D.C., 7 to 13 months for T.F., and 12 months to 2 years-9 months for L.M. All three children are on grade level (according to national norms) in their reading potential but not in their reading achievement.

D.M. shows much less of a gap between potential and achievement (ranging from 0 to seven months) and is on grade level in neither. Looking just at her reading scores, one might guess that she is simply low in intelligence and operating close to her level (at least on this test). However, her WISC Full Scale IQ of 106 discredits this possibility. Even taking into consideration just her WISC verbal IQ of 96, we would expect her to be reading at more than a primer level. D.M., like the other sample children, is underachieving.

The Logical Training Program

As reported earlier in this paper, the logical training program lasted 11 weeks, from October 5 to December 16, 1971. With the exception of Thanksgiving Thursday and one Thursday when D.M. was out sick, each child met with me individually Tuesdays and for 40 minutes as a group on Thursdays. Individual meetings were scheduled for 40 minutes each, but in general, sessions with D.M. ran at least 45 minutes while the others were about 30-35 minutes.

Of the four children, K.C. seemed to have the most success with the program. For the first 2-3 weeks she was slow and hesitant in her approach to each task involving the attribute blocks and people pieces. Nevertheless, in each task she either demonstrated understanding of the principle involved right from the beginning or soon arrived at it--with or without prompting.

K.C.'s performance on the reading tasks was a little different. After completing tasks with the other stimuli, she generally had the "right idea" of what she was supposed to do--e.g., sort on the basis of one common attribute, build a matrix, etc. However, she frequently ran into problems because of the nature of sound-letter relationships. When faced with familiar words such as "bake" and "bat", she would pronounce the A correctly as both the long and short vowel, but she would still try to classify as though there were one-to-one relationships between letters and sounds. When sorting into groups, she would have difficulties when different letters made the same sound (e.g., doll, ball) or when the same letter made different sounds (e.g., make, mat).

K.C.'s classifying seemed to be facilitated when she verbalized about what she was doing--unless she verbalized a letter rule ("They all have A in them") when she should have verbalized a vowel rule ("They all have the ă sound in them"). A question such as "Are you looking for words with the letter A or the sound ă?" generally helped her to complete a task successfully. Although there were still some confusions about sound-letter correspondences at the end of the program, by December K.C. was able to complete both nonverbal and verbal tasks efficiently and competently, spontaneously correcting most of her own errors.

D.M. was the child who seemed to find the training program most difficult. Her performance in the program confirmed the findings of the diagnostic testing (particularly the Raven PM) that she may have conceptual problems as well as perceptual ones interfering with her reading achievement. For example, D.M. was the only child in the program who consistently had trouble with the terms "same" and "different", occasionally reversing their meanings. She also had real difficulty keeping in mind the attribute by which she was classifying--she would begin with color, then shift without realizing it to shape. (Piaget says this difficulty is characteristic of the preoperational child).

D.M.'s problems in the program were not limited to the verbal stimuli. She had as much difficulty classifying by attributes, shifting, or building matrices with attribute blocks as with words. The difficulty seemed to lie in the logical principles involved rather than the verbal or nonverbal content of the materials.

One aspect of D.M.'s difficulty was a lack of precision in verbalizing the rules behind her performance. When asked how the attribute blocks in each row of a matrix were the same, she would reply "They look the same", rather than pointing out the shared attribute of color, shape or size. Similarly, when asked about the words in the rows of a matrix, she would reply "they sound the same" rather than specifying the common first, vowel or ending sound.

By December, D.M. was improving in her classifying activities, in that once started she could generally complete a task successfully. However, she was still having difficulty verbalizing the rules by which she operated, and keeping in mind the attribute according to which she was sorting. It was also apparent that not all her problems were logical in nature, but seemed to involve deployment of attention. There were several times when I sat by D.M. as she completed a written exercise, heard her verbalize the correct answer, and then saw her mark the column nearest to the problem without checking to see if it had the answer she wanted. (This was not a problem of perceptual discrimination. She was not selecting an A vs. an O, but putting an X in the columns for beginning sound, vowel sound, or ending sound).

T.F.'s performance in the program suggested both emotional and perceptual difficulties. Whenever she worked with the attribute blocks, she built towers--not precise, well-balanced towers, but somewhat haphazard, always nearly toppling towers. The first time she sorted the people pieces on the basis of attributes, she produced the following classifications: "This is a fat aunts and everything family and this is a skinny family." Again, "This is an all-man blue family and this is an all red man family." (A sexual overtone to some of her activities seemed confirmed in her interaction with the boy in the group).

T.F. had many problems interacting with the materials which may reflect visual perceptual difficulties (or something else). For example, she sometimes miscounted the number of blocks she had placed in a group, or the number of groups she had made. She had real difficulty reading even simple words. Not only did she reverse letters, but she would intermix letters from adjacent words.

T.F. had less difficulty logically than perceptually with reading tasks. Problems with sound-letter correspondences arose in the beginning of the program, but were resolved. Similarly, the first time she built a word matrix she had great difficulty and insisted it could not be done. After building columns based on rhyming words, she could not line up rows based on beginning sounds without help. However, with each subsequent matrix, her performance improved. Eventually matrices presented no real problems.

Unlike D.M., T.F. never seemed to find the training program excessively difficult. Individual tasks sometimes stymied her momentarily, but with help she always grasped the basic principles. Like K.C., T.F. generally verbalized as she proceeded in a task.

It is difficult to characterize L.M.'s performance in the program. He always seemed to bring a great many other concerns to each meeting. A great deal was always going on besides his involvement in logical tasks. He had jokes to tell, stories to recite, songs to sing, outrageous statements to make. He seldom just put blocks into groups--instead he built elaborate designs. He could be both impulsive and terribly precise. Seldom did we meet without blocks ending up on the floor. Seldom did we meet without some intricate pattern being built with attribute blocks. Because so much was going on with him all the time, L.M. never seemed to finish all the tasks, but always ended up tired.

Like D.M., L.M. frequently seemed to have trouble retaining the attribute by which he was sorting. He would start sorting blocks according to color and then get lost in the making of a design. It is possible that non-cognitive factors may be involved here, yet is consistent with his performance on the structured classification task. L.M. also had some trouble shifting in both verbal and nonverbal tasks.

L.M. had particular difficulties with verbal tasks. He had trouble with word-sound relationships. He frequently mis-read or mispronounced words. He seemed to have real difficulty focusing on words. One personal technique he seemed to have developed for sounding out new words was to look away from them for a moment--and this seemed to help!

In summary, many potential reasons for L.M.'s reading retardation seemed to emerge during his involvement in the program. He's distractible. He tires easily. He has difficulty shifting. He has trouble keeping in mind an attribute by which he is classifying. He reverses letters. He has some trouble with long vs. short vowels, and seems to lack some elementary phonetic rules. He tries to do several things at once. He has other things on his mind. Very little improvement in any of these areas was shown during the program.

The Post-Tests

The purposes of the intervention were to answer two kinds of questions: a) If children have cognitive weaknesses which may be interfering with their reading achievement, can logical training improve both their logical and reading skills? b) If children have perceptual problems which may be interfering with their reading achievement, can logical training improve their reading skills by helping them capitalize on their (cognitive) strengths? The post-test data from the Durrell Listening-Reading Test and Structured Classification Task are relevant to these questions. Both tests were administered in February, 1972, approximately eight weeks after the end of the training program and 4½ months after the pre-testing on the Durrell.

The post-test findings suggest that answers to the questions must be cautious. Surprisingly enough, the data seem to indicate that in some cases the program may be more useful for children with certain perceptual rather than conceptual problems--although this may well be a function of my own administration of the program rather than of the materials themselves.

One child who seemed to have a visual perception impairment--although she may have had other problems as well--is T.F. How did she fare in the program? A comparison of her pre-test and post-test Durrell grade equivalents, and the amount of improvement between them, is presented in Table 13. Improvement in her actual reading achievement averages about seven months, which is more than, but probably not significantly more than, the $4\frac{1}{2}$ month time span between test administrations. Improvement in her listening skills is another story, indeed, ranging from one year on vocabulary to two years on sentences. It seems likely that this rather substantial progress is due directly to the logical training program, which consistently emphasized listening as well as reading skills.

T.F.'s greater progress in listening over reading may be reflective of both the advantages and limitations of capitalizing on strengths to offset weaknesses. It may be that the training program was successful in improving her ability to deal with the logical multiplication of sound-letter relationships when the stimuli were oral because her auditory perception was intact. The same success may have been absent when the stimuli were written because of her weakness in visual perception. If this analysis is correct, then children like T.F. might benefit from having perceptual training exercises along with logical training.

TABLE 13

T.F.: PRE-TEST AND POST-TEST GRADE EQUIVALENTS AND AMOUNT OF IMPROVEMENT ON DURRELL LISTENING-READING TEST

	Potential Reading Grade			Actual Reading Grade		
Subtest	Pre-Test	Post-Test	Improvement	Pre Test	Post-Test	Improvement
Vocab.	3.2	4.2	1 year	2.3	2.9	7.2 months
Sentences	2.9	4.9	2 years	2.1	2.7	7.2 months
Total	3.0	4.1	1.1 years	2.3	2.8	6 months

T.F.'s potential reading score increased dramatically, and she achieved a grade level equivalent (approximately 4.1) beyond her own level in school. Her actual reading score increased only moderately and at the end of the program was still lower than her actual grade in school. The case of D.C. is quite different. (See Table 14). K.C. improved only slightly in potential reading (0-3.6 months) but quite substantially in actual reading (1.1 years on vocabulary and 8.2 months in total score). As a result, K.C. was on grade level in both potential (3.8) and actual (3.5) performance at the end of the program (at least according to the norms for this test).

TABLE 14

K.C.: PRE-TEST AND POST-TEST GRADE EQUIVALENTS AND AMOUNT OF IMPROVEMENT ON DURRELL LISTENING-READING TEST

	Potential Reading Grade			Actual Reading Grade		
Subtest	Pre-Test	Post-Test	Improvement	Pre-Test	Post-Test	Improvement
Vocab.	3.9	4.2	3.6 mos.	3.0	4.1	1.1 years
Sentences	3.8	3.8	0	2.5	2.9	4.8 mos.
Total	3.6	3.8	2.4 mos.	2.8	3.5	8.2 mos.

In addition to K.C.'s improvement in her reading scores, there is further evidence that she found the training program beneficial. Her mother reports that for the first time, K.C. is showing a real interest and pleasure in reading. She not only takes more books out of the library, but seems to choose them on the basis of verbal content rather than number of pictures. She now enjoys reading aloud both to younger siblings and to friends.

K. C. may have been the ideal child for the training program. At the time of the diagnostic testing she had some problems with logical multiplication and shift, but did not seem very retarded in overall cognitive development. The diagnostic testing suggested some perceptual or perceptual-motor involvement, but this affected nonverbal more than verbal stimuli. The training program, with its use of both verbal and nonverbal stimuli, and listening and reading tasks, seemed to capitalize well on her existing strengths to improve her ability to handle the logical multiplication of sound-letter relationships. Why her improvement in vocabulary was so much more dramatic than that in sentences is difficult to say--particularly since, in general, she seems to profit from context cues. The answer may lie in some sort of time or stylistic factor, since her approach to all tasks tends to be slow and deliberate. She may simply not have had enough time to work through the sentence items.

The child who might have been expected to benefit the most from the program, because of her many logical-cognitive difficulties, was D.M. The evidence does not indicate any such benefit. (See Table 15). Like T.F., D.M. improved more on potential than in actual reading, but her improvements were not nearly so dramatic. Moreover, in her actual reading grade, improvement in months was not even comparable to the length of the program. What happened?

TABLE 15

D.M.: PRE-TEST AND POST-TEST GRADE EQUIVALENTS AND AMOUNT OF IMPROVEMENT ON DURRELL LISTENING AND READING TEST

	Potential Reading Grade			Actual Reading Grade		
Subtest	Pre-Test	Post-Test	Improvement	Pre-Test	Post-Test	Improvement
Vocab.	2.7	3.1	4.8 mos.	2.7	2.9	2.4 mos.
Sentences	2.5	3.3	9.6 mos.	1.8	2.1	3.6 mos.
Total	2.6	3.0	4.8 mos.	2.4	2.6	2.4 mos.

My guess is that the fault was not in the content of the program but in the rate at which D.M. was expected to proceed. As mentioned earlier, D.M. was the child who consistently found the program most difficult. Given her confusion with the very basic terms "same" and "different" it hardly should have been expected that she could proceed quickly with problems of logical multiplication. However, because all four children met as a group on Thursdays, and because we only had 11 weeks, I did not want her to get too "behind". Consequently I may unwittingly have pushed her to the point where some activities lost all meaning for her.

One example of a situation where emphasis on time and keeping up may have meant sacrificing some of D.M.'s meaningful involvement was our playing of guessing games. These games involved guess situations such as "I'm thinking of part of the body that begins with 'f' but it is not my face." These games were introduced on a Tuesday, and all the children learned to pose the the questions as well as answer them. D.M. had trouble from the beginning, particularly with the negative information. She would say, for example, "I'm thinking of something to wear, and it begins with h, and it's not a ball." I found it difficult to help her see that all aspects of the information should be relevant. On Thursday, when we met in the group, D.M. persisted with her irrelevant negative information. K.C. protested (e.g., "but a ball's not to wear"). Because we only had 10 minutes left in the session, I neglected the opportunity of letting K.C. try to teach D.M.--who never did master this activity.

L.M. also failed to make exciting progress in the program. (See table 16). This is particularly disappointing since L.M., like D.M., seemed to have some problems of a cognitive nature which might be expected to be diminished by logical training. What went wrong?

TABLE 16

L.M.: PRE-TEST AND POST-TEST GRADE EQUIVALENTS AND AMOUNT OF IMPROVEMENT ON DURRELL LISTENING AND READING TEST

	Potential Reading Grade			Actual Reading Grade		
Subtest	Pre-Test	Post-Test	Improvement	Pre-Test	Post-Test	Improvement
Vocab.	3.6	4.2	7.2 mos.	2.6	2.8	2.4 mos.
Sentences	4.9	4.9	0	2.0	2.5	6 mos.
Total	3.5	4.6	7.2 mos.	2.5	2.7	2.4 mos.

My hypothesis again is that the problem was not in the materials or activities per se, but in the structure and administration of the program. It simply was not individualized adequately to meet L.M.'s needs. As noted before, L.M. was distractible and impulsive, and often responded idiosyncratically to stimuli. Two 40 minute meetings a week were simply not sufficient to the task of helping him to "tune in" in a more normal way to logical--or any other--kinds of problems. I believe both D.M. and L.M. would benefit from a more constant involvement in the activities used in the program--as might be possible, for example, in an open classroom. Even in a more traditional classroom like they're now in, it could be possible to have a "logic corner" as well as a library corner.

Table 17 summarizes pre-test and post-test raw scores and cognitive levels for the four children on the structured classification task. As can be seen, all four children improved. Using 20 as the cut-off point for operationality, T. F. is fully operational, K.C. and L.M. are on the verge of it, and D.M. is still transitional. There are no comparable pre- and post- data available for other groups of children on this task, so it is impossible to be sure that the improvements are due to training rather than to cognitive growth. It is interesting that K.C., who improved the most in actual reading also improved most on the SCT. D.M., who improved the least in actual reading also improved the least on the SCT.

TABLE 17

PRE-TEST AND POST-TEST RAW SCORES AND COGNITIVE LEVELS ON THE STRUCTURED CLASSIFICATION TASK

Child	Pre-Test Score	Pre-Test Level	Post-Test Score	Post-Test Level
K.C.	10	Preoperational	10	Transitional
T.F.	15	Transitional	21	Operational
D.M.	10	Preoperational	15	Transitional
L.M.	12	Transitional	19	Transitional

A Final Note on Cognitive Style

One of the advantages of working with a small sample is the opportunity for studying closely individual differences. One variable which seemed to have impressive, if inestimable, significance was cognitive style--in Sigel's sense of modes of perceiving, organizing and labeling the environment. Each child had unique and characteristic ways of interacting with the program materials, consistent over a four month period. (I met individually with each child for a final time at the end of the post-testing to investigate his stylistic consistency).

On October 19, 1971 and again in March 6, 1972, when asked to sort attribute blocks on the basis of sameness, T.F. made towers with blocks matching in size and shape. D.M. had great difficulty with sorting by attribute and shifting both on October 19 and March 6, but on both dates when she was finally led to sort (and shift) she carefully lined the blocks up in rows with the little pieces on top of the big ones. L.M., throughout the program, never just put blocks into groups (unless he was rushing to get done) but always built designs. The most salient aspect of K.C.'s approach to problems. throughout the program was its deliberateness and step-by step nature. The relationship between these stylistic aspects of behavior and academic success is by no means obvious, but I am convinced of its importance.

Conclusions

This study, because of its case study approach to four children, does not have compelling statistical data to back up its conclusions. However, there is no apparent reason why we should assume that these four youngsters are completely unique, with problems in no way similar to those of other children. Consequently, I think the findings support the following tentative conclusions.

1. The Piagetian notions of logical multiplication, class inclusion and shift do have implications for reading.

2. Children of average intelligence (with individual IQ's over 100) can have problems characterized as cognitive developmental or logical because of their weaknesses in the above areas.

3. Children with problems that are primarily logical in nature can benefit from logical training exercises.

4. Children can be generally adequate in logical development and still have difficulty with sound-symbol relationships. This difficulty may be related to or aggravated by perceptual impairments or mild emotional disturbance.

5. Children with problems that are primarily perceptual can benefit from logical training exercises designed to capitalize on their logical abilities in the word-attack process.

In the present study, all four reading retarded children had some difficulty with the logical multiplication involved in sound-symbol relationships. All four children tended to approach new word analysis from an angle of letter names rather than sounds. All four sometimes had difficulty shifting when, for example, the letter A represented first ă and then ā. While all four children thus had some problems which chould be labeled as cognitive developmental or logical, D.M. was the child whose primary difficulties seemed to be of this sort. There was also evidence that these problems were important for K.C. and L.M.

In the present study, K.C., with a lower IQ but possibly more advanced cognitive level, benefitted more from the training program than D.M., who may have needed a more paced and consistent involvement with the materials. T.F., with the highest IQ and most advanced cognitive level, benefitted more than L.M., despite her rather definite visual discrimination problems. Like D.M., L.M. may have needed a more total immersion in the activities.

In addition to these rather specific conclusions, I have arrived at some more general ones.

1. If our culture were really as child-oriented as it claims to be, it would do something to reform its language. It seems quite obvious that the high percentages of retarded readers in the schools, and functionally illiterate adults in society at large, are related to the complexities of English sound-symbol relationships. There is evidence that use of the initial teaching alphabet (where 44 different symbols represent 44 different sounds) greatly reduces early reading failures and can even be helpful with adolescent non-readers (Mazurkiewicz, Dietrich, Beauchamp & Ward, 1965). There is also evidence that children who are seriously retarded in reading can learn to read English using Chinese characters. Unlike English, Chinese characters map into speech at the level of morphemes (meanings) rather than phonemes (sounds) (Rozin, Poritsky & Sotsky, 1970). Both types of study point to the role of sound-symbol relationships in producing retarded readers and illiterates. Relating mastery of sound-symbol relationships to perceptual development (Elkind) or cognitive development (White) may contribute to our understanding of the problems involved, but real solutions may lie in the reform of the language.

2. We need more study of the relationship between measures of cognitive style and other behaviors. Shouksmith's recent book, Intelligence, Creativity and Cognitive Style (1970) would seem to be a step in this direction.

3. No single theoretical framework, no more than any single pragmatic approach, can neatly tie up and explain all reading retardation. The lack of success in reading research may reflect the attempt to administer single programs to groups of children and to guage success by group data--where individual successes may be wiped out. In order to cope with the variety of individual differences, we need to make available to children a variety of materials and approaches.

4. Short-term interventions, with one or two short meetings each week over a limited period of time, are not the most efficient means to produce change. Ultimately, an effective open classroom based, like the English Infant Schools, on Piagetian developmental principles, may be the most effective framework for teaching to individual differences. (I recognize that problems of assessment and measurement of variables are increased multifold in such a setting).

5. There is much general talk in the educational literature about "individualizing instruction", but the development of such techniques may be in its infancy--or perhaps in a second childhood, reflecting the overwhelming pressures of modern mass education. Again, as open classroom teaching grows in maturity, we may become more effective in our attempts to individualize instruction, and gear it to the needs and development of the child.

Bibliography

Baker, H. J., & Leland, B. Detroit Tests of Learning Aptitude, Indianapolis, Indiana: The Bobbs-Merrill Co., 1959.

Beery, K. E. & Buktenica, N. A. Developmental Test of Visual-Motor Integration. Chicago: Follett Educational Corporation, 1967.

Belmont, L., & Birch, H.G. The Intellectual profile of retarded readers. Perceptual and Motor Skills, 1966, 22, 787-816.

Berstein, M. The right to fail. Seminars in Psychiatry, 1969, 1, 339-343.

Birch, H. G., & Belmont, L. Auditory-visual integration in normal and retarded readers. American Journal of Orthopsychiatry, 1964, 34, 852-861.

Blank, M, & Solomon, F. A tutorial language program to develop abstract thinking in socially disadvantaged preschool children. Child Development, 1968, 39, 379-390.

Blom, G. E. The concept of "perceptually handicapped": Its assets and limitations. Seminars in Psychiatry, 1969, 1, 253-261.

Caldwell, E. G., & Hall, V. C. The influence of concept training on letter discrimination. Child Development, 1969, 40, 63-71.

Dudek, S. Attributes Games and Problems. Elementary Science Study.

Durrell, D. D., & Hayes, M. T. Combined Listening and Reading Tests, Primary Level, N.Y.: Harcourt, Brace, Jovanovich, Inc., 1970.

Elkind, D. Piaget's theory of perceptual development: Its applications to reading and special education. Journal of Special Education, 1967, 1, 357-361.

Elkind, D & Deblinger, J.A. Perceptual training and reading achievement in disadvantaged children. Child Development, 1969, 40, 11-19.

Farnham-Diggory, S. Cognitive synthesis in negro and white children. Monographs of the Society for Research in Child Development, 1970, 35:5.

Flavell, J. H. The developmental psychology of Jean Piaget. New York: D. Van Nostrand Company, 1963.

Frostig, M & Horne, D. An approach to the treatment of children with learning disorders. Hellmuth, J. (ed.), Learning Disorders, Vol. 1, Seattle, Washington: Special Child Publications, 1965, 293-305.

Frostig, M. & Horne, D. The Frostig program for the development of visual perception. Chicago: Follett, 1964.

Frostig, M., Lefever, D. W., & Whittlesey, J. R. B. The Marianne Frostig Developmental Test of Visual Perception. Palo Alto, California: Consulting Psychologists Press, 1964.

Goldschmid, M. L., & Bentler, P. M. Concept Assessment Kit-Conservation. San Diego, California: Educational and Industrial Testing Service; 1968.

Henderson, R. L. & Green, D. R. Reading for meaning in the elementary school. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969.

Huelsman, C. B. The WISC subtest syndrome for disabled readers. Perceptual and Motors Skills, 1970, 30, 535-550.

Inhelder, B. & Piaget, J. The early growth of logic in the child. New York: W. W. Norton & Co., Inc., 1969.

Johnson, D. Educational principles for children with learning disabilities. Rehabilitation Literature, 1967, 28, 317-322.

Kohnstamm, G. A. An evaluation of part of Piaget's theory. Acta Psychologica, 1963, 21, 313-356.

Mazurkiewicz, A. J., Dietrich, D, Beauchamp, J. & Ward, B. I/T/A and learning disorders. Hellmuth, J. (ed), Learning Disorders, Vol. 1, Seattle, Washington: Special Child Publications, 1965, 345-361.

McGrady, J. J., & Olson, D. A. Visual and auditory learning processes in normal children and children with specific learning disabilities. Exceptional Children, 1970, 36, 581-580.

Raven, J. C. Raven Progressive Matrices. New York: The Psychological Corporation, 1947.

Rozin, P., Poritsky, S. & Sotsky, R. American children with reading problems can easily learn to read English represented by Chinese characters. Science, 1970, 171, 1264-1267.

Sidman, M. Tactics of Scientific Research. New York: Basic Books, 1960.

Shouksmith, G. Intelligence, creativity and cognitive style New York: Wiley-Interscience, Inc., 1970.

Sigel, I. E. How intelligence tests limit understanding of intelligence. The Merrill-Palmer Quarterly, 1963, 9, 39-56

Slingerland, B. H. The Screening Tests for Identifying Children with Specific Language Disabilities. Cambridge, Mass.: Educators Publishing Service, Inc., 1969.

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

White, K. M. Conceptual style and conceptual ability from Kindergarten through the eighth grade. Child Development, 1971, 42, 1652-1656.

White, K. M. The Structured Classification Task, Unpublished Test.

Wohlwill, J. F., & Lowe, R. C. An experimental analysis of the development of the conservation of number. Child Development, 1962, 33, 153-167.

Zigmond, N. K. Learning patterns in children with learning disabilities. Seminars in Psychiatry, 1969, 1, 344-353.

APPENDIX A

STRUCTURED CLASSIFICATION TASK INSTRUCTIONS

Class Inclusion I

1. Read question as printed. Record response on line beginning "More...."

2. Whether answer is right or wrong, ask e.g., "How many men in uniforms are there? Record answer on line beginning "How many...." Ask e.g., "How many grown-ups are there?" Record answer.

3. If child answered 1 and 2 correctly, go on to next set of pictures. If he answered 1 incorrectly but 2 correctly, repeat question 1. If he answered both incorrectly, say, "Look at the pictures carefully and then tell me how many of them are grown-ups." Record response. Repeat question 1. Record response.

Class Inclusion II

Read questions as printed. Record response. Ask "How do you know?" Record justification.

Multiple Class Membership

After each response, ask child, "And can you explain why/why not?" Record Answer.

Shift

1. Spread out all the human pictures. Ask child, "In what way are all of these alike?" Record response.

2. Ask the child to put the pictures into two different groups. Have him explain groupings.

3. Have child spread pictures out again and then put them into two groups a different way. If he repeats a previous labeling, say "Now try to find a new way to put them into two groups." Try to elicit at least three sets of groupings (possibilities: young-old, male-female, black-white).

4. Repeat procedure with clothing pictures. Again, try to get at least three sets of groupings (possibilities: indoor-outdoor, boy's-girl's, shoes' clothes).

Classification Task Record Form

Part I. Class Inclusion

A. Pictures: carrot, corn, pie

Question: Are there more vegetables or more foods?

Answer: more ____________________
how many? ____________________

B. Pictures: B girl, Y girl, W girl, boy playing ball

Question: Are there more girls or more children?

Answer: more ____________________
how many? ____________________

C. Pictures: policeman, soldier, sailor, lady

Question: Are there more grown-ups or more men in uniforms?

Answer: more ____________________
how many? ____________________

D. Pictures: dogs, cat, cow

Question: Are there more animals or more pets?

Answer: more ____________________
how many? ____________________

E. Pictures: rose, tulip, geranium, tree

Question: Are there more flowers or more plants?

Answer: more ______

how many? ______

Part II. Class Inclusion II

Picture: 3 red tulips, 1 yellow tulip, 3 red roses, 1 tree

Questions:

1. Is the bunch made of all the red tulips biger, smaller or the same as the bunch of all the tulips?

   Answer: ______

2. Are there more tulips or more flowers?

   Answer: ______

3. Are there more flowers or more red ones?

   Answer: ______

4. If you take all the tulips away, will there be any flowers left?

   Answer: ______

5. If you take all the flowers away, will any tulips be left?

   Answer: ______

Part III. Multiple Class Membership

A. Picture: traffic boy

Questions: 1. Can he be a son and a brother at the same time?____________
Why?____________

2. Can he be a brother and a sister at the same time?____________
Why?____________

B. Picture: bee

Questions: 1. Can this be a bee and a mosquito at the same time?____________
Why?____________

2. Can it be an animal and an insect at the same time?____________
Why?____________

C. Picture: teacher

Questions: 1. Can she be a teacher and a mother at the same time?____________
Why?____________

2. Can she be a mother and a sister at the same time?____________
Why?____________

D. Picture: old man

Questions: 1. Can he be a father and a grandfather at the same time?____________
Why?____________

2. Can he be a father and a son at the same time?____________
Why?____________

E. Picture: doll

Questions: 1. Can this be a doll and a toy at the same time?____________
Why?____________

2. Can this be a doll and a little girl at the same time?____________
Why?____________

Part IV. Shift

A. Pictures of people.

All ______

1st match ______

2nd ______

3rd ______

4th ______

5th ______

B. Pictures of clothes.

All ______

1st match ______

2nd ______

3rd ______

4th ______

5th ______

APPENDIX B

LOGICAL TRAINING PROGRAM

Introduction

The overall purpose of the logical training program is two-fold: First, it aims to develop the child's mastery of, and confidence in, the application of logic to various kinds of problems. One approach is to encourage good guessing--that is, the making of predictions, forming of inferences and testing of hypotheses based on the logical implications of both the properties of and the relationships among objects. Second, it aims to teach the child to apply his logical skills to the process of reading. It is assumed that reading is always a conceptual as well as a perceptual process, that letters and words are tools, and that there are, ultimately, rules that bind the relationships between letters and sounds. The same reasoning that the child uses to simplify and classify the objects and events in his world may be applicable to the coding process involved in reading. For example, experimenting with possible pronunciations of the letter A in an unfamiliar word may not be logically different from deciding to which of a group of subsets a given block belongs. Certainly, the interpreting of the individualized sounds c-a-t in a meaningful way involves some sort of conceptual process, some sort of inference from the surface structure of the sounds to the deep structure of the meaning.

A preliminary outline of the structure of the logical training program follows. The activities involving the Attribute Blocks and the People Pieces have been incorporated rather directly from the Teacher's Manual for Attribute Games and Problems. They are included here for ease of program administration, and should not be considered as the original contribution of the present investigator. Moreover, the Attribute games included here are highly selective, representing the investigator's assumptions as to which activities can be most easily translated into verbal forms with applications to reading.

The units described should not be considered as individual and separate lessons to be presented once and then left behind. Rather, the child's progress through the units will depend on his own abilities and problems. For example, one child might have no problem with the first, generating the set, unit, but have great difficulty with the second, classifying, unit because of some sort of "set" which makes it difficult for him to shift. For that child, emphasis will be on providing many varied and interesting types of shift activities. A second child might have a great deal of difficulty in generating sets. Once he mastered that task, however, the others might follow quite easily. His progression through the units would thus follow a different route than the first child's.

I. Generating the set.

Purpose: Introduction to materials; introduction to processes of hypothesis testing; prediction, handling of logical implications.

A. Attribute Blocks

Procedure: Hold up the closed box with the attribute blocks inside. Shake it. Ask the child to guess what is in the box. Encourage the response: (wooded) blocks. Begin withdrawing blocks from the box one at a time. Encourage the child to guess what the blocks remaining in the box are like. Inform the child that no two blocks are exactly the same.

Sample situation: Once the child has seen that there are red, green and blue triangles, and a red and a green square, will he guess that there is also a blue square? If he is then shown that there is a yellow circle, will he guess that there is also a yellow square and a yellow triangle?

The blocks can be grouped by color shape to help the child see emerging patterns. Let the process of generating the set take its time. If a child simply asks for "a red", ask him what shape it should be. If he asks for a shape, ask him what color.

The child should be encouraged to play with the blocks, talk about them, and describe them.

B. People Pieces.

Procedure: Same as for Attribute Blocks; attributes: color (red or green), age,sex, girth.

C. Reading Task

Procedure: Same as for Attribute Blocks. One word is drawn from a box, then another, until the child is able to guess what other words may be in there. All possible English combinations are accepted for rhyming words, even if they are not real words. If the child suggests a word that is not in the box, ask him if it could be, and why. If his reasoning is good, write the word on a card and add it to the group.

Sample: bat, cat, dat, fat, etc.
bake, cake, dake, fake, etc.

II. Classifying by attributes.

Purpose: To introduce the child to the idea of attributes and to the process of mentally filling in a missing stimulus. Forerunner to matrix activities. Involves ability to consider more than one dimension at a time and ability to shift.

A. Attribute Blocks.

Procedure: Ask the child if he can put the blocks into 4 different groups. If necessary, explain that the blocks in each group should be the same in some way. When he has sorted into 4 groups, put the blocks together again, and ask if he can sort them in 4 groups another way. See if he can sort all the blocks into two groups.

After the child has sorted and re-sorted the blocks on the basis of the attributes of color, shape and size, he is ready for the take-away game. Have him take out all the pieces that are of one color (e.g., red) even though their shapes and sizes are different. Then have the child close his eyes while you remove a piece. Ask him which piece has been taken away. If this game is difficult for the child, you can have him place each small piece on top of the corresponding large piece. When a single piece is removed from such array it is easy to tell what is missing.

Play the take-away game with all the pieces that have one shape (e.g., circles) even though their colors and sizes are different.

B. People Pieces

Procedure: Ask the child if he can put the blocks into 4 different groups. If necessary, explain that the blocks in each group should be the same in some way. When he has sorted into 4 groups, put the blocks together again, and ask if he can sort them in 4 groups in another way. See if he can sort all the blocks into two groups.

C. Reading Task
(Each word is on an individual card).

Sample:	bit	hit	mit
	ball	hall	mall
	bud	hud	mud
	bone	hone	mone

Procedure 1: Ask the child if there is some way he can sort the words into 3 groups of words that are alike in some way (initial letter); 4 groups (rhymes).

Procedure 2: Start with one of the words. (Have others spread out for viewing). Ask child if he can find another word like the sample word in some way. And another word like both. You may want to help him verbalize rule that he is using for matching. Sets built on rhyming, initial letter can be built in this way.

Procedure 3: Set out words in matrix pattern as above. Remove one word. Ask the child what word is missing.

D. Further sample word sets for classifying by attributes. (Words are on individual cards).

1.	rot	rote	root
	tot	tote	toot
	mot	mote	moot
	lot	lote	loot

2.	bit	hit	mit
	ball	hall	mall
	bud	hud	mud
	bone	hone	mone

3.	dad	sad3	mad
	dob	sob	mob
	dill	sill	mill

4.	car	cat	cake
	tar	tat	take
	mar	mat	makc
	far	fat	fake

E. Supplementary Activities

1. Color Cubes

Procedure: Choose nine cubes of each of four different colors. Arrange them in a six-by-six square so that the colors alternate in both directions. With colors red, green, blue and yellow:

R	G	R	G	R	G
B	Y	B	Y	B	Y
R	G	R	G	R	G
B	Y	B	Y	B	Y
R	G	R	G	R	G
B	Y	B	Y	B	Y

There are several ways to play the game. You can remove one cube, or two, or three, and ask the child what is missing. You can remove several cubes, mix them up, hand them back to the child and ask him to replace them in the pattern. You can remove single cubes from various parts of the pattern or a number of adjacent cubes.

2. Matrix Games

Procedure: A take-away procedure can be followed with the matrix game cards, covering selected pictures, 1 or 2 at a time. Use of Matrix Games 3 & 4 is recommended.

III. Same and Different

Purpose: To help the child understand "same" and different" as applied to attributes and values. Involves multiplicative classification, foresight and hindsight.

A. Attribute Blocks

Procedure 1: Show the child paired groups of 2 or 3 blocks differing in only 1 attribute (color or shape). Ask him how the blocks in each group are alike. Ask him how the two groups are different from each other.

Procedure 2: Ask the child to arrange the set of blocks into groups (subsets) so that each subset contains only those pieces that have the same color plus the same shape. Ask: How many subsets are there? How many blocks are in each subset? How do the pieces within a subset differe from each other? Do you have a group of yellow diamonds? Can you name the other groups?

Procedure 3: Ask the child to arrange the blocks in subsets so that the pieces in each subset are alike in color and size. Ask such questions as: How many subsets are there? How many blocks in each subset? How do the blocks in a subset differ from each other? Can you think of a name for each subset?

Procedure 4: Ask the child to choose combinations of two attributes and try to answer the same questions.

B. People Pieces
Similar procedures.

C. Reading Task

Procedure 1: Show the child the sample words bad - cat - rack. Ask him how they are the same (vowel). How different (initial and final consonant). Say the words row - home - cone. Ask him how they are the same, how different. Continue procedure with other groups of words similar in one attribute.

Procedure 2: Continue visual and auditory presentation of words alike in 2 ways--e.g., ball-call-mall (same vowel and final consonant, different initial consonant).

D. Further sample word sets for same and different reading task.

1. How many attributes are the same? (Each set of three words on a single card).

a. light-might-sight
b. hot-bat-sit
c. mill-mall-mull
d. ball-call-mall
e. boat-toast-hope
f. bad-cat-rack
g. plate-mate-hate
h. mit-met-mat
i. tack-tick-tike
j. hit-hat-hot
k. bike-bat-bone
i. coat-bone-load

2. How many attributes are the same? (Each pair of words on a single card).

a. roll-coal
b. made-played
c. rock-top
d. said-red
e. bet-beat
f. rat-race
g. hot-home
h. doll-roll
i. lock-like
j. bat-bake
k. like-type
l. say-said
m. tall-doll

E. Further sample word sets for same and different listening task. (Sets of words presented orally).

1. Words auditorily the same on one attribute.

a. roll-home-cone
b. bad-cat-rack
c. take-jail-rain
d. sit-hip-lid
e. right-type-like

f. bill-bad-bump
g. red-sad-mod
h. hit-bet-lot
i. mad-most-mug
j. light-bike-time

2. Words auditorily the same on two attributes.

a. hall-tall-doll
b. bit-bet-bat
c. sit-set-sat
d. lake-take-make
e. bike-mike-like
f. mutt-not-mat
g. bait-bake-babe
h. cat-cad-cap
i. dog-dot-doll

3. How many attributes are the same?

a. lick-like-lack
b. boat-cone-load
c. top-hot-lock
d. book-look-hook
e. log-lot-loss

F. Seat work for same and different reading task. Which sounds are the same?

Sample: ball-call

1. book-took
2. bad-cat
3. take-tape
4. sit-sip
5. top-rock
6. bat-bake
7. bring-trip
8. lose-lost
9. bump-thump
10. made-played
11. break-brake
12. hope-hop
13. bake-back
14. lick-like
15. tall-doll

G. Supplementary activity: People pieces.

Procedure: Give child a key piece. Ask him to make a row of all the pieces that are different from it in just one way. Then have him make another row of things that are different in two ways.

Sample --

Key Piece

thin red girl

<u>One Difference</u>

thin blue girl	thin red boy	thin red lady	fat red girl

<u>Two Differences</u>

thin blue boy	fat blue girl	thin blue lady	fat red boy
color-sex	color-girth	color-age	sex-age

IV. Map-making

Explanation: Map-making means using one value to stand for or represent another value of the same attribute. If the child copies a pattern using blocks of the same size and shape but a different color, there is size and shape correspondence and color mapping. If he copies a pattern using blocks of the same color and shape but a different size, that is color and shape correspondence and size mapping.

Purpose: To introduce the ideas of representation and correspondence. Involves shifting attention back and forth from the model to the copy, and allowing one thing to stand for another.

A. Attribute Blocks

Procedure 1: Make a design with one set of blocks. Ask the child to copy your design with another set.

Procedure 2: Have child make a mirror map of your design.

Procedure 3: Set up one design. Copy the design, leaving out one or two blocks. Have the child fill in the missing blocks.

B. People Pieces

Similar procedures.

C. Reading Task

Procedure 1: Make a sentence using all capital letters. Have the child copy it using small letters (and vice versa).

Procedure 2: Have the child use letters to make words backwards (recommended by Furth as potentially helpful with dyslexics).

V. "Twenty Questions" and other guessing games.

Purpose: To encourage the development of efficient classification schemes. Procedure involves step-by-step provision of information leading to selection of particular piece from a given array. Involves use of both positive and negative information.

A. Attribute Blocks

Sample: I'm thinking of a piece that is not yellow, is not a diamond, and is small.

B. People Pieces

Sample: I'm thinking of a piece that is not a girl, is not red and is big.

C. Words

Sample: I'm thinking of a word that rhymes with cat but is not an animal.

D. Supplementary reading guessing game (page of seat work).
Circle the correct response.

1.	What rhymes with bat and is not an animal?	cat	tar	hat
2.	What begins with n and is part of your body?	nice	nose	face
3.	What rhymes with two and is not a color?	blue	shoe	wood
4.	What rhymes with tall and is not part of a house?	hall	talk	doll
5.	What rhymes with take and is not for eating?	break	cake	sick
6.	What begins with c and does not take you places?	car	cab	coat
7.	What rh mes with bring and is not something you wear?	brick	sing	ring
8.	What rhymes with cone and is not for a dog?	tone	bone	back

VI. Matrices

Purpose: To introduce matrices as a method of classification, involves multiplicative classification. To solve take-away problems. Child must coordinate two ideas--e.g., shape and color. Involves shifting of attention between rows and columns.

A. Attribute Blocks

Procedure: Set out the following pattern of small blocks:

red square			red diamond
	green triangle		
		yellow circle	
			blue diamond

Ask the child to complete the arrangement using the rest of the small blocks. Remove one of the pieces when he is not looking. Ask him which one is missing. Ask him how the blocks in each row are alike. Ask how the blocks in each column are alike. Explain that the arrangement is a matrix.

B. People Pieces
Procedure: Same

C. Words
Procedure: Same

Sample:

ar	ake	cat
bar	--	bat
--	take	tat
mar	make	--
far	--	--

Sample:

bet	beat
met	--
--	seat
pet	--

D. Further sample word sets for matrix reading task (Words on individual cards)

1.

rot	tot	mot	lot
rote	tote	mote	lote
root	toot	moot	loot

2.

tune	toot	tube
lune	loot	lube

3.

hike	hick
like	lick
pike	pick
bike	bick

4.

pip	pit	pick
mip	mit	mick
nip	nit	nick
sip	sit	sick

5.

boat	coat	wrote
boast	coast	roast
boost	coost	roost

6.

mit	cat	bob	tub	set
mike	cake	bone	tune	sead

E. Seat work for matrix reading tasks.
Play a matrix game!

1.

car	cake	cat
bar	____	____
____	take	____
____	____	mat
far	____	____

2.

bet	beat
met	____
____	seat
____	peat

3.

boat	____	____
____	cot	____
____	____	hoot
goat	____	____
____	____	moot
____	rot	____

4.

coat	____
____	boast
moat	____

5.

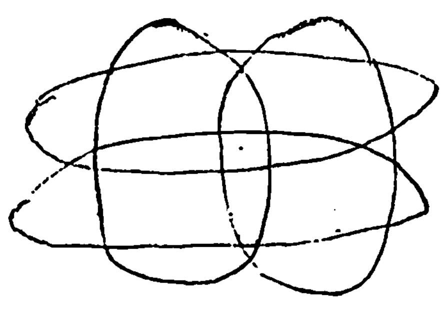
call	cat	came
____	dat	____
____	____	fame
tall	____	____
____	____	bame
____	gat	game

6.

sing	____	____
____	____	mung
____	tang	____
____	bang	____
ring	____	____
____	____	lung

F. Supplementary activity

Procedure: Tell the child that you are going to play a city-planner game. Explain that just as a dog catcher catches dogs, a city-planner plans cities. Lay out the red, green, yellow and blue loops in this pattern:



Say: "I'm going to show you the plan for a city, and perhaps you can figure out what the city will look like. These buildings (color cubes) can go in the spaces made by the loops, but only certain buildings can go in each space. This red building can go in each space. This red building can go here. (Place a red cube in one of the spaces which is enclosed only by the red loop and no other). Can you find where the rest of the buildings belong? You try putting buildings in the spaces, and I will tell you if what you do fits the city planner's rule."

The child's behavior is likely to be largely trial and error while he tries to figure out the rule for placing the buildings. It is helpful to tell him, when he has placed a block correctly, whether the space is completely filled, or there is room for more buildings, or that he might want to make a one-story building into an apartment house. ("Yes, that building belongs there, but it is not the only color that can go in that space. Perhaps there should be an apartment house").

The child may be able to tell which pieces go in each space without being able to state a rule. There is no necessity to put a rule into words, although it may be interesting to see if the child wants to attempt it. The child should be encouraged to look at the pattern he has made and to talk about it.