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ABSTRACT

Prompted by Piaget's suggestion that there might be qualitative differences in the thinking processes of children who read well as compared with those who read poorly, this study investigated the mental operations of multiple classification and class inclusion as possible characteristics required for a child to abstract and modify efficient generalizations for reading. S's were 27 second graders (1-10 years, mean IQ 116) and 29 fourth graders (9-11 years, mean IQ 107) randomly selected from Natick, Massachusetts, schools: all possessed middleclass families, spoke a standard dialect, and had received adequate reading instruction. White's Free-Sorting Classification Task and replications of items from Rigney's pictorial test of cognitive development were utilized in the experiment. Results indicated that good classifiers tend to be good readers and that poor readers tend to be preoperational. A child having problems grouping pictures according to varying criteria or dealing with part-whole relationships within a set of categories might have difficulty classifying the letter-sound generalizations necessary for efficient reading. (Author/RD)

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

Office of Education

National Center for Educational Research and Development

Abstract

MULTIPLE CLASSIFICATION, CLASS INCLUSION AND READING ABILITY

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Piaget's theory of mental development suggests there may be qualitative differences in the thinking processes of children who read well as compared with those who read poorly. The purpose of this study was to investigate the cognitive correlates (as opposed to the perceptual or motor) to reading ability.

A delay in the acquisition of the operations of multiple classification and class inclusion, might present difficulty in the abstraction of the basic structural generalizations which underlie English orthography. Low but statistically significant correlations existed between reading chievement measures of vocabulary and comprehension and multiple classification (N=56) and class inclusion (N=20), independent of age. With intelligence held constant, low but statistically significant correlations existed between multiple classification (N=51) and the reading achievement measure of comprehension as well as between class inclusion (N=20) and the reading achievements measures of vocabulary and comprehension.

Given the limitations of the size of the sample and the testing measures used, the results indicated that good classifiers tend to be good readers and that poor readers tend to be preoperational. A child having problems grouping pictures according to varying criteria or dealing with part-whole relationships within a set of categories might have difficulty classifying the letter-sound generalizations necessary for efficient reading.

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The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in te conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education Position or policy.

U.S. DEPARTMENT OF
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Dedication

To the memory of Esther Edwards, Ed.D.

1914 - 1971

who was never too busy to give direction and encouragement to her friends and students.

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Chapter I

The Problem

A child with specific reading disability is identified by Federal Law (P.L. 91-230, Title VI-A, April 13, 1970) as exhibiting a disorder in one or more of the basic psychological processes involved in understanding or using spoken or written language. Myklebust (1968, 1969) describes the child as being a year or more behind grade level in reading in spite of adequate instruction. Clements (1966) has listed a variety of labels for the disorder: perceptual-motor handicap, minimal brain dysfunctioning, dyslexia, etc. Kass (1966) states that such terms do not include children who have reading problems primarily due to the result of visual, auditory or motor handicaps, to mental retardation, to environmental disadvantages or to emotional disturbances.

Many experts (Critchley, 1964; Bender, 1958) suspect specific reading disability to be a maturation disorder. Others (Makita, 1968; Rozin et al., 1971: Durrell, 1955) suspect the nature of the orthography and poor teaching to be at fault. Chall (1967, p. 159) has written that reading failure cannot be blamed on either the child or the initial method alone.

> "Severe disability seems to result when a child has a predisposition (a set of characteristics that make it difficult for him to associate printed symbols to their spoken counterparts) and is exposed to an initial method that ignores this predisposition."

The purpose of this study was to investigate the mental operations of multiple classification and class inclusion as some of the possible "characteristics" needed by a child to enable him to abstract and modify efficient generalizations for reading.

General Problem

In New York City, Buder (1970) states that two out of every five pupils in the second through the ninth grades are at least a year behind in reading. A percentage of these children are eligible for help under the Federal Law, although the experts disagree as to the exact figure. On September 23, 1969, the U. S. Commissioner of Education (Allen, Jr., 1970) established a national goal for the United States: by the end of the 1970's, no child will leave school anywhere in the country without the ability to read. The goal will not be an easy one to accomplish even if funded adequately, for professionals cannot agree on the solution. Since frustration in the first grade is enough to turn a child against reading, schools, teachers and himself, a Government-sponsored report (Chalfant & Scheffelin, 1969) feels it is imperative to develop procedures to identify children with specific reading disability before they experience failure.

Specific Problem

The justification for this study is the hope that early identification and treatment of potential reading problems in children will be possible. Motor and perceptual correlates to the understanding and use of written language have been investigated during the last thirty years. A child with specific reading disability has been shown to have intrasensory visual disorders (Goins, 1959), intrasensory auditory disorders (Wepman, 1960), and intersensory failures of integration between auditory and visual systems (Birch & Belmont, 1964; Zigmond, 1969).

One popular theoretical model postulates that "to a large extent, so-called higher forms of behavior develop out of and have their roots in motor learning" (Kephart, 1960, p. 35). The implication that this has for identification and treatment programs is that disorders in perceptual-motor ability must be corrected first. According to Kephart (1967), the child's initial perceptual-motor learnings form a basic foundation upon which more advanced learning can be built.

Piaget (1961) maintains, on the other hand, that cognitive operations such as classification, necessary for advanced learning are a different type of knowledge than perceptual (or figurative) skills. Classification is defined as an operation which relates properties of an included class to an entire class. For example: In a group B of twelve flowers within which there is a subgroup A of six primroses you ask, "Are there more flowers or more primroses?" The child responds according to the inclusion "A is less than B." or "There are more flowers" (Piaget & Inhelder, 1969). Movements, gestures, perceptual imagery and verbal language are simply media through which this classification operation can be manifested (Furth, 1970). A perceptual-motor deficit such as poor copying ability may be a symptom of an underlying cognitive deficit, but treating the symptom with additional copying exercises may not be the most effective remediation.

Reed (1968) feels that disorders in perceptual-motor ability, when corrected, do not facilitate academic learning and that there is no justification for training children in motor activities with the expectation that their reading will improve. Bouncing on a trampoline or walking a balance bar improves balance and coordination, however, and this may indirectly help the child's image of himself. Yet, many school programs continue to use materials as if a significant relationship between motor development and reading exists. (See programs by Barsch, 1967; Chaney & Kephart, 1968; Simpson, D., 1968; Godfrey & Kephart, 1969.)

Copying ability aids a child in gaining figurative knowledge about his world. Blom (1969) feels these perceptual skills have some relationship to learning, but they are necessary but not sufficient factors for academic success. Yet, many school programs continue to use materials as if a significant relationship between perceptual development and reading exists. (See programs by Valett, 1967; Frostig, 1964, 1968.)

A renewed interest in Piaget in the United States (Ginsburg & Opper, 1969; Furth, 1970; Athey & Rubadeau, 1970; Lavatelli, 1970) has aided the investigation of cognitive (as opposed to motor and perceptual) correlates to the diagnosis and treatment of potential reading problems. It is important to know that Piaget (1970) regards perceptual development as essentially continuous but cognitive development as essentially discontinuous. His denial of developmental stages in perception, and his affirmation of stages in cognition, are based on research that successive perceptual achievements are only <u>quantitative</u> (Piaget & Morf, 1958). The presence or absence of particular logical operations, such as classification, differentiate <u>qualitative</u> levels in cognition (Tuddenham, 1966).

No wonder there is confusion among experts as to diagnostic and treatment procedures for potential reading problems in children. Besides the perceptual-motor and logical training advocates, McIntire (1970) and Staats (1970) believe that behavior modification techniques can cure any reading problem, irrespective of method. However, Pitman (1969) believes a revised alphabet is the answer. Research has shown that differences in the personality and competence of the teachers rather than materials themselves account for successful reading instruction (Bond & Dykstra, 1967).

In the midst of this confusion, members of the U. S. Congress are hesitant about funding the "Right-to-Read" program, although there is some agreement among competing professionals that top priority be given to the early identification of specific reading disability.

Statement of Purpose

Piaget's theory of stages of mental development suggests there may be a qualitative difference in the thinking processes of children who read poorly as compared with those who read well. Reading may be a difficult task for <u>some</u> primary school children because they have weak classification skills. The letter-sound variation in English with contradictory fragments of evidence in words like "bone," "gone," "done" and "one," may delay the poor classifier's ability to abstract and modify generalizations for reading.

The ability to use generalizations with a variety of modifications necessary to cope with this letter-sound variation may involve logical operations of thought such as multiple classification and class inclusion. This study attempts to understand the relationship between multiple classification, class inclusion and reading ability. Are poor readers poor classifiers? Are good readers high classifiers? Can students be grouped more efficiently for reading instruction according to their classification scores?

Definition of Terms

Letter-sound variation: Elkind (1967) believes that the essential difficulty in reading is the recognition that one and the same element can give rise to two or more different forms, depending on the context. One and the same letter in English can represent more than one sound, while one and the same sound can be represented by different letters. For instance, the letter 'a' represents sounds in "angel," "axe," "arm," "auto," "any," "altar," "father," "aisle," and "stomach." The long sound of 'a' can be spelled "able," "ate," "aim," "way," "straight," "gauge," "cafe," "matinee," "buffet," "break," "vein," "they," and "freight" (Hanna *et al*, 1966).

Multiple classification: Classification is defined as the grouping of objects by properties such as color, shape, size, thickness, number, sound value, etc. Multiple classification is defined as the grouping of objects by more than one property. An object can have more than one property and thus belong to several classes of objects; thus, a red triangle can belong to the class of triangles and red shapes; a woman can be both a mother and a teacher. The sound value for the letter 'c' can belong to the class of 'k' sounds, as in medical," as well as to the class of 's' sounds, as in "medicine."

Class inclusion: Class inclusion is defined as the taking apart of a whole class to find subclasses which are interrelated. This involves the comparison of "all" and "some". If some A and some A' equal all B, then B-A'=A; hence, A is less than B, or A' is some of B. In a group of assorted shapes, "all the triangles are red" implies that there are more red shapes than triangles and that all the red shapes are not triangles. Classes are analyzed on the basis of a property belonging to some members of a class (red or yellow beads) and a property belonging to all members of a class (wooden beads). The sound values for a given letter such as a (father, any, wander, tall, sane, sanity) can belong to a larger class, and the larger class can include subclasses of other letter patterns (ate, rain, ray, veil, obey, steak).

Delimitations

The sample in this study was randomly selected from the second and fourth grades at the Bennett-Hemenway School in Natick, Massachusetts, and is limited to 56 children. The community served by the school fell in the middle to lower-class income bracket.

Some first graders are not concrete-operational in their thought processes. Inhelder & Piaget (1969) found that the class inclusion operation is not secure until eight in 75% of the children they tested. A second grade sample of 27 children (13 boys and 14 girls) was chosen because their mean age (7-10) was before the time when the logic of classes should have been developed. The investigator could be assured, however, that they had had at least one year of adequate reading instruction.

A fourth grade sample of 29 children (15 boys and 14 girls) was chosen because their mean age (9-11) was beyond the time when the class inclusion operation should have been developed.

The criterion measures of reading are limited to vocabulary and comprehension subtest scores on the Ginn Second Grade Readiness Test (McCullough & Russell, 1967) and; for the fourth grade sample, the vocabulary and comprehension subtest scores on the Iowa Silent Reading Tests (Greene & Kelley, 1956).

The criterion measures of classification behavior are limited to the Free-Sorting Task (multiple classification) for the entire sample and the Structured-Sorting Task (class inclusion) for 20 second graders, both tasks designed by K. White (1970).

The criterion measures of IQ scores for the second graders are the California Test of Mental Maturity (Sullivan, Clark & Teigs, 1957) and the Lorge-Thorndike for the fourth graders (Lorge & Thorndike, 1959).

Null Hypotheses

With a combined sample of children (N=56) there is no relationship between reading ability and the Free-Sorting Classification Task.

If there is a relationship between reading ability and the Free Sorting Classification Task, then there is no statistically significant relationship when CA or IQ is held constant.

With a smaller sample of children (N=20) there is no relationship between reading ability and the Structured-Sorting Classification Task.

If there is a relationship between reading ability and the Structured-Sorting Classification Task, then there is no statistically significant relationship when IQ is held constant.

Chapter II

Review of Literature

Piaget's Theory as to the Origin of the Class Inclusion Operation

According to Piaget (1952, 1960), operations of thought have their origin in action. The source of intelligence is not to be found in perception or in language, but in the coordination of actions as the child manipulates objects. The Russian scientist, Zaporozhets (1969), agrees that the development of mental processes is related to external actions which undergo a series of changes in order to be converted to the internal operations of thought.

This theory is not to be misunderstood as thought having its origin in movement. The coordination of actions upon objects involves movement and motor skill. Bernstein (1967) feels that an action, however, involves the regulation and direction of movement in the attainment of some particular goal. The coordination of actions on objects involves the formation of the scheme of the permanent object and then the formation of a symbol, such as the word "chair," to represent this object when it is no longer present in concrete experience (Inhelder & Piaget, 1969). The symbolic function may not develop normally when the coordination of actions on objects and the scheme of the permanent object is delayed. It is important, however, to remember that intellectual ability to symbolize graphically is not a motor activity proper but one of abstract representation (Werner, 1948).

Sensori-motor Period of Thought

Nonverbal precursors to the class inclusion operation can be seen in a normal child as early as five months. Biphasic attention is the ability of the child to detach himself from one aspect of a stimulus field and move to another with a definite strategy (Bruner, 1969). As early as the seventh month, a child constructs equivalence relations which govern properties of various objects to which his action can be applied. A doll, a rattle and a bottle are all for dropping on the floor (Piaget, 1952).

Mental development is systematic and proceeds in an orderly sequence. First, there must be distance from the self and object. The child becomes less dominated by the immediate concrete situation, less stimulus-bound, less impelled by his affective states. He has a clearer understanding of his goals in order to substitute means and alternate ends, and he can plan delays (Werner, 1948).

By the end of the sensori-motor period when the child is approximately 18 months old, he can initiate a search for a hidden object. Objects before this time did not exist for the child apart from his actions on them (Uzgiris & Hunt, 1966). An object out of sight was out of mind. The child now can deal with an object one at a time, but he is unable to abstract any single consistent criterion to govern a concept of the object (Inhelder & Piaget, 1969). However, there is found a certain logic of inclusion of actions which are the foundation for higher thought processes (Piaget, 1969).

Preoperational Period of Thought

When an object can be dissociated from its specific content and can function in the child's mind without being tied to his action upon it, a new kind of knowledge is possible. This period is called "preoperational" and lasts from two to seven years, approximately (Piaget, 1952). A name has the capacity to represent reality through the intermediary of words that are distinct from what they signify. The word "chair" is no longer a property or attribute of the object chair, but represents a concept of "chair" (Werner & Kaplan, 1963). Every word is a generalization and will grow to serve an extremely wide range of purposes, from a mere index of the object to a metaphorical use (Vygotsky, 1965). Vocabulary and grammar manifest a logic of syntax in much the same manner as the child's searching action for a hidden object manifested a logic of actions.

Language acquisition should thus be considered within the framework of the total cognitive development of the child. The roots of thought are anterior to language, and the verbal transmissions of concepts are necessary but not sufficient in themselves to establish structures in a child's mind (Sinclair-de-Zwart, 1969). There is a time lag between an initial practical act of intelligence and the first verbal production, and the particular character of the child's first words show they are personal symbols with a diffuseness of primary meanings. They are not signs in the sense of belonging to a structured and shared system. Rozengart-Pupko (1948) experimented with various words, offering a number of objects for each name. The actual object being named was always absent; however, the objects presented had some attribute in common with the missing object. The two to three-year-old child was easily confused, picking up any object having any kind of attribute in common with the object named.

The Relationship of Thought to Language

At two years, there is a distance between the subject and object, where in an earlier period they had been fused (White, S., 1965). The child's first words are used purposely as novel means to achieve new goals while previously concrete actions had been the only tools. Naming an object gives the child a sense of power over the object, as if the name itself were a property or attribute of the object (Werner, 1948).

Words are more than attributes of objects, however, and they are more than indices or signals of anticipated events. As symbols they have the capacity to represent reality through signifiers distinct from what they signify. Piaget (1962) has shown that one vocabulary word can develop several referents. "Quah" can mean a swimming duck, any liquid or milk in a bottle, or a coin with an eagle on it. The child's thought processes are typical chain complexes, with each new object having some attribute in common with another element, but undergoing endless change (Vygotsky, 1965).

At the same time, there are many morphological clues and syntactical positions for one referent. Greenfield (1970) reported that her baby used holophrastic sentences for the assertion of the properties of objects, for the location of objects, for prepositions, and so forth. The relational functions of one referent leads to the combining of words for more precise communication (McNeill, 1966). The combination process, however, is different for a baby than for a chimpanzee, lending support to Lenneberg's (1967) theory of species-specificity of language. In no two of the chimp's utterances are the words combined with restrictions or organized into grammatical relations as they are with humans (Gardner & Gardner, 1969).

For this reason, an empiricist theory of learning is incomplete for it is incapable of producing a system of rules for the deep-seated properties of language. Surface phrases do not reflect deep syntactic structure not represented directly in the form of an auditory signal. The theory is incapable of explaining why patterns "com<u>ed</u>" and "do<u>ed</u>" weigh more heavily with the child than the frequency of repetition of sounds ("came," "did") from correct adult models (McNeill, 1966).

The child's acquisition of language is a kind of theory-construction process. He discovers this theory with only small amounts of data - as his parents' speech is random and incomplete, with many fragments, false starts and other distortions of the underlying abstract forms. In formulating an appropriate hypothesis from a restricted class of data, the child tests, rejects and modifies the theory according to reinforcement by the environment. Bruner (Pines, 1970) feels that this language competence is just one example of an even more significant ability with which infants enter the world, the basic ability to pick up logical rules from mere fragments of evidence and then use these rules in a variety of combinations.

Concrete Operational Thought

By the end of the preoperational period when the child is approximately seven years old, his knowledge of the world is extended beyond specific actions on objects and beyond the specific words which represent these actions. For Piaget, concrete operations emerge when the object in question can be transformed in a variety of ways and still be conserved (White, S., 1970). Conservation is defined as a mental operation by which a child retains the object as an idea when he no longer perceives the object as a concrete thing, whether broken into pieces, flattened out, or dissolved in water (Wolff, 1960).

Every operation in thought is associative. That means that thought is free to make detours so that a result obtained in two different ways remains the same in both cases. Every operation combined with a converse operation is annulled so that identity of a thought is maintained. When two elements are compared with each other, neither the standard nor the compared entity is distorted by the comparison itself. This lack of distortion has important implications for the child who must generalize a rule about experience and then modify it as the situation demands.

If a number of facts are reached by variable and flexible routes, a certain objectivity can be attained by such "decentrism" (Piaget, 1960). Every change in thought is reversible as well. What elements are added together can be subtracted, and what elements are multiplied can be divided. A child should be able to construct hypotheses, discard each one that doesn't work, and return to the starting point to begin again. If he follows one path of thought, he can retrace his steps without changing the ideas employed.

Furth (1970, p. 39) feels that reversibility of a scheme implies that the human subject has the possibility of making mental experiments:

> ...doing and undoing, going in one direction and compensating for it in another direction (e.g. conservation of length); regarding a thing as belonging to one class and at the same time to another class, and relating classes to each other (e.g. class inclusion); co-ordinating one perspective with another perspective (e.g. horizontality) or transforming successively the position of a thing moving around a fixed point (e.g. rotation).

Stages in Classification Behavior

Piaget (1960) has shown how children construct their own mental models of the world in successive stages, following an invariant sequence, though the children may go through the stages at different rates. As children realize that objects have properties which do not depend on their immediate appearance, they are able to deal with more and more complex levels of abstractions which can be observed in their syntactical constructions as well as in heir hypothetical reasoning.

There have been striking similarities in the description and invariance of the stages of classification behavior in the work of Hanfmann & Kasanin (1963), Goldstein & Scheerer (1941) and Vygotsky (1965), to support Piaget's theory (Inhelder & Piaget, 1969).

Stage I (2-4 years old; preoperational period)

The child is unable to analyze all the objects in a given problem. He is unable to transcent the immediate experience of each object because the attributes of color, shape, etc. belong to a given figure as an undivided whole. His classification behavior is one of chaining; that is, one response serves as a stimulus for the next, with no preliminary plan. He concentrates on one dimension and as a new one is added, he ignores it.

Stage II (4-6 years old; early transitional period)

The child is able to analyze all the properties of a whole so that the given object can be divided into attributes. Perceptual distortions, however, such as the proximity in space or functional belonging, get in the way. The child makes judgments on how things look and centers on one attribute only, usually the visual one. He forgets a first dimension as the new one is added. He lacks the ability to coordinate attributes, and has difficulty realizing that an object can possess more than one property and thus belong to several classes. If he first classifies by color, he can move to shape and so forth, but there is oscillation between alternative attributes. Unanalyzed elements distort the system as there is no general criterion for classification.

Stage III (6-8 years old; late transitional period culminating in concrete operations)

The child no longer oscillates between alternative attributes. He can vary two properties simultaneously such as size and thickness, putting to one side the perceptual salient cues of color and shape. Other properties, such as number, can be integrated into the whole without destroying the set. The child understands the class inclusion relationship, that $B-A^1=A$; hence B is more than A. B is not lost when A is compared with the disrupting property A^1. Property A is included in whole B; thus, all the A's are some of B. He has anticipation as well as hindsight; that is, the pattern can be reorganized or modified in light of existing criteria (Inhelder & Piaget, 1969).

Goldstein (1939) defines abstract thought which is possible in this period as:

a. an ability to assume a mental set, discriminating essential from non-essential details;
b. an ability to shift voluntarily from one aspect of a situation to another in order to recombine the set;
c. an ability to hold two or more dimensions simultaneously in the mind;
d. an ability to transcend the immediately given aspects of surface impressions; not to be bound to the immediate experience of a unique object or situation or to the immediate claims of perceptual attributes; and
e. an ability to grasp the whole, while isolating parts in order to vary them. No dimensions, left unanalyzed at one moment, reappear as disturbing influences.

Stages in Language Development

Children in the cultures studied use similar rules for the production of language. N. Chomsky (1968) feels this evidence says something about the structuring of the mind. Both Chomsky and Piaget feel that children do not learn to speak as a result of stimulus-response mechanisms. Chomsky believes that children's ability to abstract generalizations in the language they hear allows them to generate sentences that have never been spoken before. Piaget would emphasize that a long period of construction is required for such an accomplishment. Gal'perin (1969) also believes that thought is dependent on practical activity and is not a manifestation of a ready-made faculty but formed in the process of fulfilling a task. The operations that carry out the growth of syntax are internalized actions which have performed simpler functions during the sensori-motor period.

Work by Friendlander (1969) and Lieberman (1967) tends to support the child's biologically determined capacity to learn linguistic structures through classification and serial ordering processes. By "analysis by synthesis," the child ignores the acoustic signal and fills in the phonetic features, using his knowledge of the syntactic and semantic constraints of language. If the processes underlying language are classification and serial ordering, then there must be a manifestation of these universal cognitive capacities which can be matched by the universal features of the base structure of language and their transformations (McNeill, 1966).

Slobin (1968) believes there is evidence from comparative studies in Russia and Japan that a child is not born with a set of linguistic categories, but with a process mechanism or a set of procedures and inference rules for classifying and ordering linguistic data. Linguistic universals, then, are the result of an innate cognitive competence rather than the content of such a competence (Slobin, 1964).

Children play within their linguistic system but do not attempt to correct it. If they lack a transformational rule, they will include nothing in surface utterances which cannot be related to deep structures. If the negative transformation and do support are not known, imitations of sentences, "I can't catch you", and "I don't like you," are repeated, "I no catch you," and "I no likes you," (Menyuk, 1969). A child who has not reached a stage in which he uses certain grammatical rules spontaneously, who was still missing the syntactic foundations and prerequisites, could repeat correctly only that which is formed by rules he has already mastered. This is the best indication that language is not acquired by simple imitation, but that the child abstracts regularities or relations from language he hears which he then applies to constructing more complex syntax.

Jakobson (1969) has shown that the "s" first learned in the plural word "coats," then as a possessive in a phrase "Pat's coat," and finally as the third person singular in a sentence "Jim pats Pat's dog," covers a span anywhere from two to eight months. The difficulty may be with the underlying mechanism which regulates thought, with the ability to operate and shift a number of dimensions in order to generate alternative and progressively more difficult structures.

At an early preoperational stage (2-4 years), the child is unable to analyze all the objects in a problem. Syntactically, he does not analyze all the elements of a sentence, he merely adds a "why" marker to form a question without inverting the subject and verb: "Why Mommy come?" He merely adds the "no" or "not" marker to form the negative construction: "No can do it." "He not waking up" (Bellugi & Brown, 1964; Klima & Bellugi, 1966).

At a later stage, the child is able to analyze all the properties of a whole, but he lacks the ability to coordinate properties, usually centering on one property at a time, or oscillating between the two. Syntactically, the child analyzes all the elements of a sentence but is unable to carry more than one property simultaneously in his mind. He says, "Nobody don't like me." After many corrections, he says, "Nobody don't likes me" (McNeill, 1966).

Sinclair-de-Zwart (1969) has found evidence for analogous logical and syntactical stages with the comparative construction. Preoperational children say, "That is small," and, "That is big." Operational children use relational terms, "That one is shorter." Preoperational children are more restricted to the use of "big" and "little" for all differences in size. Operational children use more differentiated terms like "wider," "fatter," "taller," "thinner." Preoperational children tend to mention only one dimensional difference: "That one is thin" and "That one is a bit big." Operational children use coordinated descriptions to talk about two dimensions: "That one is thinner and taller." C. Chomsky's recent research (1972) on certain language structures demonstrated a considerable variation in age of acquisition which did not affect order of acquisition of different structures.

Lyle (1970) has hypothesized a generalized lag in syntactical growth noticeable between two to four years of age would be found in a sample of children with specific reading disability, although articulation defects would not necessarily be found. Syntactic competence might also discriminate children with reading problems from normal readers. Poor readers can read individual words in a sentence but they do not grasp the unified contextual conception. They cannot appreciate that words derive meaning from sentence context and fail to subordinate emotional-concrete meanings of separate words to the syntactical relationships between words (Farnham-Diggory, 1967; Denner, 1970).

Stages in Perceptual Development

Perception is another manifestation, as is language, of developing intelligence. Both are a necessary but not a sufficient condition for thought, as each in its own way distorts reality. Perceptual activity is less influenced by the distortions inherent in experience when it becomes directed by thought. Age is an important variable in the "tunnel effect" task. A moving object visible at A→B, hidden by a screen B→C, and visible again at C→D, only to be hidden again at D, confuses a six-month-old child. He can follow the A→B movement; when the object disappears at B, he looks at A and is amazed to see it reappear at C (the peek-a-boo effect). He will follow it C→D but when it disappears again at D, he looks for it at C and then at A. A two-year-old child will search at D because the logical substructures of displacements in space have been constructed at this time (Piaget, 1961).

Experiments with the perception of space best describe the developmental framework necessary for understanding children with specific reading disability. Up to four years or so, the child scribbles rhythmically on a piece of paper. (Remember that these stages are known to be invariant, although the age norms vary from culture to culture.) In Stage IA, the child can distinguish open from closed space only (❙ ○); in Stage IB, he can distinguish topological properties such as juxtaposition, proximity, separation and enclosure, including points in, on and outside of shapes (⊙, ʘ, ȯ). In Stage IIA, he can distinguish lined shapes from curved ones (○ □), the number of sides on a shape (△ □), and the dimensions of length, height and width (□ ▭). In Stage IIB, the diamond is mastered (◇), as well as points of contact and internal details (● ▲). Inversions, reversals and rotations are frequently last to be recognized due to the inadequacy of the child's reconstruction of order along the horizontal axis (Piaget & Inhelder, 1967). Gibson (1969) has reported similar findings.

The preoperational child relies heavily on his perceptions, feeling the compunction neither to justify his reasonings, nor to look for possible contradictions in his logic (Wohlwill, 1970). He is apt to center on one arbitrary feature of an object such as width, without taking into account another feature such as height. In the now famous conservation of liquid task, there are two equal jars filled with equal amounts of water. A is poured into A', and the child assures the tester there are equal amounts of water. When jar B, which is taller and thinner than A or A' is used, the preoperational child sees the column of water rise and claims now there is more because "it is higher" (Inhelder & Piaget, 1969). Only at a later stage will he be able to work out a ratio of height and width in his head.

Stages in Reading Ability

As the child develops, he constructs more efficient systems (perception, language) to process data about the world (Langer, 1969). At the end of the sensori-motor period, he can perform an action in order to obtain a goal not immediately available in his concrete experience. During the preoperational period, he forms symbols to represent objects not actually present in his experience. Reading may be an even more abstract system of processing data about the world. Letters are arbitrary signs to represent sounds which, in turn, as words, are arbitrary symbols to represent objects.

Bettelheim (1961) feels that the manipulation of symbols in reading develops in stages.

Stage I: (preoperational)	Each object or symbol has a unique and personal meaning

Stage II: (transitional) — Each object or symbol has an independent unchanging reality of its own; it is always one and the same thing.

Stage III: (concrete operational) — Each object and/or symbol has generic qualities representing different examples of the same class of objects.

Chall (1967) indicates that the child's mastery of the code of the alphabet may suggest a qualitative leap in his abstraction ability. Pointing to and naming a letter, or writing a letter, at an early age is quite different from pointing to or drawing a picture of a cat, a truck, or a tree. The child who can identify or reproduce a letter engages in symbolic representation.

The Structures of the English Language

The structure of the English language necessitates that the child understand that one letter has several sounds and that one sound can be represented by several letter patterns. Alphabetic orthography is a set of generalizations enabling an individual to transcribe the graphic symbols into the sounds of oral language. The set of generalizations for phoneme-grapheme correspondences is based upon three levels of analysis, phonological, morphological and syntactical (Hanna, et al., 1966).

The phonological factors which determine the generalizations are:

a. position as in sane - sanity;
b. stress as in angel - angle;
c. internal constraints as in ceiling - vein.

The morphological and syntactical factors, more important for spelling than they are for reading, are:

a. compounding as in playground (not plaiground);
b. affixation as in acute - account;
c. words with the same sounds (homonyms) as in weigh and way;
d. words with common etymology as in elite, regime, machine.

A facile reader intuitively devises his own shorthand system to organize the cue value of various letter combinations from the above factors (Cromer & Weiner, 1966). The American English phonological structure underlying the orthography provides a rich source of information (Venezky, 1970), but the child with specific reading disability has an impaired ability to abstract and devise rules for data processing, especially when the data is verbal (Dykman, et al., 1970).

Wickens (1963) has shown that good readers were significantly better able to perform abstraction tasks and verbalize their reasons for doing so than were poor readers. Santostefano (1969) believes that the poor reader scans small segments of information, is pulled off the track by irrelevant details, and is unable to group parts and wholes in any systematic plan. A poor reader therefore would have difficulty generalizing rules from a sight method approach to reading, for the relationship between the component parts of the spoken and written word is kept a secret. The words "gone," "done," "bone" and "one" provide no clues to breaking the code. Liberman (1971) has shown that the phonemic segments of language are not transmitted individually either; that is, the units g-o-ne are not processed in the brain as three discete sounds. On the basis of this evidence, an entirely phonetic approach to reading might confuse a poor reader as well.

Makita (1968) reports that reading disability is rare in Japan, occurring in less than one percent of the Japanese population. He questions the possibility that the Japanese might have less malformation of the cerebral gyri, less conflict of hemispheral dominance, or less emotional problems. He believes that reading disability is a philological rather than a neuropsychiatric problem, and goes on to show that the Japanese reformed alphabet has no symbols which stand in mirror relationship to each other (English has p, q, b, d); that there is one consistent way to pronounce a letter (English has letters pronounced according to their pattern with other letters); and that the consonant is always tied to a vowel (English has consonants represented by two or more letters such as k and ch; f and ph).

English spelling is a more efficient system than the surface irregularities would lead one to believe, providing considerable syntactic and semantic information on the part of the speaker (Chomsky, C., 1970). For a mature, native speaker who knows implicitly the phonological rules of English, spelling captures underlying deep similarities that exist between words. Chomsky & Halle (1968) have shown that the orthography plugs in at a particular linguistic level other than the phonetic one. English, in its rich structure, contains a system of automatic alternations. The first alternation is stress: télegraph, telégraphy, telegráphic. Rules governing these examples are very general throughout the language, part of an entire pattern and, given some new and unfamiliar word, the speaker should know how to apply stress. The process which decides the stress is not haphazard; the endings -y and -ic determine which syllables have full vowels and which have reduced vowels.

Vowel alternation is the second variable: grateful, gratitude; sane, sanity; nation, national. The underlying phonetic variation /e-æ/ is cued by the suffixes attached to the root. The third type of alternation is consonant variation: medical, medicine; critical, criticize; sage, sagacity.

It may be important to understand that the spelling of a word may never be phonetically exact in its full form, but that this underlying form varies little from speaker to speaker, even across major dialect boundaries. Very simple and general rules are applied in a sequence to an abstract lexical representation and convert it in successive stages into a phonetic representation that bears little point-by-point resemblance to the underlying form. This highly abstract system of lexical representation which is surprisingly close to conventional orthography, and extends over a wide range of dialect, functions in the use and understanding of English sentences.

The Chomskys (1968, 1972) make one very important qualification, however. The child of six may not have mastered this rich phonological system in full. His intuitive organization of the sound system continues to develop and deepen as his vocabulary is enriched and as his use of language extends to wider intellectual domains and more complex function. He is not yet in full mastery of abstract processes to depart phonologically from surface phonetics.

Reading Readiness

Not all children are "ready" to read at age six, the time when most children enter first grade (Morphett & Washburne, 1931). Age has been shown to be a poor criterion (Gates & Bond, 1936). Olson (1959) has found that height, weight and skeletal development were unreliable factors as well. Multi-factors theories are popular today, combining intellectual, physical, experiential, language, emotional, social and motivational correlates (Monroe, 1932; Robinson, 1955; Harris, 1961). "Readiness" is measured by the identification of the areas of weakness which must then be strengthened to forestall failure. Reading instruction should theoretically be delayed until the child is "ready."

Most reading specialists believe that a child should know the language he is going to learn to read - at least to a certain degree of competence (Carroll, 1970). He should learn to recognize a certain number of printed words from their total configurations (Dolch, 1936). He should learn the left-to-right principle as it applies to complete words in continuous text (Gates, 1929). He should learn to recognize, discriminate and name the letters of the alphabet (Durrell, 1955). The child should learn to dissect the spoken words into component sounds (Durrell & Murphy, 1953) and blend them together into words (Chall, Roswell, _et al._, 1963), although the Liberman (1971) research questions this technique. Finally, the child should learn the correspondences of letters and sounds, either by an analytic approach involving the analysis of whole words, or by a synthetic approach involving the synthesis of sounds into words and phrases (Bear, 1964). No one code emphasis method apparently is better than any other (Chall, 1967).

Many specialists reject alphabet reform as unnecessary if the job of teaching reading were only carried out by competent teachers, and if adequate time could be devoted to the task of teaching reading (Engelmann, 1969; Cohen, 1969). Johnson and Myklebust (1967) argue, however, that analytic and synthetic reading methods may differ in effectiveness from child to child. They feel the auditory dyslexic has difficulty in relating the temporal sequence to a visual-spatial sequence. The visual dyslexic, on the other hand, cannot retain the visual image of a whole word. Modality strengths and weaknesses are, therefore, important in a diagnostic prescription.

Maturational Lag in Poor Readers

Bender (1958) describes children with specific reading disability as having a maturational lag. Sparrow (1969) refers to such a lag across all modalities, particularly the visual and auditory pathways. Birch and Lefford (1963) suggest that the ability to treat visual and auditory patterned information as equivalent is one of the main factors that differentiates good from poor readers. Intersensory equivalence is felt to be developmental, and intrasensory weakness in any modality may limit this intersensory equivalence.

Doehring and Rabinovitch (1969) agree that poor readers, although equal to normal learners in perception of spoken words, are deficient in the processing of temporal sequences of complex nonverbal stimuli, as well as speech sounds. They conclude that this may be due to the more abstract nature of auditory stimuli and/or due to the process mechanism in the brain itself.

Ajuriaguerra (1968) lists a number of factors such as oculomotor trouble, articulation disorders, right-left orientation difficulties and rhythmical problems, but states that all these factors are found in disorders other than specific reading disability. Children, in spite of the above problems, learn to read. He feels the problem lies instead in the translation of the sounds the child perceives into the appropriate letter patterns.

Blank (1968) feels there is a failure to code accurately the temporally presented components of a reading task and that this deficit is a conceptual rather than a perceptual one. McGrady and Olson (1970) administered a battery of thirteen tests, representing various intra and intersensory functions, to ninety-nine learning disability and normal children. The children with learning disabilities tended to perform more poorly on tasks which utilized verbal stimuli, regardless of psychosensory modality.

The efficient classification of sound-letter patterns implies auditory-to-visual and visual-to-auditory coding ability. Zigmond (1969) has found children with specific reading disability deficient in auditory-to-visual coding when compared to a group of normal readers. In another study comparing learning patterns in normal and braindamaged children, Farnham-Diggory (1967) hypothesized that learning the words to be synthesized might be a necessary but not sufficient condition for the integration of ideas involved in reading. Farnham-Diggory found no significant differences between normal and braindamaged children in the ability to act out simple commands presented orally or pictorially. However, braindamaged children were delayed in the ability to learn symbolic forms of the commands called logographs, and even by age thirteen 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 braindamaged children may have difficulty with the conceptual synthesis underlying adult syntax even when they can process the individual symbols.

Conclusion

A deficiency in the processing of temporal sequences (Doehring & Rabinovitch, 1969) and in the translation of sounds into appropriate letter patterns (Ajuriaguerra, 1969) seems to this investigator to be the key point in understanding specific reading disability. Farnham-Diggory's research (1967) has shown that the lack of conceptual synthesis underlying adult syntax differentiates braindamaged children from normal learners. Liberman (1971) now suggests that a child has difficulty in reading because he cannot segment words into their constituent phonemic elements. This ability involves a <u>cognitive analysis</u> of the phonological structure of English. Mental operations necessary for this cognitive analysis might include multiple classification and class inclusion.

Chapter III

Research Design and Methodology

A review of the literature has led this investigator to feel that the conceptual synthesis underlying adult syntax is the key to understanding reading ability. Sensory and perceptual-motor processes are important, to be sure, but the intervening cognitive processes such as multiple classification and class inclusion may be just as important, and these intervening cognitive processes are often overlooked in early identification and treatment programs.

In order to learn to read, a child needs rich phonological input in the standard dialect, or he needs adequate reading instruction which will substitute for his conceptual and/or linguistic delays in development. The choice of setting for this study attempted to control for adequate phonological input in the standard dialect. The choice of subjects attempted to control for adequate reading instruction.

Setting

This study was carried out in a public elementary school located in Natick, Massachusetts, a suburb west of Boston. The community served by the school fell in the middle to lower-middle class income bracket. Semi-professional, small business and high level white-collar occupations predominated. Standard English was the language spoken in the homes.

Subjects

The total population of children in the school, grades kindergarten through six, was approximately 748. The second grade population was approximately 136, of whom a sample of 27 children were randomly selected, 13 boys and 14 girls. Their mean age was 7-10. The mean of a group IQ test (CTMM, Sullivan, Clark & Teigs, 1957) available for 24 of the 27 children, was 116; the range of IQ was 73-142, with a standard deviation of 15.3. See Tables 1, 2

The fourth grade population was approximately 113, of whom a sample of 29 children were randomly selected, 15 boys and 14 girls. Their mean age was 9-11. The mean of a group IQ test (Lorge & Thorndike. 1959) available for 27 out of the 29 children, was 107; the range of IQ was 85-124, with a standard deviation of 10.5. See Tables 1, 2

Table 1

Age and Grade Distribution of Sample

Grade	Age Range	Mean Age	Number	Boys	Girls
2	7-5 to 8-6	7-10	27	13	14
4	9-4 to 10-4	9-11	29	15	14

Table 2

IQ Scores for Grades 2 and 4 of Sample

Grade	IQ Range	Mean IQ	Number	s.d.
2*	73-142	116	24	15.3
4**	85-124	107	27	10.5

* California Test of Mental Maturity, administered in Grade 1.

** Lorge-Thorndike, administered in Grade 3.

In terms of the Piagetian developmental model of cognitive development, the following stages can be hypothesized to be represented by this sample: (a) The second grade (mean age 7-10) by the late transitional phase from preoperational thought to concrete operations (approximately six to eight years) and (b) The fourth grade (mean age 9-11) by the period of concrete operations (approximately eight to thirteen years). Although some first graders are concrete-operational in their thought processes, the class inclusion is not secure until the next grade. Of the children tested by Inhelder & Piaget (1969), 75 percent did not acquire the class inclusion operation until eight.

Many children in the second grade sample would have a "semilogic" (Piaget, 1968) or a general inability to maintain that an object conserves its properties on various physical dimensions in spite of apparent perceptual changes. These children would lack a fundamental cognitive structure, therefore, to execute multiple classification and class inclusion operations. Although they could classify according to one property they would be unable to classify an object by a number of different properties simultaneously. They could compare subclasses among themselves, but would be unable to understand that the total class must be as big or bigger than one of its constituent subclasses.

Many children in the fourth grade sample would be able to conserve an object in spite of apparent perceptual changes. They would be able to classify an object by a number of different properties simultaneously, and thus be able to shift the criterion to any particular set of objects. In other words, they would have the class inclusion operation.

Classification Tests and Instructions

This study attempted to control for adequate phonological input and reading instruction in order to concentrate on the intervening cognitive processes necessary for reading ability. Multiple classification and class inclusion operations were singled out because this investigator believes that such operations related to reading more directly than do the mental operations, for example, of seriation.

The Free-Sorting Classification Task, designed by K. White (1970), was used to test multiple classification operations. Multiple classification is defined as the identification of properties of an object and the understanding that one object, with more than one property, can belong to several classes of objects. The Free-Sorting Classification Task consisted of 48 colored pencil drawings on 5" x 8" index cards. Twenty-four of the 48 pictures used in the present study represented human figures, varying along the dimensions of age, sex, color, dress, activity, occupation and affective expression. The remainder of the pictures were replications of items used in the pictorial test of cognitive equivalence, developed at the Harvard Center for Cognitive Studies (Rigney, 1962), representing familiar objects such as clothing, animals, buildings, food, playthings and means of transportation. See Appendix for more complete description of items.)

The instructions for the Free-Sorting Classification Task administered to 56 second and fourth graders were: The examiner told the child, "This is not a test so there are no right or wrong answers. I have a lot of pictures on this table and I'd like to see how different boys and girls make groups out of them. Everyone seems to make very different groups. Please pick out all the pictures that are the same or go together in some way, and tell me why you'd like to have them in a group. Then you can put those cards back and make another group. The groups can be as big or small as you like. If some of the pictures seem to belong in more than one group, you can use them again."

If any child expressed difficulty in understanding the task, the instructions were repeated once and the child was encouraged to go ahead and try to find some pictures that seemed to belong together. Any grouping was accepted as long as the subject was able to verbalize its basis. If the selection appeared to be random and the child was unable to give any rationale for it, he was told, "You can pick out any cards as long as you can tell me how they're alike or how they go together."

After each child had finished five groupings, he was told, "You are doing a very good job of making groups; you've made five already; let's see if you can make five more. Everybody is making ten groups for me."

The Structured-Sorting Classification Task, designed by K. White (1970), was administered to 20 second gr ..rs. The children were selected alphabetically depending on their presence in school on a given day. The Structured-Sorting Classification Task was used to test class inclusion operations. Class inclusion refers to the hierarchical nature of item classification and presupposes the understanding of two propositions: All A are some B (e.g., all vegetables are foods), and A is less than B (e.g., there are fewer vegetables than foods).

The Structured Classification Task consists of 40 colored pencil drawings on 5" x 8" index cards. Nineteen of the 40 pictures used in the present study represented human figures, varying along the dimensions of age, sex, color, dress, activity and occupation. The remainder of the pictures represented familiar objects such as food, animals, plants, insects, playthings and clothing.

The instructions for the Structured-Sorting Classification Task were: The examiner asked the child, "Are there more vegetables or more foods in this picture?" Whether the answer was right or wrong, the examiner then asked, "How many vegetables are there?"

If the child answered questions 1 and 2 correctly, the examiner went on to the next set of pictures. If the child answered question 1 incorrectly but question 2 correctly, the examiner repeated question 1. If the child answered both incorrectly, the examiner said, "Look at the pictures carefully and then tell me how many vegetables are in the picture? How many foods are in the picture?"

Part II of the Structured-Sorting Classification Task examined the class inclusion operation in greater depth. The pictures included three red tulips, one yellow tulip, three red roses and one tree. The examiner asked, "Is the bunch of red tulips bigger, smaller or the same size as the bunch of tulips? Are there more tulips or more flowers? Are there more flowers or more red ones? If you take all the tulips away, will there be any flowers left? If you take all the flowers away, will any tulips be left?"

Part III, the multiple class membership section of the Structured-Sorting Classification Task, included a picture of a traffic boy. The examiner showed the child the picture and asked the question, "Can he be a son and a brother at the same time? Can he be a brother and a sister at the same time?"

Section IV of the Structured-Sorting Classification Task had pictures of children and clothing. The examiner spread out all the pictures of the children and asked the child, "In what way are <u>all</u> of these alike?" The examiner showed the child the key picture (black boy playing baseball) and asked, "Now can you find some pictures that are the same as this one in some way, but <u>not</u> the way they're all alike?" The examiner replaced the picture and asked, "Now can you find another picture that is like this one (black boy) in a different way?" If the child tried to repeat his first grouping, the examiner said, "No, you already made a group of boys, now try to make a different group." The examiner repeated the procedure until four matchings (after original "all" response) had been made <u>or</u> the child was unable to continue. The examiner repeated the procedure with the clothing pictures.

If the child grouped thematically, such as, "This boy might play with this boy," his response was recorded but the examiner said, "Yes, but instead of telling stories about the pictures, can you make groups of things that are the <u>same</u> in some way?" If the child persisted in thematic responding, the examiner simply recorded what he said.

Reading Tests

The reading tests were administered by Natick public school personnel, and the investigator had no role in their selection. For the second grade, the vocabulary and comprehension subtest scores on the Ginn Second Grade Readiness Test (McCullough & Russell, 1967) were used. For the fourth grade, the vocabulary and comprehension subtest scores on the Iowa Silent Reading Tests (Greene & Kelley, 1956) were used.

Procedure

To avoid examiner bias, the investigator employed a graduate student to administer the classification tests, as outlined on p. 22, to the second and fourth grade sample in the spring of 1970. This graduate student was not informed as to the specific hypotheses of the study.

Each child was tested individually on the school premises during school hours. The testing lasted one-half hour a child. The picture holder was spread out flat on a reading table and the child was able to see all the pictures. The children were not asked to identify the pictures so that they could be free to label objects as they wanted, according to the needs of the grouping they were forming.

During the testing session, the pictures were displayed in a heavy cardboard holder, with individual clear plastic envelopes or windows, allowing relatively easy removal and replacement.

The reading tests were administered on a group basis in the fall of each school year. The range of reading scores was 1.3 to 6.0, with a low reading designation arbitrarily set at 1.0 to 2.0, an average at 3.0, and a high at 4.0-6.0.

Scoring

In the Free-Sorting Classification Task, a modification of the Kagan, Moss & Sigel (1964) system developed by Wallach & Kogan (1965) was used. Frequency counts for the occurrance of multiple classes were the index of the child's ability to classify logically. Two types of groupings were scored as multiple (a) those in which two dimensions coincided, e.g., "They're round and you can eat them" and (b) those in which reference was made to two dimensions, both of which had other variants within the task, e.g., "girls' toys."

In the Structured-Sorting Classification Task, one point was given for every operational answer in each section, as follows:

Section I:	Class inclusion	5 points
Section II:	Class inclusion	5 points
Section III:	Multiple Class Membership	5 points
Section IV:	Shift	10 or more points

Section V: Shift 10 or more points

The range of classification scores was 11-32, with a low classification designation arbitrarily set at 11-13, an average at 21-23 and a high at 25-32.

Interscorer Reliability

Because of the judgmental nature of the cognitive style scoring system derived from Wallach & Kogan (1965), three independent judges scored every Free-Sorting Classification Task protocol, identified only by a code number and revealing no information as to the age, grade, sex, etc. of the child. Disagreements were resolved by discussion among the judges and with the aid of the Sigel scoring manual (Hess et al., 1967). Pearson product-moment correlation coefficients (Walker & Lev, 1953) for the initial scores ranged from .84 to .98, all statistically significant beyond the 0.001 level. (See Table 3).

Table 3

Interscorer Reliability

Grade	N	A B	B C	A C	Statistically Significant
2	27	.98	.95	.98	0.001
4	29	.84	.90	.88	0.001

Validity

Class inclusion and multiple class membership tasks are considered valid measures of conceptual ability (Pinard & Laurendeau, 1964; Tuddenham, 1968). Kaufman (1971) has recently shown that a Piaget battery (including class inclusion and multiple class membership) correlated about .60 with a Gesell battery and MA, but only about .15 with a measure of physical maturity.

Statistical Analysis

The Pearson product-moment correlation coefficient (Walker & Lev, 1953) was used to assess the relationship between the independent variable, Free-Sorting Classification, and the dependent variables, reading vocabulary and reading comprehension.

A partial correlation coefficient analysis (Fleisch, 1970) was used to assess the relationship between the independent variable, Free-Sorting Classification, and the dependent variables, reading vocabulary and reading comprehension, holding chronological age constant. A t test (Walker & Lev, 1953) was used to assess the statistical significance at the 0.05 level of the partial correlation coefficients.

A partial correlation coefficient analysis was used to assess the relationship between the independent variable, Free-Sorting Classification, and the dependent variables, reading vocabulary and reading comprehension, holding IQ constant. A t test was used to assess the statistical significance at the 0.05 level of the partial correlation coefficients.

The Pearson product-moment correlation coefficient was used to assess the relationship between the independent variable, Structured-Sorting Classfication, and the dependent variables, reading vocabulary and reading comprehension.

A partial correlation coefficient analysis was used to assess the relationship between the independent variable, Structured-Sorting Classification, and the dependent variables, reading vocabulary and reading comprehension, holding IQ constant. A t test was used to assess the statistical significance at the 0.05 level of the partial correlation coefficients.

Chapter 4

Presentation and Discussion of Data

The goal of this study was to determine relations between the logical operations of multiple classification and class inclusion and reading ability. Fifty-six children, randomly selected in the second and fourth grades, were given the Free-Sorting Classification Task. Twenty children in the second grade were given the Structured Sorting Classification Task. All the children were given reading achievement tests. Results of the testing can be seen in Tables 4 5 and 6

The null hypothesis states

(a) there was no statistically significant correlation between reading ability and a Free-Sorting Classification Task.

The Pearson product-moment correlation coefficient (N=56) for a Free-Sorting Classification Task and reading vocabulary was 0.3403, and for a Free-Sorting Classification Task and reading comprehension it was 0.3392 ($r=0.262$, $p= < .05$). Thus, there was a statistically significant correlation between reading vocabulary and reading comprehension, and a Free-Sorting Classification Task.

The null hypothesis states

(b) there was no statistically significant correlation between reading ability and a Free-Sorting Classification Task with chronological age held constant.

To determine whether or not the differences among these children in their classification operations were related to differences in their CA, a partial correlation coefficient analysis was performed. The independent variable was the Free-Sorting Classification score. The dependent variables were the reading vocabulary and reading comprehension scores, with CA held constant. With N=56, the correlation coefficient for classification and reading vocabulary was 0.3055 ($t=2.42$; $p= < .05$). The correlation coefficient for classification and reading comprehension was 0.2969. ($t=2.42$; $p= < .05$). Thus, there was a relationship between classification and reading ability with CA held constant.

The null hypothesis states

(c) there was no statistically significant

Table 4

Reading Achievement and Free-Sorting Classification Scores for Grade 2

Subject	Reading Vocabulary	Reading Comprehension	Free-Sorting Classification	CA	Calif. Test of Mental Maturity IQ	MA
1	5.7	6.0	2	7-10	130	122
2	5.1	5.3	0	7-11	118	112
3	4.8	4.6	0	8-2	132	129
4	4.1	3.5	0	7-7	110	100
5	4.1	5.3	1	7-5	142	126
6	4.1	4.8	0	7-7	113	103
7	4.1	3.7	1	7-5	111	99
8	4.0	5.3	0	8-2	124	122
9	4.0	4.6	3	7-6	132	119
10	3.8	3.5	1	8-2	106	104
11	3.8	2.5	1	7-7	-	-
12	3.7	3.7	0	7-6	122	110
13	3.5	3.4	2	7-11	-	-
14	3.5	3.3	0	7-5	124	110
15	3.4	4.3	0	8-6	113	115
16	3.4	3.5	0	7-9	94	87
17		2.2	0	7-5	-	-
18	3.1	3.8	0	8-4	109	109
19	3.1	3.8	0	7-7	118	107
20	3.0	1.7	0	8-2	118	116
21	2.8	2.4	0	7-11	124	118
22	2.6	2.8	0	7-10	73	69
23	2.4	1.8	0	7-10	95	89
24	2.4	2.5	0	7-7	110	100
25	2.0	2.2	0	7-7	126	115
26	1.3	1.3	0	7-11	93	88
27	1.4	1.4	0	8-9	127	133

Mean Age 7-10, Mean IQ 116, Range 73-142

Table 5

Reading Achievement and Free-Sorting Classification Scores for Grade 4

Subject	Reading Vocabulary	Reading Comprehension	Free-Sorting Classification	CA	Lorge-Thorndike IQ	Lorge-Thorndike MA
1	8.2	7.0	2	10-3	113	139
2	8.2	7.1	0	10-0	116	134
3	8.2	8.0	1	10-2	109	133
4	8.0	6.5	0	10-2	-	-
5	7.4	6.5	2	9-4	115	129
6	7.2	6.3	0	10-1	105	127
7	7.2	7.0	1	9-4	119	133
8	7.0	6.4	2	9-9	114	133
9	6.9	7.2	1	9-8	106	123
10	6.8	6.5	1	10-3	123	151
11	6.5	6.0	0	9-6	101	118
12	6.5	4.7	0	9-9	103	121
13	6.5	6.3	1	9-8	111	129
14	6.2	5.3	2	10-3	85	105
15	6.1	5.7	0	9-5	110	124
16	6.0	6.5	2	10-4	103	128
17	5.8	4.8	3	9-8	114	132
18	5.8	3.4	0	9-9	117	117
19	5.7	4.6	0	9-9	101	118
20	5.4	4.5	0	9-9	101	118
21	5.3	5.6	2	9-8	107	124
22	5.1	4.1	1	10-0	-	-
23	4.9	4.1	0	10-4	97	120
24	4.7	3.9	1	10-2	94	115
25	4.4	4.8	0	10-2	124	151
26	4.4	3.4	0	10-4	90	112
27	3.8	5.0	0	10-1	122	148
28	3.8	2.4	1	10-0	98	118
29	3.0	4.1	0	9-10	90	106

Mean Age 9-11, Mean IQ 107, Range 85-124

Table 6

Reading Achievement and Structured-Sorting Classification Scores for Grade 2

Subject	Iowa Voc.	Iowa Comp.		Mult. Class (range 11-32)
1	3.5	3.4	aver.	24 average class.
2	4.1	3.5	high reading voc.	22 average class.
3	4.1	5.3	high reading	32 high class.
4	4.1	4.8	high reading	29 high class.
5 (redone)	2.8	2.4	low reading	28 high class.
6	4.1	3.7	high reading voc.	25 high class.
7	3.4	3.5	average	19 low class.
8	5.1	5.3	high reading	22 average class.
9	1.3	1.3	low reading	11 low class.
10	3.1	1.7	low reading	13 low class.
11	3.8	3.5	average	23 average class.
12	3.1	3.8	average	22 average class.
13	3.8	2.5	low reading comp.	23 average class.
14	3.4	4.3	high reading comp.	23 average class.
15	2.4	1.5	low reading	21 average class.
16	4.0	5.3	high reading	21 average class.
17	2.0	2.2	low reading	22 average class.
18	1.4	1.4	low reading	24 average class.
19	3.1	2.2	low reading comp.	10 low class.
20	5.7	6.0	high reading	31 high class.

correlation between reading ability and a Free-Sorting Classification Task with intelligence held constant.

To determine whether or not the differences among these children in their classification operations were related to differences in their IQ, a partial correlation coefficient analysis was performed. The independent variable was the Free-Sorting Classification score. The dependent variables were the reading vocabulary and reading comprehension scores, with IQ held constant. With N=51, the correlation coefficient for classification and reading vocabulary was 0.2714 ($t=1.95$; $p= < .05$). The correlation coefficient for classification and reading comprehension was 0.2877 ($t=2.08$; $p= < .05$). Thus, there was no relationship between classification and reading vocabulary with IQ held constant. The null hypothesis was upheld. There was a relationship between classification and reading comprehension with IQ held constant.

The null hypothesis states

(d) there was no statistically significant correlation between reading ability and the Structured-Sorting Classification Task.

With N=20, the Pearson product-moment correlation coefficient for the Structured-Sorting Classification Task and reading vocabulary was 0.5068, and for the Structured-Sorting Classification Task and reading comprehension, 0.6073 ($r=0.433$; $p= < .05$). Thus, there was a relationship between reading vocabulary, reading comprehension and the Structured-Sorting Classification Task. The relationship between reading comprehension and the Structured-Sorting Classification Task was statistically significant at the 0.01 level.

The null hypothesis states

(e) there was no statistically significant correlation between reading ability and the Structured-Sorting Classification Task with intelligence held constant.

To determine whether or not the differences among these children in their classification operations were related to differences in their IQ, a partial correlation coefficient analysis was performed. The independent variable was the Structured-Sorting Classification score. The dependent variables were the reading vocabulary and reading comprehension scores with IQ held constant. With N=20, the correlation coefficient for classification and reading vocabulary was 0.5081 ($t=2.42$; $p= < .05$). The correlation coefficient for classification and reading comprehension was 0.5764 ($t=2.87$; $p= < .05$). Thus, there was a relationship between reading vocabulary, reading comprehension and the Structured-Sorting Classification Task with IQ held constant. See Table 7

Table 7

Statistically Significant Correlation Coefficients

	No.	Statistical Analysis	Independent Variable	Dependent Variables	Constant	Coefficient
1.	56	Pearson product-moment	Free-Sorting	Reading vocabulary Reading comprehension		0.3403 0.3392
2.	56	Partial correlation	Free-Sorting	Reading vocabulary Reading comprehension	CA CA	0.3055 0.2969
3.	51	Partial correlation	Free-Sorting	Reading vocabulary Reading comprehension	IQ IQ	0.2714 0.2877
4.	20	Pearson product-moment	Structured-Sorting	Reading vocabulary Reading comprehension		0.5068 0.6073
5.	20	Partial correlation	Structured-Sorting	Reading vocabulary Reading comprehension	IQ IQ	0.5081 0.5764

(* statistically significant at 0.01 level)
(** statistically significant at 0.05 level)

Discussion

Statistically significant correlations ($p = < .05$ in all but one test) were found between the logical operations of multiple classification and class inclusion and the reading tasks of vocabulary and comprehension. The implications of this data for the theoretical point of view expressed in Chapter II suggest that certain logical thinking skills of children who are poor readers differ from those of children who are good readers. Typically, Piagetian studies have shown no sex differences on task performances (Sigel et al., 1968; Goldschmid & Bentler, 1968; Pinard & Laurendeau, 1964; Tuddenham, 1968). Age and intelligence, however, were partialed out to determine whether or not statistically significant results were independent of CA and IQ.

As Piagetian tasks are numerous (Lavatelli, 1970) the investigator had to select those which related as directly as possible to the cognitive analysis of adult syntax. Without multiple classification skills, the variability of the letter-sound relationship would appear hopelessly disparate as there are approximately 172 different graphic options for 52 phonemes (Hanna et al., 1966, p. 121).

The child as he learns to read, either by the whole word or phonic method, begins to induce a number of generalizations for the letter "a" which help him attack unknown words. The letter "a" has four subclasses of possible sounds as well as the schwa. The subclasses of sounds can be classified as generalizations and exceptions to the rule and are included in the class of the letter "a." To confuse matters even more, almost every element of the subclass "A" is included in other classes of letters. For example, the first sound for the letter "a" as in "brake" or "vain" can be spelled with a letter pattern from the letter "e" class as in "break" or "vein." The fourth sound for the letter "a" as in "taught" can be spelled with a letter pattern from the letter "o" class as in "ought." The letter "o" is particularly confusing as there are nine subclasses of possible sounds as well as the schwa, depending on the speaker's dialect.

Every element of the subclass "A," the exception to the rule class, is included in the other classes of letters. "Wash" and "father" are not pronounced to rhyme with "cash" and "rather" but, instead, with the second sound for "o" as in "stop." "Any," "said" and "says" are pronounced like the second sound for "e" as in "set." "Plaid" and "laugh" are pronounced like the second sound for "a" as in "apple." "Gauge" is pronounced like the first sound of "a" as in "ape." "Aisle" is pronounced like the first sound for "i" as in "ice."

It occurred to the investigator that a child having problems grouping pictures according to varying criteria such as age, sex, color, dress, activity, etc., would have difficulty classifying the highly abstract letter-sound relationships necessary for efficient reading.

The alphabet is an abstract system man has invented to process data about his world more efficiently. The preoperational child may be unable to abstract generalizations from the speech environment and then to modify these generalizations to handle the variability of the letter-sound relationships of English. He may be unable to work out rules (unconscious, to be sure) for an invariant response over a series of changing letters and then to transfer such knowledge to unknown words (Gibson, 1970). He may not be able to recognize that one and the same letter can give rise to different sounds, depending on the context of the pattern. He may not be able to classify the perceptual dimensions of letters and sounds in many varied combinations (Levin & Williams, 1970).

Reading for a preoperational child is probably a matter of recognizing global configurations of certain words, an adequate procedure when the vocabulary is small, but no help in the analysis of new and unfamiliar words. If "a" always sounded /æ/, as in "apple," and "c" sounded /k/ as in "candy," the preoperational child might not have any difficulties with reading except those imposed by such limitations as memory and the learning of phonetic rules (White, K., 1971).

The concrete-operational child can anticipate the inverse or negation of a series of mental actions and relate subclasses to superordinate classes. In Bettelheim's words (1961), the child understands that each symbol has generic qualities representing different examples of the same object. He can coordinate intension and extension; that is, to define a class with a superordinate label and to extend it to all appropriate stimuli. He is adept at handling additive and multiple classes which involves keeping more than one set of characteristics in mind at once. He can shift the criteria by which he classifies sound or letter (Inhelder & Piaget, 1969). Sounds and letters, like objects and pictures, can be classified by many criteria; the letter "a," as the discussion has shown, does represent several different classes of sounds and each sound is represented by several classes of letters.

It may be possible to talk of logical classes of sounds as well as logical classes of objects like children and clothing. If the child can make the "k" sound whenever it appears in a word, and if he knows that the letters "c," "k" and "ch" can all make that sound, then he could be said to have a true class of "k" sounds.

The reading achievement measures (Ginn Second Grade, Iowa Silent Reading) chosen by the Natick Public Schools, are a definite limitation to the interpretation of the results of the study. The reading vocabulary task more closely relates to a decoding task, to a logical understanding that one letter has certain sounds and one sound certain letter patterns. For instance, the word "leap" is presented, and the child is asked to choose the appropriate synonym from "learn," "stand," "play" and "jump." Clearly an individual diagnostic test such as the Gates-MacGinitie (1965) or the Roswell-Chall (1959) would have been more closely related to the multiple classification task. Reading comprehension is supposedly more dependent on guesswork, and thus intelligence, than is reading vocabulary (Serwer, 1966).

The results of the study indicated there was a low but statistically significant relationship between multiple classification, reading vocabulary and reading comprehension, independent of age. Older children, in other words, were not necessarily the better classifiers. With intelligence held constant, the relationship held between multiple classification and reading comprehension, contrary to expectation. There was no statistically significant relationship between multiple classification and reading vocabulary, with intelligence held constant, contrary to expectation. The investigator believes it would be a mistake to draw any conclusions from these results due to the limitations of the measures used.

An examination of the answers given by certain "preoperational" children provided the clue to the possible connection between the cognitive structures of class inclusion and reading ability (Simpson, B., 1969). A child had been presented with a box containing twenty wooden beads, two white and eighteen brown. He agreed that both the white and brown beads were made of wood. When he was asked, "Does the box contain more wooden beads or more brown beads?", his preoperational answer was "more brown ones." Apparently he was not able to think about the whole (wooden beads) and its parts (brown and white beads) at the same time.

When asked, "What color would a necklace made of wooden beads be?", the child would show once again that he understood the question and the vocabulary by answering "brown and white." But when asked, "which necklace would be longer, the one made with the wooden beads or the one made with the brown beads?", he persisted with a preoperational answer, "the brown one." Apparently the class of wooden beads ceased to be preserved as a whole as the child continued to compare the brown beads with the white beads. See Appendix

The investigator then translated the answers to the wooden bead inclusion task into modern math terminology.

Brown beads and white beads are wooden beads. $A + A' = B$

There are more wooden beads than brown beads. All brown beads are wooden. — A is < B; thus all A are some B

A necklace of brown wooden beads and a necklace of white wooden beads are different from a necklace of brown and white wooden beads. — A or A' is not whole B

The investigator believes that the ability to deal with part-whole relationships within a set of categories, especially shifting categories, is important in efficient reading ability. The tendency of a pre-operational child is to compare parts, for whenever attention is called to a part of a whole class, the whole class ceases to be preserved as a whole. Whole B must be preserved so that A will not be compared to A'. When A is compared with A', confusion results.

In relationship to reading, the class inclusion operation would involve the following implicit realizations:

a) The letter "a" (B) has a class (A) of predictable sounds ("able," "am," "auto," "arm," "sofa") and a class (A') of unpredictable sounds ("father," "any," "senate"...)

b) The "long a" sound in class A as in "able" is made by letter patterns other than "a" such as "vein," "they," "break."

c) Other letter patterns such as "ea" have predictable sounds such as "seat" and "head." The "ea" in "break" is not a predictable generalization.

A preoperational answer to the question in the Structured-Sorting Classification Task, "Are there more vegetables or more foods?" was "more vegetables." Apparently, the class of foods ceased to be preserved as a whole so that the vegetables were compared with the dessert. It occurred to this investigator that a child having problems including parts of a given class into its whole would have a hard time remembering that only some "k" sounds are made by the letter "c."

A key point, and one that is frequently misunderstood, is that 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 & Piaget (1969) found the 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 some 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. Rules for the letter "o" should be more confusing to the poor reader than rules for the letter "i" since "o" involves ten predictable sounds and "i" only four.

Another limitation to the study was the fact that the class inclusion task was given to only 20 children in the second grade. If the Structured-Sorting Classification Task had been given to the total sample, then answers to the following questions would be more conclusive:

a) Do good readers have the class inclusion operation?
b) Do poor readers not have the class inclusion operation?
c) Is the class inclusion operation dependent on age?
d) Is the class inclusion operation dependent on IQ?
e) How does the study account for high classifiers with low reading scores?
f) How does the study account for low classifiers with high reading scores?

The Structured-Sorting Classification results indicate that not only was there a statistically significant relationship between class inclusion and reading ability, but that the results between the Structured-Sorting Classification Task and reading comprehension were statistically significant at the 0.01 level, contrary to expectation. Again, this investigator believes it would be a mistake to draw any conclusion from these results due to the limitations of the measures used and the size of the sample.

Among the 20 second graders, children with high classification scores were expected to do well in reading See Table 8 In all instances, the relationship between expectation and performance held. (Note that columns C and G in Table 8 are empty.) Child #5 was retested and found to be an average reader.

Given the limitations of the study, it is possible to conclude the following results:

a) Good readers appear to have the class inclusion operation.
b) Poor readers do not appear to have the class inclusion operation.
c) It was not possible to determine the effect of CA on the results as only 20 second graders were tested.
d) The class inclusion operation for 20 second graders was independent of IQ.

Certainly there are many reasons for poor reading ability in primary school children. Knowledge of letter names and visual-motor coordination are important factors although there is a gap in the variation which cannot be accounted for (Serwer, 1966). The unaccountedfor variation in the multi-variate analysis of reading readiness may involve other logical operations as well, including those factors measured by individually administered intelligence tests. The investigator believes, however, that the cognitive correlates to the identification of specific reading disability have been overlooked. This study has tried to explain how a delay in the acquisition of the multiple classification and class inclusion operations might present difficulty in the abstraction of the basic structural generalizations which underlie the orthography of English.

Table 8

Expectation-Performance Results

High Classifiers			Average Classifiers			Low Classifiers		
A High Reader	B Average Reader	C Low Reader	D High Reader	E Average Reader	F Low Reader	G High Reader	H Average Reader	I Low Reader
#3,4,6, 20	#5	-	#2,8,14, 16	#1,11,12	#13, 15, 17,18	-	#7	#9,10,19

Chapter V

Summary, Conclusions and Implications

Reading "readiness" may be more than the acquisition of habits or perceptual abilities. Reading "readiness" may involve cognitive "readiness" as well. Cognitive "readiness" is a qualitative difference in the ability to abstract generalizations from fragmentary evidence and to use these generalizations with the variety of modifications necessary to deal with the letter-sound variability in English.

This study was specifically concerned with the cognitive structures of multiple classification and class inclusion and their relationship to reading ability. A pilot study (Simpson, B., unpublished research 1968-69), had indicated that children with specific reading disability could not pass the wooden bead class inclusion task (Pinard & Laurendeau, 1969). A close examination of the preoperational answers given by these children provided a clue to the possible connection between the cognitive structures of multiple classification and class inclusion and reading ability. Levi (1969) had indicated, as well, that a poor reader might be a child who uses preoperational tools of thought beyond the chronological time when the logic of classes should have been developed. Since reading ability involves logic, reading problems might disappear if instruction could be delayed until logical skills were secure.

A sample was randomly selected from second and fourth graders in a suburban public school, making certain that all the children had adequate reading instruction in school and rich phonological input from home. Two cognitive operations, multiple classification and class inclusion, were selected for testing because the investigator believed that the ability to deal with part-whole relationships within a set of categories, especially shifting categories, is important for efficient reading. A letter has certain predictable sounds, and a sound certain predictable letter patterns, given phonological, morphological and syntactical analysis of English.

The results of the study made the following conclusions possible, given the limitations of the testing criteria and the size of the sample:

a) Good readers tend to have the multiple classification (N=56) and class inclusion (N=20) operations.

b) Reading ability and multiple classification (N=56) tend to be related, independent of CA.

c) Reading comprehension and multiple classification (N=51) tend to be related, independent of IQ.

d) Reading vocabulary and multiple classification (N=51) are not related, independent of IQ.

e) Reading ability and class inclusion (N=20) tend to be related, independent of IQ.

Obviously a significant statistical relationship does not mean that a causal relationship exists; that is, that because children are poor classifiers they will necessarily be poor readers. The correlations are low, as well. Cognitive operations such as multiple classification and class inclusion are relevant but not exhaustive to reading readiness, necessary but not sufficient for reading ability.

If the present study can be replicated on a larger sample and the findings remain statistically significant, then the following implications might be made:

a) Johnson & Myklebust (1967) believe modality strengths and weaknesses are important in early identification and treatment of children with possible reading problems.

Liberman (1971, p. 30) disagrees:

> I disagree with writers who classify children with problems in phonetic analysis and synthesis as "auditory dyslexics" ... I would say that if the spoken language of the child is "generally good," ... if he can hear and speak the words well, then his difficulty with segmentation is cognitive, not auditory.

Grouping children by visual and auditory perceptual-motor deficits has meant an expensive and time-consuming program of diagnostic testing. See Appendix

When the battery is finished, there is no assurance that there will be a clearcut profile of an auditory or visual learning style in the child. Above all, it is not clear to this investigator how such a learning profile relates to the reading process, given the recent insights of Gibson (1970), Liberman (1971) and C. Chomsky (1972). Letter-to-sound coding is an integrative process involving <u>both</u> the visual and auditory modalities, and is only possible when a child realizes that a visual perceptual feature can change its form, yet hold its sound constant (Elkind, 1967).

The administration of multiple classification and class inclusion tasks is relatively easy and inexpensive to give to a group of children. Intervention for remedial reading instruction could possibly be based on an analysis of reading as a logical process. Apparently the 20 children in the second grade sample who read well had developed beyond the preoperational stage. Apparently no child who was having trouble with reading was at the concrete operational stage. There are obviously other factors in reading retardation, but if a preoperational level of cognitive development is causing some of the trouble, reading ability might be improved if cognitive development could be accelerated.

b) A developmental scale of cognitive ability can be applied to reading problems. Such a model can accomodate all known causes of specific reading disability, medical, genetic, environmental, as etiology is not as important as the exact description of the level of the child's mental development. The model can deal with the level of the child's thought processes at a specific stage of development. In the most severe reading disability, the child's thinking is confined to Stage I. A child with a moderate reading disability is confined to Stage II, and a child with a mild reading disability to Stage III.

A diagnosis of specific reading disability would not dwell on what a child cannot do but instead would give a positive description as to what the child can do. Most important of all, there would be a description of the orderly sequence of mental development so that the teacher would have a framework for remediation (Kolstoe, 1970). Remedial procedures could then be based on broad developmental theory. This analysis would avoid the "dead-end skills" types of interventions which have been used with children with specific reading disability (Falik, 1968; Mann, 1970).

Remediation for a cognitive deficit would emphasize a conceptual rather than a perceptual attitude toward dimension in general and could then be extended to language and reading skills (Levi, 1968, 1969).

Stage I: The child analyzes all the elements of a whole so that the given object can be divided into parts. He discovers one dimension, for example, shape, ignoring other dimensions such as color, texture, etc. He can forget the first dimension and adopts an alternative. The newly-analyzed dimension distorts the whole system as the child has no general criterion for classification.

Stage II: The child varies two dimensions simultaneously such as size and thickness, putting to one side the perceptually salient cues of color and shape. The classification of objects can be considered relative, dependent on criteria selected as the basis for the set. They can be combined or shifted in various ways to produce new categories. The child should be able to recognize the invariant dimension even if it is presented in many different ways. Objects with multiple characteristics can be classified on the basis of two or more dimensions and ordered in a system of hierarchies or nested in structures, with subordinate/superordinate class relationships. A + A' are individual classes in their own right and, at the same time, members of B.

Stage III: The child understand the inclusion relationship as new dimensions are reconciled with the existing classification. He develops flexibility as the pattern must be rearranged or modified in light of existing criteria. The possible rearrangements are increasingly systematic. The child understands that part A is included in whole B; thus all the A's are some of B. B can be set aside in order to analyze A, free from the disturbing interference of A^1. Whole B retains its identity when parts are varied. The child now has the capacity to conceive a correlative figure required to complete a matrix of relations. He is able to compare the characters of two figures and, from a third figure, infer by analogy the nature of a fourth. The child can now verbalize the rules for the above problem.

c) Major developmental theorists such as Kephart (1960) and Valett (1967) assume mastery of perceptual-motor processes as necessarily prior to higher cognitive processes and, hence, to scholastic achievement. Bibace and Hancock (1969) have found cases which are contrary to this theoretical assumption: both younger and older children can be found who show gross deficits in perceptual-motor abilities and who, despite these deficits, do well in school. The concept of "perceptual-motor handicap" needs to be extended to include cognitive deficits as well, and perceptual-motor training programs extended to include logical training (Jordan & Speiss, 1970).

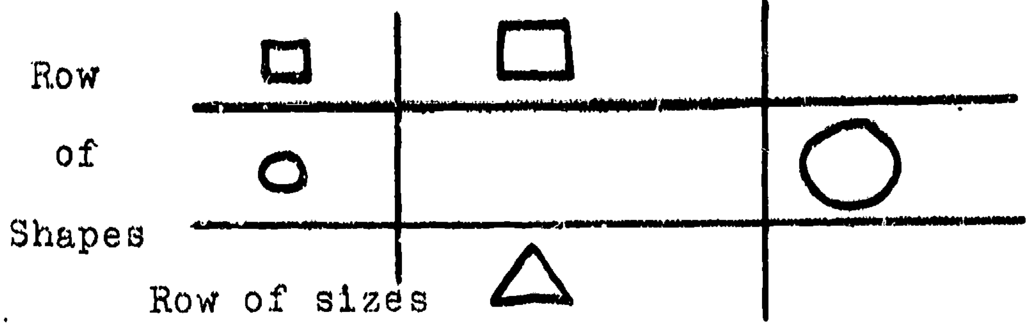
Need for Further Research

If a child lacks a system for categorizing ideas, he will face more decisions than he can make. He will limit his choice to a single stimulus dimension in order to reduce the complexity of the task, frequently making mistakes (Scholnick, 1970). Children can be trained to accelerate a lag in mental development (Sigel, Roeper & Hooper, 1968; Smedslund, 1968; Wallach & Sprott, 1964; Wohwill & Lowe, 1962; Beilin & Granklin, 1962). The question remains whether or not logical ability to deal with parts and wholes is formed in relative isolation and thus be transferable to other problem areas such as reading (Kohnstamm, 1967, 1970).

The matrix is a simple and inexpensive game for developing logical operations. Given a picture with a row of different colored leaves and a row of green objects and a blank space at the juncture of the rows, the child is asked, "What picture will go well with both rows?" Not until the concrete-operational period is well established does there tend to be a systematic preference for a green leaf, or the object which possesses defining attributes of both sets. The crucial task is not just to learn a few sets such as shape, color, size, function, number, etc., but to be able to scan among a variety of possibilities for the appropriate one in any given exercise.

Table 9

Example of a Matrix Game



In other matrix exercises, the child can be given as many as eighteen cards to sort (four squares, four circles and four triangles in four different colors). He then closes his eyes while a card is removed and is asked to figure out the attributes of the missing card (Sharp, 1969). The same game can be played with a picture of a hole in a boy's pocket, a donut, an ascending rocket, and so forth (Upton & Samson, 1961). Hull (1961) also has developed exercises with the attribute blocks, using a number of variations on this technique. Eventually, the matrix can be used to teach complex analogies and metaphors, by working creatively with two matrices at once, each of the matrices being defined by a different pair of conditions. Karl (1968) uses the

Piagetian model to increase the student's awareness of the structural relationships of literary passages and his sensitivity to the deeper symbolic levels of meaning.

General logical training may accelerate operational stages of thought. It is not certain whether this logical training per se will improve speech and/or reading. It may very well be that one of the best ways to teach reading is to enrich the child's vocabulary, not by a word-count-type of program but by an exposure to a rich variety of language inputs in interesting stimulating situations. A logical analysis of the morphological and syntactical restrictions that can be applied to words might also be helpful (Chomsky, C., 1972).

A reading program which builds on the principles of the matrix game could be effective in the prevention of reading failure. The letters of the alphabet are one condition of the set; the significant sounds of the child's dialect the other condition. The child then figures out for himself which letter patterns correspond to what sound he articulates on a predictable basis (Venezky, 1970). An ordered syllabic approach to the teaching of reading apparently is consistent with recent research (Rozin et al., 1971; Liberman, 1971), especially if it takes into consideration distributional factors such as phonological, morphological and syntactical cues (Hanna et al., 1961). There are many approaches to a patterned presentation of words. A successive syllabic approach adheres to the systematic presentation of the short vowels in consonant vowel consonant patterns (pan, pin, pond, pun, pen). Generally speaking, this approach is used in most remedial materials, and the variant and unpredictable patterns are delayed until the child has thoroughly learned to trust words. Among the programs utilizing this method are Bloomfield et al., (1961), Fries et al., (1965), Sullivan (1960), Stern (1966) and Rasmussen & Goldberg (1964).

Gibson (1969) suggests, however, that a concurrent presentation of syllabic patterns is the most efficient way to teach reading. She feels that if a child is presented with the multiple correspondences of sound and symbol early in his reading instruction, he will be able to tolerate what is known as a "set for diversity" (Williams, 1970, p.270). This "set for diversity" is a useful problem-solving approach to reading which aids in classifying unpredictable and exceptional patterns.

It would seem to this investigator, therefore, that a child must be cognitively "ready" to begin initial reading instruction. If he is not cognitively "ready," he must begin reading with a series which aids in the development of his classification ability. He must be shown how to make modifications about language rather than to plod along with a set of responses, which although mastered thoroughly are inappropriate. If a child is aware there is more than one sound associated with a particular letter, he will likely try out a variety of pronunciations when faced with an unfamiliar word. If he does not know that variation is possible, he is not likely to develop a scheme for proficiency and speed.

One type of concurrent syllabic presentation is many sounds for a constant letter pattern: e.g., "ei" in "ceiling," "vein," "forfeit," "heifer." This approach is chosen by McCracken & Walcutt (1965) and Glin (1968). Another type of concurrent syllabic presentation is many letters for a constant sound, e.g., /ā/ in "baby," "way," "rain," "ate," "weight," "great" ... This is the method chosen by Hughes (1970) and Gattegno (1964).

Gillingham & Stillman (1963) use a multiple classification approach in the presentation of the reading material, and Crane (1970) controls for modality strengths and weakness as well. Do these reading systems significantly reduce the percentage of children with specific reading disability?

Children obviously do not all learn in precisely the same way (White, K., 1972). Some are visually dependent, some haptically oriented, and some aural-oral minded. A multi-sensory approach seems the best solution: the visual approach reinforces the sense of hearing, for instance, and is essential as an image-fixer of words which cannot be explained by the structural generalizations. The basic rules which underlie the orthography, when inductively learned, enable the child to develop a relatively small set of effective strategies instead of having to develop as many strategies as there are words. The teacher, rather than initiating the rule, should encourage the child to extract it from close examination of words which illustrate the generalizations. Poor readers respond idiosyncratically; that is, they learn the generalizable patterns too well and become easily confused by the modifications and the exceptions. They need to be shown how to determine the invariant patterns of words, modify the predictable patterns, and memorize the unpredictable patterns with any clue they can use. (Venezky, 1967).

Learning situations which permit simple responses may be detrimental to the child's thinking process (Gibson, 1969). Many programmed reading books today are based on this technique of simple response learning. The rationale is a good one, as far as it goes: to keep the learning experience from confusing the child. Part of each page in the book is covered by a cardboard marker while the child is led, step by step, to teach himself in natural progression. He checks his progress by lifting the cardboard. This programmed approach offers a "tightly organized, carefully supervised zeroing in on specific problems," but nevertheless children are not learning any more efficiently than those in a control group (Hechinger, 1972, E9).

Possibly it is multiple labeling and classifying that a child needs; an increased sensitivity to the multiplicity of attributes of objects, parts-to-whole relationships, and the intersections of classes. Objects and words need to be shown as multi-dimensional, with each dimension a possible criterion by which to create another classification. Gibson (1970) experimented with three approaches to the teaching of reading; one approach provided a general clue to aid the discovery of a phonetic rule, the second gave the specific rule itself, and the third gave no aid at all. Gibson found that a general clue brought greater transfer in decoding unfamiliar material than no aid or the specific rule itself. Can reading materials be developed along these principles?

There is evidence that conceptual training does improve reading skills in disadvantaged children (Blank et al., 1968; Blank & Solomon, 1968). In the Elkind and Deblinger study (1969) an experimental group of second grade inner-city Negro children trained with "nonverbal perceptual exercises" for fifteen weeks and 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 (White, K., 1971). In fact, in earlier studies Elkind proposed that the well developed perceptual activities useful in reading require logical multiplication (Elkind, Horn & Schneider, 1965; Elkind, Larson & Van Doorninck, 1965).

Lombard (1968) has shown that manipulative problem solving can be taught, strengthening the operative aspects of thought; yet schools are slow to adopt games as alternative means to learning. Logical training holds great promise for all children, not just those who have disabilities (Inhelder, 1970; Mackay et al., 1970; Fischbein et al., 1970; Davies, 1965).

Conclusion

Future research must determine whether children have trouble reading because they are at a preoperational level in cognition, and why children have trouble reading with the necessary cognitive prerequisites. Will conceptual ability overcome perceptual integrative interference with reading? Will treatment oriented toward the rehabilitation of underlying thought processes be more effective than remedial reading tutoring? Can good instruction overcome psychoneurological deficiencies? What is the relation of ego strength to the growth of cognitive structures?

A top priority of school personnel should be:

a) the acceptance of the possibility that cognitive abilities necessary for reading are not well or equally developed in all six-year-olds;

b) the willingness to support controlled experimentation with the "ungraded" classroom to meet the needs of these children with developmental delay;

c) the development of logical training programs which relate to all areas of the curriculum.

Dr. Randolph Byers has written:

> Children with reading difficulties may be individuals in whom the various connections between various parts of the brain are installed in a different way from what they are in most of us. The main difference between the human brain and that of apes is the enormous enlargement of the central association area which comes between the hearing area of the temporal lobe, the sensory motor area of the parietal cortex, the visual area of the occipital cortex. Nobody knows how to assess how rich are the contributions from each of these areas to the central language association part of the brain in different individuals. Under these circumstances, I have tried to take the point of view that the best thing to do with children with reading difficulties is not to keep their noses on the grindstone of reading, but to try to find out what their other assets are ... .

The revolution in the public education system in Great Britain has "opened" the curriculum to adjust to these individual differences and interests. The British claim they have few children with specific reading disability in their school system (Featherstone, 1971); that children learn to read in their own good time, when they themselves are motivated and interested enough to do so.

The "Right-to-Read" imperative, then, may involve more than an innovative, cure-all reading system. It may involve a revolutionary change in the graded, lockstep, test oriented American primary school. It is important to remember that Olson's (1959) concept of "readiness" included pacing by the teacher to encourage <u>self-selection</u> of reading materials by the pupil.

Dr. C. Chomsky (1972, p. 33) agrees with this solution:

> The effort should be towards providing more and richer language exposure, rather than limiting the child with restrictive and carefully programmed materials. In this way the child would be permitted to derive what is accessible to him from a wide range of inputs, and put it to use in his own way.

It seems to this investigator that the "Right-to-Read" goal could become a reality in the 1980's, and, moreover, that all children not just the disabled could benefit from training in logical thinking (Voyat, 1970) based on an application of Piagetian theory.

APPENDIX I

STRUCTURED-SORTING CLASSIFICATION TASK

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
   Question: Are there more girls or more children?
   Answer: more
   how many?

C. Pictures: policeman, soldier, sailor, lady
   Question: Are there more grownups 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

Question: Is the bunch made of all the red tulips bigger, smaller or the same as the bunch of all the tulips?

Answer:

Question: Are there more tulips or more flowers?

Answer:

Question: Are there more flowers or more red ones:

Answer:

Question: If you take all the tulips away, will there be any flowers left?

Answer:

Question: If you take all the flowers away, will any tulips be left?

Answer:

Part III. Multiple Class Membership

A. Picture: traffic boy
   Question: Can he be a son and a brother at the same time?
   Answer:
   Why?
   Question: Can he be a brother and a sister at the same time?
   Answer:
   Why?

B. Picture: bee
   Question: Can this be a bee and a mosquito at the same time?
   Answer:
   Why?
   Question: Can it be an animal and an insect at the same time?
   Answer:
   Why?

C. Picture: teacher
   Question: Can she be a teacher and a mother at the same time?
   Answer:
   Why?
   Question: Can she be a mother and a sister at the same time?
   Answer:
   Why?

D. Picture: old man
   Question: Can he be a father and a grandfather at the same time?
   Answer:
   Why?
   Question: Can he be a father and a son at the same time?
   Answer:
   Why?

E. Picture: doll
   Question: Can this be a doll and a toy at the same time?
   Answer:
   Why?
   Question: Can this be a doll and a little girl at the same time?
   Answer:
   Why?

Part IV. Shift

A. Pictures of children

Key Picture - boy playing baseball

All
1st match
2nd
3rd
4th
5th

B. Pictures of clothes

Key Picture - brown boots

All
1st match
2nd
3rd
4th
5th

APPENDIX II

CLASS-INCLUSION TASK

Inclusion of one class of objects with another

(1) (20 yellow beads, 2 blue beads)

Are the (yellow) beads made of wood?
Are the (blue) beads made of wood?
Tell me are there more wooden beads or more (yellow) beads?
Why do you say ....

If the child answers there are more (yellow) beads or if having answered correctly, he cannot explain his reply

What color would a necklace made of wooden beads be?
A necklace made with (yellow) beads would be what color?
Which necklace would be longer, one with wooden beads or one with (yellow) beads?
Why do you say ....

If the child corrects himself and says the necklace with the wooden beads would be longer

Tell me, are there more wooden beads or more (yellow) beads?
Why do you say ....

If the child persists in saying that the (yellow) bead necklace would be the longer, or if having answered correctly, he does not explain

Are all the beads (yellow)?
Are all the beads made of wood?
If I took all the (yellow) beads, would there be any left?
If I took all the wooden beads, would there be any left?
Which necklace would be the longer one, the one with wooden beads or the one with (yellow) beads?
Why do you say ....

If the child corrects himself and says that the wooden necklace would be the longer one

Tell me are there more wooden beads or more (yellow) beads?
Why?

If the child persists in saying that the (yellow) bead necklace would be the longer one, or if, having replied, he cannot explain

Put all the beads we would take to make a necklace with the (yellow) ones together
Put all the beads we would take to make a necklace with the wooden ones together

If the child gathers all the beads

Which necklace would be the longer one, the one with the wooden beads or the one with the (yellow) beads?
Why?

If the child shows only the (blue) beads

Only these?

Why?

Aren't the other beads made of wood also?

Which necklace would be the longer one, the one with the wooden beads or the one with the (yellow) beads?

Why?

(2) Are the (blue) beads made of wood?

Are the green beads made of wood?

Are there more wooden beads or more (blue) beads?

Why?

APPENDIX III

PERCEPTUAL MOTOR SKILLS

1. Attending: responding to stimuli, i.e.	Test
KINESTHETIC-TACTILE	
adequate muscle strength, tone;	PPMS "Kraus Weber"
finger localization; two point sensation; tracing shapes on skin.	
motor speed & precision; touching finger/thumb, reproduction finger positions, reciprocal coordination fist/edge/palm.	Detroit #5
hand-eye dominance;	
dynamic & static balance;	PPMS; Doll-Oseretsky; Kohen-Raz
VISUAL	
acuity; far point, near point, color.	Keystone; Titmus
awareness; eye movements following a moving target (ocular-motor pursuits) without additional and/or unnecessary movements (overflow).	PPMS
constancy; recognizing an object in a variety of positions, sizes, etc.	ITPA #2; Frostig #3
figure-ground; recognizing an object in a confusing background.	Frostig #2
closure; recognizing an object from incomplete drawing.	ITPA #7
AUDITORY	
acuity; recognition of sound or no sound.	Audiometry
awareness that sound has started, stopped, changed;	
localization of sound source;	
constancy; recognition of sound despite pitch, duration, intensity, etc.	
figure-ground; recognition of relevant sound with background of irrelevant noise.	

closure; recognition of word from incomplete sound pattern.	ITPA #11
2. Imitating: repeating a stimulus with object present, i.e.	
KINESTHETIC-TACTILE	
movement copying; pointing to body parts, crossing midline of body, simultaneous use of both sides of body, use of one side of body with no additional and/or unnecessary movements (overflow)	PPMS Cohen *et al.*
gait; cross pattern creeping, walking, running, skipping, hopping, obstacle course.	MSSST, PPMS
use of same arm/leg consistently in throwing, kicking activities.	Harris Test of Lateral Dominance
fine motor control; fastening, lacing, tying, scissor use, peg-board skills; tracing, dot-to-dot, copying geometric shapes.	Frostig, #1 PPMS Beery Developmental Test of Visual Motor Integration
VISUAL	
matching of simple pictures	MSSST
AUDITORY	
articulation; sound-making in initial, middle, final positions	Goldman-Fristoe
repetition of word, sentence	MSSST; MacDonald; Menyuk
3. Differentiating: discriminating between two or more stimuli, i.e.	
KINESTHETIC-TACTILE	
word concepts; pointing to body parts, up/down, right/left, back/front when named.	Boehm Test of Basic Concepts
hand patterns	MSSST
organization of forms in space; copying two or more designs and arranging designs on paper.	Bender Gestalt
VISUAL	
matching pictures with minimal differing features	MSSST; Frostig #4
organization of forms in space	MSSST

directionality	Money Road Map
AUDITORY	
differences in non-verbal sounds (stress, rhythm, melody)	
differences in sharply differing speech sounds	
differences in minimal differing speech sounds	Wepman Goldman - Fristoe, et al.
4. Labeling: relating ideas which are received through one or more modes and coded in any one or more modes, i.e.	
KINESTHETIC-TACTILE	
giving gesture in response to picture	ITPA #10
stereognosis: with eyes closed, naming object placed in hand; drawing shape that hand has traced on form board	
VISUAL-AUDITORY	
seeing picture and giving name	
hearing name and pointing to picture	PPVT
hearing description and naming object	
5. Recalling: remembering and recognizing stimuli (short term and long term memory), i.e.	
KINESTHETIC-TACTILE	
remembering movement	
VISUAL	
remembering designs, pictures	MSSST; Detroit #12
AUDITORY	
remembering single events such as day of week, birthday, address	
6. Sequencing: expressing information in a serial progression	
KINESTHETIC-TACTILE	
miming a story	
rhythmic patterns with fine motor skill	

VISUAL	
serial ordering of pictures, designs	ITPA #3; Detroit #9, #10
block tapping	MSSST
picture arrangement	WISC
AUDITORY	
related sounds, words such as days of week, months	MSSST
unrelated words, digits	ITPA #5, Detroit #6
sentence completion	MSSST; ITPA #9
complicated directions	MSSST; Detroit #7, #18
story telling	MSSST

7. Categorizing and Analyzing: combining component parts into whole and separating wholes into component parts, i.e.

VISUAL	
design analysis	Witkin, WISC
disarranged pictures	WISC; Detroit #17
classifying pictures, objects	CMMS; Detroit #19; ITPA #8
pictorial opposites, absurdities	WISC; Detroit #1, #3
AUDITORY	
word analysis; sound blending	ITPA #12; Roswell-Chall
sentence construction with isolated words	
similarities and opposites	WISC; Detroit #4
verbal absurdities	Detroit #2
multiple meanings	

8. Making Analogies: stating logical relationships, making appropriate inferences

VISUAL	
analogies	ITPA #4
matrix puzzles	

AUDITORY

analogies — ITPA #6

metaphors

proberbs

Identification of Abbreviations

CMMS - The Columbia Mental Maturity Scale - Burgemeister *et al.*
ITPA - The Illinois Test in Psycholinguistic Abilities - Kirk *et al.*
MSSST - The Meeting Street School Survey Test - Hainsworth & Siqueland
PPMS - The Purdue Perceptual Motor Survey - Roach & Kephart
PPVT - The Peabody Picture Vocabulary Test - Dunn
WISC - The Wechsler Intelligence Scales for Children - Wechsler

APPENDIX IV

READING, SPELLING, HANDWRITING SKILLS

1. LETTER RECOGNITION: perception of distinctive features of letters (capitals, lower-case, printed, cursive).

    a. open (c - o)
    b. closed (b - h)
    c. lined (v - u)
    d. curved (f - t)
    e. height (h - n)
    f. inversed (m - w)
    g. rotated (b - d)
    h. internal details (h - k)

2. LETTER SEQUENCING: left-right direction. — SLINGERLAND, 1969 (Subtest IV)

    a. Word matching: (pan nap npa pan nag) student sees letter or word on page; marks it.
    b. Visual tracking: Timed letter or word matching. — SMITH, et al., 1962-5
    c. Word matching from memory: Visual stimulus is removed. — SLINGERLAND, 1969 (Subtest III); DURRELL, 1955, #6
    d. Sequential or alphabetic ordering of letters from memory: — DETROIT TEST OF LEARNING APTITUDES, (Subtest XVI)
    e. Letter or word copying: — SLINGERLAND, 1969 (Subtests I, II)
    f. Letter or word copying from memory: — SLINGERLAND, 1969 (Subtest V)

3. LETTER NAMING
   Student sees letter; says letter name. If letter names are known, the student will also know one sound value for the letter. The letter names for h, g, w, y are exceptions. — DURRELL, 1955, #5

4. LETTER CODING
   Student sees letter; says sound value. The student needs to understand that separate phonemes lose their characteristic sound value in combination with other letters: — ROSWELL-CHALL, 1959, #I, II, III, IV

th	-ng
sh	wh
ch, -tch	-dge
ph	-ck

5. MULTIPLE CORRESPONDENCE OF LETTER-SOUND VALUES
A letter will have a highly predictable sound value if it is considered in conjunction with surrounding letters:

sane	sanity
divine	divinity
medicine	medical

6. SOUND BLENDING:
   a. Tester says sound values /k æ t/ for cat. Student says cat. — GATES-McKILLOP, 1965, #7; ROSWELL-CHALL AUDITORY BLENDING TEST, 1956; DURRELL, 1955, #7
   b. Tester says straight. Student isolates sounds at beginning or at end of word.
   c. Tester says straight. Student isolates sounds into sequence /s t r ey t/.

7. VISUAL-AUDITORY INTEGRATION TASKS:
   a. Student sees word; student reads word. — GATES-MacGINITIE, 1965, #1; GATES-McKILLOP, 1962, #2; ROSWELL-CHALL, 1959, (I, II, IV); DURRELL, 1955, #1
   b. Syllabication — GATES-McKILLOP, 1962, #8.3; GATES-MacGINITIE, 1965, #8.3; ROSWELL-CHALL, 1959 (V)

      The student is asked to read "nonsense words" and blend syllables into words.

8. AUDITORY-VISUAL INTEGRATION TASKS:
   a. Tester says letter name; student marks it.
   b. Tester says sound value for letter; student marks letter.
   c. Tester says word; student spells word; marks it. — SLINGERLAND, 1969 (Subtest VIII)
   d. "Nonsense words" — GATES-McKILLOP, 1962, #6.1
      The student is asked to mark the correct word.

9. AUDITORY-VISUAL-MOTOR INTEGRATION TASKS
   a. Tester says words; student writes beginning, ending letter for sound value. — SLINGERLAND, 1969 (Subtest VII)
   b. Tester says letter name, word; student writes it. — SLINGERLAND, 1969 (Subtest VI)

10. WRITTEN COMPOSITION — MYKLEBUST, 1967

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