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AUTHOR Blackman, Leonard S.; Burger, Agnes L.
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ABSTRACT

Efforts to establish what psychological processes make up the framework through which beginning reading skills are developed led to this study, aimed at identifying perceptual, learning, cognitive, memory, and language variables which influence beginning reading of normal and educable mentally retarded children. A total of 172 first-grade subjects, 78 in the normal group and 94 in the retarded group, were chosen on the basis of Peabody Picture Vocabulary Test (PPVT) scores. These children, from 11 New York City schools, were also tested using the Metropolitan Achievement Tests (MAT), the Wide Range Achievement Tests (WRAT), and 17 readiness measures, all composed of verbal material. Factor analysis and other multiple regression procedures were used to analyze the data. Significant differences, attributable to the differences in mental age, were found between the two groups on almost all measures. Among the findings were that (1) auditory and visual skills were dominant for the retarded group, (2) only auditory skills were pertinent for the normal group, (3) a visual wordness subtest was the best predictor for the retarded group, and (4) a learning sample subtest correlated with skill acquisition for both groups. Tables and a 130-item bibliography are included. (MS)

INTERIM REPORT

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# PSYCHOLOGICAL FACTORS RELATED TO EARLY READING BEHAVIOR OF EDUCABLE MENTALLY RETARDED AND NORMAL CHILDREN

Leonard S. Blackman and Agnes L. Burger
Research and Demonstration Center
for the Education of Handicapped Children
Teachers College, Columbia University
New York, New York

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Department of Health, Education, and Welfare

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On the following pages, please note, stepwise regression analysis should be read as forward selection analysis:

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lines 7, 20, 25

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## INTRODUCTION

This study has evolved from what has been a continuing effort to establish those psychological processes which seem to represent the underlying structural framework on which beginning reading skills are developed. Numerous studies have implicated a wide variety of readiness factors which have evidenced moderate relationships with reading achievement. The three research paradigms which in the past have been employed to identify these factors are: comparisons of good and poor readers; correlation of readiness factors with a reading criterion; and factor analytic techniques. Efforts to upgrade reading achievement by the remediation of readiness deficits, however, have not proven to be conspicuously successful (Rosen, 1966; Niles, 1967; and Warner, 1968). Hence, despite the considerable research attention focused in this area, both the validity of currently identified readiness factors as well as the role they play in the acquisition of reading skills bear further clarification.

The purpose of this study has been a more comprehensive attempt to identify, through factor analytic and other multiple regression procedures, those perceptual, learning, cognitive, memory, and language variables, which appear to cluster with and predict a reading criterion. Equally important, the topography of readiness variables essential to reading competence has also been explored by comparing the factor structure obtained with a sample of normal children to that obtained with an educable mentally retarded group.

# PSYCHOLOGICAL FACTORS
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## REVIEW OF THE READING READINESS LITERATURE

In reviewing studies of readiness and achievement in reading, two convenient categories can be established. These may be described as: 1) comparative studies which compare and contrast the reading readiness skills of "good" and "poor" readers; and 2) predictive studies which determine relationships between tasks of reading readiness at a pre-reading level and reading achievement at the end of first grade or in subsequent grades. In this second category, the statistical techniques employed in data analysis are correlational analysis and factor analysis which were separately noted in the Introduction. As the research studies reviewed here tend to use these two techniques concurrently, they are discussed together.

With regard to comparative studies, there are generally two techniques used to determine the relationship between reading readiness and reading achievement in "good" and "poor" readers. In one technique, comparisons are made of group differences between adequate and inadequate readers or between intellectually normal and retarded pupils. In the other method, pairs of subjects are matched in terms of certain variables and the discrepancies in reading abilities compared.

In an early study using the group comparison technique, an attempt was made to determine whether children of equal MA but of markedly different CA and IQ tended to achieve about the same reading level (Bliesmer, 1954). The criteria for the "bright" group and "dull" group were an estimated Stanford-Binet IQ of 116 or above and 84 or below, respectively. The sample, containing 28 subjects in each group, was selected from the public school system. The subjects were matched in MA, 10-8 through 12-6; the mean CAs for the "bright" and "dull" groups were 9-3 and 15-5, respectively; the mean IQs for the two groups were 126.5 for the "bright" group and 79.5 for the "dull" group. Criterion test materials were geared at tapping reading comprehension abilities at the fourth- to fifth-grade level. A "group-by-levels" analysis of variance design was used in analyzing data where the "levels" were constituted by six-month intervals over the two-year MA range. Significant differences in favor of the "bright" over the "dull" groups were obtained for the following five abilities: 1) total comprehension abilities; 2) location or recognition of factual details; 3) recognition of main ideas; 4) drawing inferences and conclusions; and 5) listening comprehension.

The reading processes of 20 Caucasian educable mentally retarded boys and 30 normal boys with MAs within the limits of 8-0 to 10-0 were investigated by Dunn (1956). The subjects, selected from the public school system. had mean CAs of 13-3 and 8-10 for the retarded and normal boys, respectively. In addition to nine standardized reading and arithmetic achievement tests, tests of ability to use context cues as well as eye movement, auditory and visual acuity, and speed in recognizing tachistoscopically presented printed material were administered. $\underline{t}$ tests on mean comparisons showed that the normal group performed significantly better than the retarded group on 1) all measures of silent and oral reading, 2) ability to use context cues, 3) oral spelling ability and 4) auditory and visual acuity. On analysis of reading errors, the normal group had significantly more repetitions and additions of sounds; the retarded group had significantly more faulty vowels, omissions of sounds, and words aided and refused.

School children were compared with retarded hospitalized patients by Meyers, Dingman, Attwell, and Orpet (1961) in an attempt to determine whether systematic differences would appear between the two groups on reading related variables. Subjects were 50 boys and 50 girls within three months of their sixth birthday with mean IQs of about 108. The 100 retarded subjects were under 18 years of CA and had MAs between 4-5 and 7-5. The thirteen-test battery represented four factors: hand-eye skill, perceptual speed, linguistics, and non-verbal reasoning. Three tests were devised for each of the four factors; the thirteenth was a digit-span test. The means of the normal group significantly exceeded those of the retarded on all variables but one of the linguistic measures, expressive vocabulary. The investigators of this study, however, emphasized that this linguistic measure only involved words as units while complex language structure and verbal reasoning were not included.

A recent study analyzing group differences was reported by Crawley, Goodstein, and Burrow (1968). In their investigation, information was obtained pertaining to reading and psychomotor characteristics of two samples, retarded and average children, each with subgroups of good and poor readers. The MAs of the retarded and normal groups were 9 and 10 years, respectively; the CAs of the two samples were 13 years for the retarded and 10 years for the normal. All subjects were administered tests measuring reading abilities, psychomotor processes, visual and auditory attention, associative learning, language development, visual retention, and lateral dominance. Structural components were obtained through a principal components factor analysis. Four factors were identified: a) reading and language characteristics, b) an associative learning factor, c) perceptual development characteristics, and d) letter and word recognition errors. Some of the conclusions of this study were as follows: a) on a majority of measures retarded and average children did not tend to differ significantly; b) the performance of good readers among retarded and average children approximated their MAs; poor readers of both groups performed 2 1/2 years below their MAs; c) measures of reading rather than psycho-motor characteristics frequently differentiated between good and poor readers; and d) specific deficits were difficult to identify and no particular group patterns were observed, but children who were inadequate in one area seemed to be inadequate in others as well.

A study involving the use of the matched-pairs technique was reported by Shotick (1961). This investigation compared the performance of mentally retarded and normal subjects on reading comprehension and related tasks. For the retarded group, IQs ranged from 61 to 76 and for the normal group, from 94 to 107. The retarded and normal subjects were matched individually on the bases of MA (retarded $\overline{MA}$ = 105.36 months; normal $\overline{MA}$ = 104./3 months), socio-economic status, visual perceptual difficulties, race and sex. Tasks of reading comprehension included utilization of context cues, interpretation of figurative language, locating factual information, selecting the main idea, sequential ordering, and classifying and indexing ideas. Seven performance tasks, taken from standardized tests, were included. Statistical analysis by t ratio indicated a significantly superior performance by the normal group on all reading tasks but no significant differences between the normal and retarded groups on any performance task.

Another investigation of reading process using a similar technique of matched-pairs was reported by Sheperd (1967). Twenty pairs of Caucasian educable mentally retarded boys, whose mean CAs ranged from 7-0 to 10-0, were matched on reading age and MA (mean = 8.5). Subjects were classified either as adequate or inadequate readers based on the deviation of reading age from MA. Using Chi-square and t test techniques, the retarded and normal groups were differentiated more on measures directly related to reading than on social and emotional adjustment. The differences seemed to center around the inadequate readers' lack of word-attack skills: faulty vowels and consonants, reversal errors, omission of sounds, substitution of words, sound blending, and the use of contextual clues.

Reading readiness studies concerning the predictive relationship of performance on specific tasks during the pre-reading period to subsequent reading achievement in the first grade have received considerable attention. One of the first major studies was a dissertation by Deputy (1930). Data for this investigation were based on 103 first graders in a New York City public school. Five tasks were used to predict reading achievement: the Pintner-Cunningham Primary Mental Test, visual-visual association, word selection, visual-auditory association, and content comprehension and recall. These tests were administered during the first four weeks of the semester. The reading achievement tests consisted of the Detroit Word Recognition Test and two other tests constructed by the investigator based upon the vocabulary which the subjects had studied. Reading achievement was measured during the thirteenth week and again during the eighteenth week of the semester. Among the five tests of reading readiness, the Pintner-Cunningham Mental Test produced the highest correlation (.70) in predicting first-grade reading achievement as measured by the composite score on the three tests of reading achievement. The other four correlations of readiness tests with the criterion were .52, .49, .39, and .37, respectively.

Gates has conducted extensive research on reading readiness from 1930 to 1940. One of the more comprehensive studies in which the results of a number of previous investigations were included was reported by Gates, Bond, and Russell (1939). Using 97 first graders from four New York City public school classes, they administered examinations, ratings, and tests covering appraisals of intelligence, auditory acuity and discrimination, visual acuity and discrimination, reading readiness (a series of standardized tests), phonic abilities, memory, alphabet and word recognition, story completion, speech, hand- and eye-dominance, reading achievement, and home background and personality traits. The tests were given shortly after the pupils entered the first grade, and then repeated at mid-term and again at the end of the year. Half of these subjects were retested at the beginning of the second year. Means of the correlation coefficients for those variables which were deemed best for predicting reading progress were: 1) tests of word recognition, .59; 2) tests of ability to complete a story, .54; 3) tests of giving rhyming words, .43; 4) Stanford-Binet MA, .40; 5) tests of blending word sounds given orally, .38; 6) tests of reading letters of the alphabet, .31; 7) ratings of previous instruction in reading, .23.

In the process of standardizing her Reading Aptitude Test, Monroe (1935) administered 15 readiness tests to 434 children in the primary grades. In the case of 85 first graders, correlation coefficients were computed between the child's composite percentile scores on each of the major types of readiness tests and his grade scores at the year-end. No correlations were computed, however, for the individual tests. Correlations between reading and the composite scores in seven areas were as follows: 1) auditory, .66; 2) visual, .60; 3) articulation, .57; 4) intelligence (Detroit Intelligence Test), .57; 5) motor, .50; 6) language, .50; and 7) laterality, .18. The correlation between reading grade score and total percentile score on reading readiness was reported to be .78.

Five readiness factors which may influence reading achievement were investigated by Petty (1939). The study used 102 first graders in the Austin public schools. The results were as follows: 1) a correlation between reading achievement and MA was found to be .52; 2) a correlation of .48 was found between children's drawings as measured by the total score on Forms A and B of the Peck and Manuel's Non-Language Prediction Test and reading achievement; 3) the condensation of the Lee-Clark Reading Readiness Test provided two measures of ability to deal with the symbols used in reading: time required to complete the tests and accuracy as indicated by the scores; correlations of these two measures with reading achievement were .40 and .44, respectively; 4) definite conclusions were impossible to be drawn between susceptibility to illusions and reading achievement; and 5) the median of a number of correlation coefficients between reading achievement and the presence of eidetic ability was .26.

A study reported by Steinbach (1940) was conducted during the school year of 1938-1939. The subjects used in the study were 300 first grade pupils from nine parochial schools in Milwaukee and vicinity. Readiness tests measuring the following abilities were administered: intelligence, range of information, vocabulary, auditory discrimination, visual discrimination of letters and words. These readiness tests were administered at the beginning of the school year. The reading grades were computed in the mid-year and then again at the end of the year. Multiple correlation techniques were used to study the relationship between reading readiness and achievement. Significant correlations between the measures of reading readiness skills and reading-grade scores were listed in rank order as follows: 1) information, 2) auditory discrimination, 3) MA, 4) visual discrimination, and 5) vocabulary knowledge.

To determine whether a Reading Prognosis Test could be constructed to predict reading ability based on the child's present reading status and a knowledge of his socio-economic status, Weiner and Feldmann (1963) administered eight subtests covering the areas of language, perceptual discrimination, and beginning reading skills to 126 first grade pupils from six schools in New York City. The Reading Prognosis Test was given in October of the school year. In June of the same school year, two subtests of the Gates Primary Reading Test: Sentence Reading and Paragraph Reading were administered to the same group of children. Language subtests (Word Meaning and Story-telling) yielded $R^2$s of .56, .43, and .41 for the total group (Total), low socio-economic status group (LC), and middle socio-economic status group (MC), respectively. The perceptual discrimination subtests (Auditory Discrimination, Visual Discrimination, and Visual Similarities) resulted in $R^2$s of .76, .78, and .71 for the Total, LC, and MC groups, respectively. Beginning reading skills subtests (Capital Letters, Small Letters, and Sight Vocabulary) yielded $R^2$s of .85, .77, and .81 for the Total, LC, and MC groups. The correlations of the total scores on the Reading Prognosis test and the Paragraph Reading test ranged from .72 for the LC Negro female group to .89 for the MC white male group. The correlations of the total scores on the Reading Prognosis and the Sentence Reading test varied from .61 for the MC Negro female group to .88 for the MC white female group. Based on these results, the authors concluded that poor readers and their specific reading deficiencies can always be identified irrespective of their socio-economic status.

The readiness variables used by Silvaroli (1964) in his investigation were MA, auditory discrimination, visual discrimination, letter identification. social class status, and maternal need achievement. Eighty-five subjects were administered readiness tests and their mothers were given need achievement and projective tests. Multiple correlations and regression equations were computed to identify factors which could predict first grade reading success as defined by the criterion variable of the Gates Primary Reading Test. The results indicated that a measure of upper and lower case letter identification can be used to predict reading achievement as well as all or any combinations of the other readiness factors in this study.

The predictive measures selected by Alshan (1965) for his study were: visual discrimination, visual-motor coordination, oral language proficiency, auditory discrimination, and auditory blending. These tests were administered to eighty-two children in the middle of the first grade. Before the tests were given, teachers' ratings of pupils on a five-point scale were recorded. These ratings included three aspects of reading ability: word recognition, phonics, and comprehension. They also included six variables suspected to be predictive of reading success: gross motor coordination, fine motor coordination, ability to understand English, ability to speak English, ability to pay attention, and general intelligence. At the end of the first grade, the Gates Primary Word Recognition Test and a test of knowledge of letter names and sounds were administered. Multiple correlations were computed on all test scores and rating scales. A principal components analysis followed by varimax rotations were carried out to determine what factors were most predictive of first grade reading achievement as defined by the outcome variables. The five factors which predicted first grade reading as measured by the Gates Primary Word Recognition Test were, ranking from highest to lowest: 1) Factor 2, auditory blending and consonant combination; 2) Factor 1, teachers' ratings--excluding gross motor coordination; 3) Factor 5, visual discrimination; 4) Factor 4, letter names and consonant sounds; and 5) Factor 3, oral language proficiency.

The most recent predictive study conducted on reading readiness was by de Hirsch, Jansky, and Langford (1966). The sample for their investigation was selected from children who had participated in the Fetal Life Study carried out at Babies Hospital, Columbia-Presbyterian Medical Center, New York City. Fifty-three subjects were chosen based on the following criteria: 1) CAs between four and five; 2) IQ range from 84 to 116; 3) English was the predominant language spoken in the home; and 4) no significant sensory deficits were present. Thirty-seven tests, tapping sensorimotor, perceptual, and linguistic functions, were administered when the subjects were in kindergarten. These tests were both adapted from standardized instruments and devised by the authors. At the end of the first grade, the subjects were tested in writing and reading (the Gates Sentence and Paragraph and the Gray Oral Reading tests). At the end of the second grade, the subjects were administered tests in writing, reading (the Gates Advanced Primary and the Gray Oral Reading), and spelling; in addition, four items from the kindergarten test battery were readministered. Correlations between the kindergarten tests and end-of-second-grade performance were computed. An overall reading performance index (ORP Index) was developed as a single measure of reading achievement at the end of the second grade by combining the scores obtained from the Gates Advanced Primary and the Gray Oral Reading tests. Nineteen of the 37 tests which were significantly related to the ORP Index and their respective correlation coefficients were as follows: Behavioral Patterning, .46; Fine Motor Patterning:

Pencil Use, .34; Body Image: Human Figure Drawing, .23; Visual-Perceptual Patterning: Bender Visuo-Motor Gestalt, .44; Auditory-Perceptual Patterning: Tapped Patterns and the Auditory Discrimination (Wepman), .30 and .26, respectively; Expressive Language: Story Organization, Number of Words, and Categories, .28, .40, and .24, respectively; Reading Readiness: Name Writing .43, Letter naming .55, Reversals (Horst) .36, Word Matching (Gates) .35, Word Rhyming (Gates) .22, Word Recognition I (Pack) .40, Word Recognition [illegible] (Table) .48, and Word Reproduction .42; and Style: Ego Strength and Work Attitude, .48 and .43, respectively.

In conclusion, comparison studies differentiating between groups of adequate and inadequate or intellectually normal and retarded readers seemed to bear evidence that the group differences lie in measures of reading skills rather than in sensorimotor characteristics. A number of deficiencies in reading skills occurred frequently, namely: 1) reading comprehension which included locating factual details, recognizing main ideas, drawing inferences as well as making conclusions; and 2) word attack skills in faulty vowels and consonants, reversal errors, omission of sounds, substitution and addition of words, and the use of contextual cues. Predictive studies which have attempted to determine relationships between reading readiness during the pre-reading period and the subsequent reading achievement have reported correlation coefficients ranging approximately from .20 to .75. Reading readiness tasks which were reported as relatively high in predicting reading achievement were: letters and word identification, visual discrimination, auditory discrimination, expressive language, intelligence, and vocabulary knowledge.

## RATIONALE FOR TEST SELECTION

### Auditory Blending Test

Auditory blending has been shown to be a significant factor related to success in beginning reading. Despite the findings reported by Gates and Bond (1936) and Reynolds (1953) suggesting no relationship between tests of auditory blending and reading ability, strong evidence to the contrary exists. Bond (1935) found significant differences between groups of good and poor readers in several measures of auditory blending. In a similar study by Gates (1939) on the degree of phonetic emphasis in reading instruction, correlations between skills in blending ability and reading achievement ranged from .10 to .54. Mulder and Curtin (1955) found a significant correlation coefficient of .44 between a measure of auditory blending and general reading ability. This result was confirmed by Chall, Roswell and Blumenthal (1963) who reported a positive relationship between auditory blending ability and oral and silent reading ability. The correlation coefficients between auditory blending test scores and various tests of reading achievement obtained when the subjects were in first through the fourth grades ranged from .26 to .66. Moreover, Chall et al. stated that auditory blending ability related most highly to achievement in word analysis skills. In a factor analytic study by Alshan (1965), auditory blending was found to be an important predictor of first grade reading achievement. This result substantiated the observations and findings of Monroe (1932), Orton (1937) and Vernon (1960) that an inadequacy in the ability to blend sounds is one of the major characteristics of children with reading disability.

<u>Auditory Discrimination Test</u>

The relationship of auditory discrimination and reading achievement was investigated in a number of studies. Goetzinger, Dirks, and Baer (1960) reported significant differences between groups of "good" and "poor" readers on the word-pair discrimination task. Earlier comparison studies of a similar nature all demonstrated significant differences between these two groups of readers in auditory discrimination tasks (Monroe, 1932; Bond, 1935; and Wolfe, 194[illegible]).

Other studies using only disabled readers have shown conflicting results regarding auditory discrimination as one of the causal factors in reading disability. Based on observations of backward readers over a period of eight years, Schonell (1948) stated that only 38 per cent of these children demonstrated some degree of deficiency in auditory discrimination. Poling's investigation (1953) indicated that the subjects' levels of performance on auditory discrimination tasks bore no relationship to the type and frequency of errors committed in word recognition.

Studies of intellectually normal pupils reported positive relationships between auditory discrimination and reading achievement; correlation coefficients obtained from these studies ranged from .22 to .56 (Reynolds, 1953; Durrell and Murphy, 1953; Wheeler and Wheeler, 1954; and Templin, 1954). Predictive studies on performance of auditory discrimination tasks during the pre-reading period and subsequent success in first grade reading reported positive relationships ranging from approximately .20 to .60 (Monroe, 1935; Gates, Bond and Russell, 1939; Steinbach, 1940; and Dykstra, 1966). Because the majority of the research evidence suggested that ability in auditory discrimination contributes to adequacy in beginning reading, it was included as one of the predictive readiness factors in the present investigation.

Auditory Memory Test

Several studies have investigated the relationship between short-term auditory memory span and reading ability. Bond (1935) reported significant differences between groups of "good" and "poor" readers in auditory memory for digits. Reynolds (1953) found significant correlations between various silent reading test scores and tests of auditory memory. Poling (1953), in a study of auditory deficiencies of poor readers, concluded that there was a positive relationship between auditory memory span and development of adequate word recognition. Rose (1958) found that children referred for diagnosis of reading difficulties seemed to have higher failure rates on auditory memory span tests than children of average reading ability.

A number of studies used verbal material in assessing short-term auditory memory span. Dale and Chall (1948) reported a correlation coefficient of .47 between length of sentence recalled and reading comprehension. Other investigators, however, indicated that this relationship could be modified by such factors as "naturalness" of word order (Selfridge, 1950; Marks and Jack, 1952; Nichols, 1965) and familiarity of vocabulary (Nichols, 1965).

In view of the above research findings, two types of test material were used to investigate auditory memory. These were memory for letters and memory for sentences tests.

Visual Analysis and Visual Synthesis Tests

The importance of visual analysis and synthesis in reading behavior can readily be seen in children's ability to discriminate identical letters which differ only in spatial position, e.g., reversals and inversions (Wohlwill, 1960; Wohlwill and Wiener, 1964). The processes of visual analysis and synthesis were studied by Birch and Lefford (1964, 1967). In the 1964 study of five to 18 year-old normal and cerebral-palsied subjects, these investigators reported that the cerebral-palsied group performed significantly poorer in both visual analytic and synthetic abilities than the normal group. While both groups showed development with increased age, the normal group attained the maximum visual analysis task score at age 12 whereas the cerebral-palsied group only started to approach the maximum by age 18. On visual synthesis tasks, the normal group developed this ability with increasing age but no such trend could be established in the cerebral-palsied group. Their 1967 study on perceptual functions was carried out with normal children whose ages ranged from five to 11. It was found that visual analytic ability improved with increasing age but that the improvement occurred most rapidly between the ages of five and eight. The correct responses increased with age with regard to directionality and parallelism. Visual synthesis ability also increased with age. Two aspects of the visual synthetic task which seemed to control difficulty level were directional orientation and the linear dimensions of the presented elements.

Since the present investigation has included both mentally retarded and normal subjects whose ages ranged from five to 12, it is of interest to tap the level of their visual analytic and synthetic development and to explore the relationship between these perceptual functions and reading achievement.

Visual Discrimination Test

The positive relationship between visual discrimination and reading achievement has been evidenced by numerous reading readiness studies as reviewed by Barrett (1965a). The relative predictive power of various measures of visual discrimination, however, bears consideration in order to select one or an optimum combination of these tests which best predicts reading achievement.

With the exception of the studies by Potter (1949), Goins (1958), Ashlock (1964), and Barrett (1965b), most research results indicate that visual discrimination of letters and words is a better predictor of reading achievement than geometric or pictorial designs (Deputy, 1930; Wilson and Burke, 1937; Gates, Bond and Russell, 1939; Gates, 1939, 1940; Wilson, 1942; Gavel, 1958). Comparisons made on discrimination of letters and words as predictors of reading achievement appear inconclusive. Discrimination of words was reported to be a better predictor than discrimination of letters (Gates, Bond and Russell, 1939; Gates, 1939, 1940; and La Pray, 1962). On the other hand, the contrary was also found (Smith, 1928; Lee, Clark and Lee, 1934; Wilson and Flemming, 1940; Wilson, 1942; Olson, 1958; Gavel, 1958; Weiner and Feldmann, 1963; and Barrett, 1965). Moreover, on the basis of the reports of Steinbach (1940) and Potter (1949), no difference exists between the use of words and letters to predict reading achievement.

In view of the above research findings, the present investigation includes both discrimination of letters and words in the test battery. This approach is in agreement with positions held by Goins (1958), Weiner and Feldmann (1963), Barrett (1965b), and Shea (1968) that a combination of tasks requiring discrimination of letters and words tends to best predict reading achievement.

Visual Embedded Figure Test

The relationship between figure-ground and reading achievement is reminiscent of Piaget's developmental theory of perceptual schematization and perceptual reorganization (Elkind, 1967). The whole-part schematization is related to reading in that the reader must recognize individual letters as units as well as the construction of words by letters. A study of the perceptual development of whole-part coordination reported the following: 1) the ability of children to perceive the parts and the whole of a figure increases with age; 2) parts are perceived at an earlier age than the whole; and 3) part-whole integration is present in 75 per cent of children by age nine (Elkind, Koegler and Go, 1964).

Perceptual reorganization of a figure-ground reversal is important in learning phonics in that the reader must realize that the same letter can represent more than one sound depending on the context. Elkind, Larson and Van Doorninck (1965) reported that, in a sample of 60 third through sixth graders, slow readers were significantly less adept in their ability to reverse figure and ground in comparison to average readers of matched sex and intelligence.

Because of the close relationship between perceptual development and reading achievement, and because the subjects of the present study ranged from six to 12 in age when the perceptual processes of schematization and reorganization take place, the task of figure-ground perception was included in the present investigation.

Visual Memory Test

Studies of the relationship between visual memory ability and reading achievement appear inconclusive. Kendall (1948), based on the performance of children six to 16 years of age, reported that there was no significant correlation between visual memory and reading. Similarly, Sheperd (1967) found that visual memory ability did not discriminate between "adequate" and "inadequate" mentally retarded readers ranging in age from nine to 19 years. However, findings to the contrary have also been reported. Waters' (1961) study of second graders showed that there was a significant difference in visual memory between readers with "high" and "low" reading ability. Confirmation of Waters' results was reported by Sutton (1963) with eight- to 11-year-old educable mentally retarded "high" and "low" readers and by Song and Song (1969) with "high" and "low" groups of institutionalized mentally retarded readers 15 and 16 years of age.

Because of the contradictory research findings, the present investigation has included a visual memory test in order to explore further its relationship with reading achievement.

Visual Wordness Test

This test was designed on the premise that a child who recognizes the ideographic structure of his language has achieved a higher stage of reading readiness than a child who does not recognize this structure. The development of this ability may be a function of the frequency with which children are exposed to written material in their everyday environment. On the other hand, failure to recognize the ideographic structure of English could be attributable to an incidental learning deficit. Regardless of the etiology of this deficit, it is suggested that children who have reached this stage of development are more likely to benefit from reading instruction than those who have not.

Auditory-Visual Test

The importance of auditory-visual integration in learning to read has been frequently stressed (Birch and Bitterman, 1949, 1951; Rabinovitch, Drew, DeJong, Ingram, and Withey. 1954; Birch, 1962; Birch and Lefford, 1963; MacGinitie, 1967). This construct has been explored by several research studies. In a study of normal and retarded nine- and 10-year-old readers, Birch and Belmont (1964) found that judgments of auditory-visual equivalence were significantly poorer in retarded readers than in normal readers. Within each of these two groups, children with lower auditory-visual test scores were reported to have lower reading achievement test scores. This supported earlier findings by Katz and Deutsch (1963), among third and fifth graders; namely, that retarded readers performed more poorly on tasks requiring modality shifts than normal readers. Furthermore, Beery (1967) reported that the performance of dyslexic children, ranging in age from eight to 13 years, was significantly inferior to that of their normal controls on auditory-visual integrative tasks.

However, later findings by Birch and Belmont (1965) with normal children ranging in age from five to 12 years showed that a strong relationship between auditory-visual integration test scores and reading skills existed only in young children between the ages of five and seven. This relationship declined as a function of increasing age and essentially became asymptotic by the fifth grade. The trends observed in the inter-grade comparisons are compatible with those of Bryan's (1964) investigation which found that the power of visual-perception test scores to predict reading achievement decreased with increasing age-grade placement. Using only first graders, Muehl and Kremenak (1966) reported that the ability to relate information from the auditory to the visual sense was significantly associated with later reading achievement.

Contrary results relative to the role of auditory-visual integration in the reading process with increasing age were found by Sterritt and Rudnick (1966) and Rudnick, Sterritt, and Flax (1967). They held that general intelligence and auditory-visual cross-modal perceptual abilities become more important in reading achievement at the third-to fourth-grade level. Kahn and Birch (1968), in an effort to resolve the discrepancy of the observed opposing age trends, added 10 items to the Birch-Belmont auditory-visual test in order to remedy the possible attenuating effect of a low-age ceiling. A significant relationship between auditory-visual scores and reading comprehension was reported for boys in grades two through six; the correlation coefficients ranged from .42 to .49. Auditory-visual integrative performance was also found to be related to reading skill when the effects of IQ were partialled out. Ford (1967), using a modified version of Kahn's (1965) 20-item auditory-visual test with fourth graders, found a low but significant relationship between the auditory-visual task and reading achievement. The above studies demonstrate that, regardless of the age-specific competence controversy, a relationship exists between reading achievement and the ability to make judgments of auditory-visual equivalence.

Visual-Motor Organization Test

The relationship between reading achievement in the primary grades and visual-motor perceptual skills, measured by the Bender-Gestalt Test, has been extensively investigated as reviewed by Billingslea (1963). With a few exceptions, most research studies dealt with normal beginning readers. Keogh (1963,1965) found that when intelligence was held constant, the correlation was negligible between the Bender-Gestalt Test performance of kindergarten children and their later third grade achievement. Earlier, however,Smith and Keogh (1962) obtained a significant correlation between the Bender-Gestalt Test scores, reading readiness, and reading achievement measures of kindergarten children. Their findings were substantiated by Strauss and Lehtinen (1947), Harriman and Harriman (1950), Justison (1960), and Lachman (1960). In a study of first to fourth graders on problems in visual-motor perception, the Bender-Gestalt Test has been found to discriminate significantly between pupils of above and below average achievement (Koppitz, 1958, 1960). Additional studies with similar samples by Koppitz (1959, 1961, 1964) have shown a significant correlation between the Bender-Gestalt Test and reading achievement.

Comparatively few studies dealt with mentally retarded and gifted children. Keller (1955), in a study of institutionalized mentally retarded boys (IQ 50-90), found a significant relationship between performances on the Bender-Gestalt Test and reading achievement. Findings contrary to this were reported by Cellura and Butterfield (1966) who administered the Bender-Gestalt Test to mildly retarded institutionalized adolescents and found no difference between "high" and "low" reading groups. Results similar to those of Cellura and Butterfield (1966) were obtained by Song and Song (1969). The only study regarding the relationship of reading achievement to visual-motor perceptual development among gifted primary pupils was carried out by Chang and Chang (1967). A positive and significant relationship was indicated.

Since the research findings on the relationship between performance on the Bender-Gestalt Test and reading achievement are essentially in agreement, a visual-motor perceptual ability test using letters has been included in the present investigation.

Visual-Tactile Test

The relationship between visual-tactile intersensory integration and reading achievement has been largely neglected in research. Only two studies exploring this relationship are known to the present investigators. Buchner (1964), in a study of 110 fourth graders, found significant relationships between visual-tactile performance, intelligence, and school achievement; correlation coefficients, ranging from .56 to .87, were all significant beyond the .01 level. Ford (1967) replicated Buchner's study on 121 male fourth graders, but was unable to substantiate his results. The correlation coefficients, ranging from .02 to .17, were too low to be interpreted meaningfully. In view of this ambiguity and the obvious need for more data, a visual-tactile test is included in the present study.

Conceptual Categorization Test

One aspect of children's cognitive development is their capacity to categorize. This categorizing ability appears related to academic learning behavior of children (Formanek and Morine, 1968). Research studies of categorizing ability with regard to color, size, and form are here discussed with special emphasis on the relative importance of these abilities at various stages of the child's development.

White (1965) found that children's shift from "color-dominance" to "form-dominance" as a basis for categorization takes place around age six. After six, children prefer form over color most of the time. Partially conflicting results were reported earlier by Brian and Goodenough (1929) and Colby and Robertson (1942). The latter two investigators indicated that children, prior to age three, choose predominantly on the basis of form but that during the period from three to six years of age, color provides the principal cue. In partial support of the above studies, House and Zeaman's (1963) data on three to eight year-old retarded children showed that choice by form or color was equally frequent in the three to five MA range, but that the choice by form increased to 60 per cent in their older subjects. Form, color and size were used as possible sorting principles in a study reported by Kagan and Lemkin (1961). Subjects ranging in age from three to eight were divided at the median into "young" and "old" groups. The results indicated that form was preferred over color, and color in turn was preferred over size for both groups combined. For boys, there was no age difference in this response pattern, but "older" girls were found to use color as a basis of classification less than "younger" girls.

The Weigl-Goldstein-Scheerer Color Form Sorting Test was used as an evaluative instrument in all the following research studies. Reichard, Schneider and Rapaport (1944) reported results contrary to the above findings. They held that form sortings predominate over color sortings in children below five years of age. They also found that this group of children does not shift from one grouping principle to another. However, among their eight year-olds 75 per cent were capable of using both form and color sortings and of shifting from one grouping principle to another. With regard to mentally retarded subjects, Halpin's (1958) data showed that the ability of seven-to 14-year-old children to sort on the basis of more than one grouping principle exhibited a slow non-linear increase with both CA and MA. Parenthetically, even at the upper age levels only 20 per cent were able to categorize by more than one sorting principle. The mentally retarded children of this sample were attracted more by color qualities.

In light of the apparent importance of categorizing behavior to reading, some clear indications of its transitional nature at age six, and previous ambiguous data, a Conceptual Categorization Test was included in the present investigation.

Learning Sample Test

Learning, or the process of acquiring new behavior, is generally agreed to result from practice or training. As a child learns to read, numerous opportunities for associating the printed to the spoken word are required. Hence, the efficiency with which these associations develop can be defined as a function of learning rate or the number of practice pairings required. On the basis of the potential of this variable for predicting reading achievement, learning rate, as measured by trials to criterion on a verbal paired-associate task, was included.

Oral Language Test

In spite of disagreement as to the extent and nature of the relationship between competent use of language and reading achievement (McCarthy, 1954; Martin, 1955; and Winter, 1957), most studies recognize that reading is primarily a linguistic process as reviewed by Hildreth (1964). Research investigating the relationship between various aspects of language development and reading performance have found that disabled readers also exhibited language deficiency irrespective of the origin, e.g., bilingualism, socio-economic status or intelligence (Singer, 1956; McCanne, 1966; Ching, 1968; Ching, 1969). Parallel results have recently been reported with intellectually normal children. Vernon (1960) analyzed the WISC protocols for a small sample of poor readers and noted that a majority scored considerably lower on verbal tasks than on performance tasks. Alshan (1965) found a positive correlation between oral language proficiency and reading. de Hirsch (1966) reported decidedly inferior oral language among failing readers. These reports fully substantiate earlier findings implicating language as a factor in learning to read (Monroe, 1932; Buckingham, 1940; Kirk, 1940; Schonell, 1942; Tireman, 1945; Durrell, 1956).

## METHOD

Sample

Subjects were chosen from eleven public schools mostly in the disadvantaged areas in the borough of the Bronx, New York City. The sample size was limited by the 1968 teachers strike which forced a delay in school opening and consequently a shortened pretest period. Hence a group of 125 apparently normal subjects was chosen from the first grade entrants in September, 1968. The group of 125 educable mentally retarded subjects was selected through examination of records in the district offices as well as in the prospective schools. Of the retarded subjects chosen, all met the following criteria: 1) each child was examined and declared eligible for special classes by a certified psychologist; and 2) no significant sensory-motor deficits were present.

The Peabody Picture Vocabulary Test (PPVT) was administered to all subjects to obtain IQ and MAs. Based on these scores, 39 subjects were discarded so that the IQ range of the mentally retarded children was 30-80 and that of the normal children was 75-125. Another 39 subjects were discarded for reason of absence from one or more of the series of tests or withdrawal from school. In the final data analysis, 172 subjects were included, of which 78 were in the normal group and 94 were in the retarded group. Moreover, since about half of both the normal and retarded subjects were bilingual, the minimum IQ and MA levels for subject selection were lowered considerably. Although this procedure allowed for their possible English deficiency, some overlap between groups resulted. Subjects who spoke no English were not included in the sample. Descriptive data for the two samples appear in Table 1.

Table I

SUMMARY DATA FOR CA, IQ AND MA

| | | Mentally Retarded | Normal |
|---|---|---|---|
| | $\bar{X}$ | 9.34 | 6.50 |
| CA | S.D. | 1.16 | 0.41 |
| | Range | 6.25-12.08 | 5.08-7.92 |
| | $\bar{X}$ | 55.73 | 100.65 |
| IQ | S.D. | 12.72 | 11.47 |
| | Range | 31-78 | 71-123 |
| | $\bar{X}$ | 4.77 | 6.57 |
| MA | S.D. | 1.12 | 0.93 |
| | Range | 2.92-7.00 | 4.58-9.08 |

## Instruments

The test battery employed in this study was comprised of an intellectual appraisal, the Peabody Picture Vocabulary Test (PPVT); two criterion reading achievement measures, the Metropolitan Achievement Test (MAT) and the Wide Range Achievement Test (WRAT); and 17 readiness instruments evaluating a variety of perceptual, learning, cognitive, memory, and language abilities. These readiness tests were composed of only verbal material.

PPVT (Form B) School records of IQs for the mentally retarded children were not always complete. In many instances, the name of the test, the date when the test was administered, and the IQ scores were missing. IQ scores for intellectually normal subjects were not available. For this reason, a uniform easily administered IQ measure for all subjects was needed. PPVT was chosen despite recent controversies as to its validity as an estimator of IQ or verbal intelligence (Dunn, 1965; Rice and Brown, 1967; Brown and Rice, 1967; Carr, Brown and Rice, 1967; Mueller, 1969).

MAT (Primary I Battery) Three MAT subtests were used to appraise reading achievement level: Word Knowledge, Word Discrimination, and Reading.

WRAT The Reading subtest of the WRAT was also administered because it provided for a lower basal level for subjects who were deficient in reading.

Auditory Blending Test This test tapped the ability to blend two- and three-phoneme words. The entire test consisted of three sets of cards; each set contained five cards and each card depicted an object pictorially. The subject was presented the set of five cards spread out in front of him. Simultaneously with the card presentation, the name of one of the five objects was pronounced in phoneme blending form, e.g., /b/ /oy/. The subject was asked to match the blended phonemes with the correct picture. In order to control variant conditions such as articulation and intensity of sounds, the auditory portion of the test was pre-taped and all subjects used earphones during the test administration.

Auditory Discrimination Test This test appraised the child's auditory discrimination ability with regard to similarities and differences in the beginning consonants, medial vowels, and final consonants in paired words. The test consisted of twenty word-pairs and subject was to determine whether each pair was the same or different. The test was pre-taped and earphones were used during testing in order to control for variations in articulation and intensity of sounds.

Auditory Memory Test--Letters This test measured the auditory memory span of children. It was a modification of the digit span test; instead of digits, verbal reproduction of letters both forward and backwards was required.

Auditory Memory Test--Sentences The Sentence subtest from the Wechsler Preschool and Primary Scale of Intelligence was used to tap the auditory memory span of the subjects. It differs from the Auditory Memory Test--Letters in that 1) verbatim reproduction of sentences is required; and 2) credit is given for partial recall.

Visual Analysis Test This test estimates the ability to identify selected segments of a letter. A card containing the letter was placed in front of the subject. Segments of this letter were presented alongside on stimulus cards one at a time. The subject was required to locate the segment contained in the letter.

Visual Discrimination Test This test appraised subject's ability to discriminate between visually presented letters and words. The test consisted of nineteen items and the subject was asked to match letters or words with the standard in each item. Spatial positioning errors such as reversals and inversions which are commonly made by beginning readers were included among the test items.

Visual Embedded Figure Test This test tapped the subject's ability to distinguish figure from background. The test consisted of five items each containing the stimulus letter and a figure with the same letter embedded. The subject was asked to identify the hidden letter in the figure.

Visual Memory Test This test measured the memory ability of subjects. The nature of the test resembles that of the Visual Discrimination Test except that the standards were printed on separate cards. After each of the standards was presented and removed, the subject was required to match the standard from memory with one of four response choices of letters or words.

Visual Synthesis Test This test estimated the ability to reorganize fragments of a letter so as to reproduce that whole letter. The subject was asked to select from several choices those fragments which could be arranged to reproduce the letter given as the standard.

Visual Wordness Test This test measured the subject's knowledge of English ideographic structures. Subject was asked to discriminate nonsense words composed of English letters from other "word-like" figures constructed from modifications of Greek, Russian and Sanskrit letters.

Auditory-Visual Tests--Versions A and B These two tests appraised auditory-visual integration ability. Subjects were required to associate one of a set of three visual patterns with a previously presented pattern of auditory stimuli. In the A version of the Auditory-Visual Test, auditory stimuli were presented as a series of short and long sounds which corresponded with visual patterns of dots and dashes, respectively. In the B version (Birch and Belmont, 1965) the auditory stimuli were a series of rhythmic taps which were associated with visually presented dot patterns.

Visual-Motor Organization Test This test estimated the subject's visual-motor perceptual coordination. It is a modified Bender-Gestalt Test in that letters instead of geometric forms were used as stimuli. Subjects were asked to copy letters from stimulus cards. The scoring system was adapted from Koppitz (1964).

Visual-Tactile Test This test, appraising visual-tactile interaction, involved the matching of a tactile stimulus to a visual counterpart. Subject was asked to feel the standard with finger tips first and then to identify the correct answer visually from response choices.

Conceptual Categorization Test This test tapped cognitive development level. Subject was asked to sort a set of letters which varied as to color, form, and size. Subject's sorting preference indicated his developmental hierarchy.

Learning Sample Test This test measured subject's ability to make and retain associations between pictures of objects and printed symbols. Subject was shown three picture-word cards each containing the picture of an object and the word for it. After all three words were correctly identified with the pictures, these picture-word cards were removed. Cards containing only the words were then presented and subject was asked to identify the word. Learning rate was defined as a function of the number of trials required to achieve criterion performance.

Oral Language Test As the language measure, three pictures were used to elicit verbal responses which were recorded on tape and subsequently evaluated on the basis of lexicon and syntax.

Administration

The battery of readiness tests was originally scheduled to be given to the subjects in October 1968. The administration of the tests had to be postponed until November, however, due to the teachers strike and the resulting closing of the schools. All readiness tests were given individually by one of the investigators and by experienced graduate students enrolled at Teachers College, Columbia University. All participating graduate students had received special training and supervised practice in the administration of these tests. The seventeen readiness tests were grouped into three batteries, according to both the nature of the tests and the length of time each test required in administration. The time needed in administering any one battery of tests was half an hour. No subject was tested for more than one hour per day. All readiness tests were administered within six weeks.

At the end of the same academic year, May 1969, two achievement tests were given to the subjects who had participated in the November testing program. One of the achievement tests was given individually; the other was given to groups of approximately 10 pupils each. All administration of achievement tests was completed in two weeks.

## RESULTS

The purpose of factor analyzing the correlation matrix, consisting of both the readiness and reading criterion variables, was to explore further, by an infrequently applied statistical procedure, those readiness factors associated with reading. These variables were identified as those loading significantly on the same factor as did the criterion variable.

A 27-variable correlation matrix was computed separately for retarded and normal subjects. In order to avoid distorting the factor analysis, an effort was made to eliminate an overlap in variables resulting from: 1) high correlational interdependence manifested in the three MAT subtest scores, the WRAT, and the Expressive Language measures; 2) the use of two derived scores from the PPVT; and 3) the lack of clarity in the literature regarding the developmental status implied by scores on the three Conceptual Categorization tasks. Hence, the original 27 variables were reduced to 19 variables by the following changes: 1) the reading criterion was represented only by the MAT Word Knowledge subtest instead of the original four measures which also included the MAT Word Discrimination, MAT Reading, and WRAT Reading; 2) the intellectual evaluation was represented only by PPVT MA, with the exclusion of the PPVT IQ scores; 3) among the readiness variables, Conceptual Categorization was represented only by the Form score instead of the original three subtest scores of Size, Form, and Color; for Expressive Language, Sentence Length was selected from the three original measures of Sentence Length, Syntax, and Word Rating. The reduced 19-variable matrices for retardates and normals are presented in Tables II and III, respectively (see pages 35 and 36).

Factor Analysis A principal components method of factor analysis (Harman, 1967) using communality estimates in the diagonal was carried out with the 19 variables. The varimax solution was obtained by rotating all factors with eigenvalues greater than .50. Six factors were extracted for the mentally retarded subjects and seven factors for the normal subjects (Tables IV and V, see pages 37 and 38). Following procedures suggested by Fruchter (1954) and Guilford (1961), the variables with loadings above .30 for each factor were considered and are presented in Tables VI and VII (see pages 39 and 40). For each factor, the variables have been arranged according to factor loading.

For the mentally retarded sample, Factor 5 generated the highest loading (.64) for the reading criterion variable, MAT Word Knowledge. Associated with the criterion on this factor are three visually oriented

Table II

Correlation Matrix for Readiness and Criterion Variables: Mentally Retarded

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. MA (PPVT) | 1.00 | .35 | .42 | .33 | .42 | .49 | .31 | .37 | .47 | .26 | .41 | .36 | .40 | .07 | -.33 | .27 | -.02 | .29 | .25 |
| 2. MAT--Word Knowledge | | 1.00 | .30 | .30 | .51 | .50 | .24 | .49 | .38 | .44 | .29 | .56 | .43 | .27 | -.35 | .24 | .05 | .54 | .17 |
| 3. Auditory Blending | | | 1.00 | .34 | .48 | .46 | .42 | .23 | .33 | .35 | .37 | .27 | .36 | .33 | -.26 | .18 | .14 | .23 | .43 |
| 4. Auditory Discrimination | | | | 1.00 | .32 | .34 | .06 | .39 | .54 | .21 | .47 | .35 | .18 | .00 | -.28 | .32 | .06 | .37 | -.05 |
| 5. Auditory Memory--Letters | | | | | 1.00 | .64 | .49 | .44 | .44 | .43 | .27 | .41 | .46 | .31 | -.29 | .26 | .17 | .35 | .51 |
| 6. Auditory Memory--Sentences | | | | | | 1.00 | .43 | .24 | .25 | .31 | .19 | .40 | .45 | .31 | -.22 | .15 | -.03 | .33 | .47 |
| 7. Visual Analysis | | | | | | | 1.00 | .21 | .31 | .34 | .51 | .27 | .53 | .57 | -.25 | .25 | .15 | .32 | .78 |
| 8. Visual Discrimination | | | | | | | | 1.00 | .60 | .44 | .56 | .51 | .16 | -.02 | -.48 | .30 | .19 | .51 | -.07 |
| 9. Visual Embedded Figure | | | | | | | | | 1.00 | .20 | .53 | .32 | .25 | .07 | -.48 | .34 | -.04 | .46 | .13 |
| 10. Visual Memory | | | | | | | | | | 1.00 | .34 | .30 | .02 | .18 | -.28 | .22 | .19 | .45 | .29 |
| 11. Visual Synthesis | | | | | | | | | | | 1.00 | .37 | .26 | .05 | -.30 | .36 | .09 | .30 | .42 |
| 12. Visual Wordness | | | | | | | | | | | | 1.00 | .30 | .16 | -.26 | .27 | .08 | .42 | .23 |
| 13. Auditory-Visual (A) | | | | | | | | | | | | | 1.00 | .51 | -.19 | .06 | .07 | .28 | .54 |
| 14. Auditory-Visual (B) | | | | | | | | | | | | | | 1.00 | .02 | -.01 | .04 | .12 | .60 |
| 15. Visual-Motor Organization | | | | | | | | | | | | | | | 1.00 | -.25 | -.11 | -.61 | -.03 |
| 16. Visual-Tactile | | | | | | | | | | | | | | | | 1.00 | -.10 | .23 | .15 |
| 17. Conceptual Categorization--Form | | | | | | | | | | | | | | | | | 1.00 | .14 | .23 |
| 18. Learning Sample | | | | | | | | | | | | | | | | | | 1.00 | .09 |
| 19. Expressive Language--Sentence Length | | | | | | | | | | | | | | | | | | | 1.00 |

r = .20 significant at the .05 level

Table III

Correlation Matrix for Readiness and Criterion Variables: Normal

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. MA (PPVT) | 1.00 | .50 | .29 | .43 | .43 | .28 | .35 | .42 | .25 | .27 | .50 | .30 | .29 | .06 | -.22 | -.04 | -.21 | .35 | .07 |
| 2. MAT--Word Knowledge | | 1.00 | .23 | .36 | .62 | .18 | .41 | .42 | .10 | .28 | .37 | .26 | .31 | .11 | -.34 | .22 | -.13 | .52 | .08 |
| 3. Auditory Blending | | | 1.00 | .14 | .38 | .25 | .11 | .28 | .26 | .13 | .23 | .02 | .35 | .25 | -.20 | .09 | .01 | .27 | .08 |
| 4. Auditory Discrimination | | | | 1.00 | .25 | -.13 | .16 | .34 | .12 | .12 | .26 | .20 | .22 | .07 | -.36 | .23 | -.08 | .14 | .07 |
| 5. Auditory Memory--Letters | | | | | 1.00 | .38 | .23 | .33 | .23 | .18 | .42 | .19 | .40 | .28 | -.32 | .08 | -.02 | .34 | .09 |
| 6. Auditory Memory--Sentences | | | | | | 1.00 | -.04 | .00 | .03 | .00 | .03 | .15 | .02 | -.01 | .06 | -.19 | -.03 | .14 | .01 |
| 7. Visual Analysis | | | | | | | 1.00 | .45 | .22 | .33 | .58 | .29 | .33 | .20 | -.58 | -.04 | -.11 | .34 | .21 |
| 8. Visual Discrimination | | | | | | | | 1.00 | .27 | .45 | .59 | .25 | .39 | .21 | -.43 | .20 | -.26 | .35 | .15 |
| 9. Visual Embedded Figure | | | | | | | | | 1.00 | .09 | .37 | -.03 | .17 | .20 | -.32 | .16 | .04 | .15 | -.02 |
| 10. Visual Memory | | | | | | | | | | 1.00 | .30 | .06 | .21 | .22 | -.20 | .04 | -.18 | .18 | .15 |
| 11. Visual Synthesis | | | | | | | | | | | 1.00 | .21 | .40 | .22 | -.49 | .04 | .00 | .36 | .26 |
| 12. Visual Wordness | | | | | | | | | | | | 1.00 | .09 | -.10 | -.21 | .06 | -.15 | .08 | .15 |
| 13. Auditory-Visual (A) | | | | | | | | | | | | | 1.00 | .31 | -.30 | .06 | -.16 | .15 | .06 |
| 14. Auditory-Visual (B) | | | | | | | | | | | | | | 1.00 | -.02 | .21 | .08 | .09 | .15 |
| 15. Visual-Motor Organization | | | | | | | | | | | | | | | 1.00 | -.09 | -.01 | -.33 | -.24 |
| 16. Visual-Tactile | | | | | | | | | | | | | | | | 1.00 | -.05 | .06 | -.11 |
| 17. Conceptual Categorization--Form | | | | | | | | | | | | | | | | | 1.00 | -.07 | .05 |
| 18. Learning Sample | | | | | | | | | | | | | | | | | | 1.00 | .29 |
| 19. Expressive Language--Sentence Length | | | | | | | | | | | | | | | | | | | 1.00 |

r= .22 significant at the .05 level

Table IV

Rotated Factor Loadings of Readiness and Criterion Variables: Mentally Retarded

**Factor 1**

| | |
|---|---|
| Visual Synthesis | .75 |
| Visual Embedded Figure | .55 |
| Auditory Discrimination | .48 |
| Visual Analysis | .45 |
| Visual Discrimination | .44 |
| Visual Tactile | .44 |
| Auditory Blending | .37 |
| MA | .34 |
| Auditory Memory--Letters | .27 |
| Visual Memory | .26 |
| Expressive Language--Sentence Length | .26 |
| Visual Wordness | .23 |
| Visual-Motor Organization | -.20 |
| Learning Sample | .13 |
| Auditory Memory--Sentences | .07 |
| MAT--Word knowledge | .05 |
| Conceptual Categorization--Form | .04 |
| Auditory-Visual (A) | .02 |
| Auditory-Visual (B) | .02 |

**Factor 2**

| | |
|---|---|
| Auditory-Visual (B) | .72 |
| Expressive Language--Sentence Length | -.36 |
| Auditory-Visual (A) | .33 |
| MAT--Word Knowledge | .21 |
| Auditory Discrimination | .20 |
| Auditory Blending | .16 |
| Visual Tactile | -.11 |
| Auditory Memory--Sentences | .08 |
| Learning Sample | .08 |
| Visual Memory | .06 |
| Conceptual Categorization--Form | .06 |
| Visual Analysis | .05 |
| Auditory Memory--Letters | .04 |
| Visual Discrimination | .04 |
| Visual-Motor Organization | .04 |
| MA | .03 |
| Visual Wordness | .03 |
| Visual Synthesis | -.02 |
| Visual Embedded Figure | .00 |

**Factor 3**

| | |
|---|---|
| Auditory Memory--Sentences | .68 |
| Expressive Language--Sentence Length | .66 |
| MA | .56 |
| Auditory Memory--Letters | .53 |
| Auditory Visual (A) | .52 |
| Auditory Blending | .38 |
| Auditory Discrimination | .38 |
| MAT--Word Knowledge | .33 |
| Visual Wordness | .27 |
| Visual Embedded Figure | .23 |
| Visual Synthesis | .19 |
| Visual-Motor Organization | .18 |
| Visual Discrimination | .13 |
| Learning Sample | .12 |
| Visual Analysis | .12 |
| Visual Memory | .09 |
| Auditory-Visual (B) | .06 |
| Visual-Tactile | .06 |
| Conceptual Categorization--Form | .01 |

**Factor 4**

| | |
|---|---|
| Conceptual Categorization--Form | .71 |
| Expressive Language--Sentence Length | .39 |
| Visual Memory | .28 |
| Visual Analysis | .21 |
| Visual-Tactile | -.19 |
| Auditory Memory--Letters | .15 |
| Auditory Blending | .13 |
| Visual Embedded Figure | -.13 |
| Visual Synthesis | .13 |
| Visual Discrimination | .12 |
| MAT--Word Knowledge | -.09 |
| Visual-Motor Organization | -.08 |
| Auditory Memory--Sentences | -.07 |
| Auditory-Visual (B) | .07 |
| Auditory Discrimination | -.06 |
| Learning Sample | .06 |
| MA | -.05 |
| Auditory-Visual (A) | -.04 |
| Visual Wordness | -.03 |

Table IV (continued)

**Factor 5**

| | |
|---|---|
| MAT--Word Knowledge | .64 |
| Visual Memory | .59 |
| Visual Wordness | .47 |
| Visual Discrimination | .44 |
| Learning Sample | .44 |
| Auditory Memory--Letters | .41 |
| Auditory Memory--Sentences | .38 |
| Visual-Tactile | .25 |
| Visual-Motor Organization | -.21 |
| Auditory Blending | .20 |
| Auditory Discrimination | .13 |
| Visual Embedded Figure | .13 |
| Visual Synthesis | .13 |
| Auditory-Visual (B) | .12 |
| Expressive Language--Sentence Length | .11 |
| MA | .08 |
| Visual Analysis | .07 |
| Conceptual Categorization--Form | .07 |
| Auditory-Visual (A) | -.03 |

**Factor 6**

| | |
|---|---|
| Learning Sample | .63 |
| Visual Analysis | .61 |
| Visual-Motor Organization | -.59 |
| Visual Discrimination | .51 |
| Visual Embedded Figure | .48 |
| Auditory-Visual (A) | .40 |
| MAT--Word Knowledge | .34 |
| Visual Wordness | .25 |
| MA | .23 |
| Visual Synthesis | .22 |
| Auditory Memory--Letters | .20 |
| Auditory Discrimination | .18 |
| Visual-Tactile | .14 |
| Conceptual Categorization--Form | .11 |
| Auditory Memory--Sentences | .10 |
| Visual Memory | .09 |
| Auditory Blending | .06 |
| Auditory-Visual (B) | .02 |
| Expressive Language--Sentence Length | .01 |

Table V

Rotated Factor Loadings of Readiness and Criterion Variables: Normal

**Factor 1**

| | |
|---|---|
| Visual-Motor Organization | -.67 |
| Visual Synthesis | .65 |
| Visual Embedded Figure | .63 |
| Visual Analysis | .62 |
| Visual Discrimination | .48 |
| Learning Sample | .32 |
| MA | .30 |
| Auditory-Visual (A) | .26 |
| Visual Memory | .22 |
| MAT--Word Knowledge | .21 |
| Auditory Blending | .20 |
| Auditory Memory--Letters | .20 |
| Auditory Discrimination | .17 |
| Expressive Language--Sentence Length | .11 |
| Visual Wordness | .10 |
| Auditory Memory--Sentences | -.09 |
| Auditory-Visual (B) | .06 |
| Conceptual Categorization--Form | .05 |
| Visual-Tactile | .04 |

**Factor 2**

| | |
|---|---|
| Auditory Memory--Sentences | .75 |
| Auditory Memory--Letters | .63 |
| MAT--Word Knowledge | .51 |
| MA | .43 |
| Learning Sample | .41 |
| Auditory Blending | .40 |
| Visual Synthesis | .15 |
| Auditory-Visual (A) | .14 |
| Visual Embedded Figure | .14 |
| Visual Wordness | .13 |
| Visual Discrimination | .11 |
| Visual-Tactile | -.07 |
| Auditory-Visual (B) | .04 |
| Visual Analysis | .03 |
| Visual Memory | .03 |
| Visual-Motor Organization | -.03 |
| Conceptual Categorization--Form | -.03 |
| Auditory Discrimination | -.01 |
| Expressive Language--Sentence Length | -.01 |

**Factor 3**

| | |
|---|---|
| Visual-Tactile | .77 |
| MAT--Word Knowledge | .35 |
| Auditory Memory--Sentences | -.27 |
| Auditory Discrimination | .24 |
| Learning Sample | .22 |
| Visual Wordness | -.16 |
| Auditory-Visual (B) | .15 |
| Visual Discrimination | .15 |
| Expressive Language--Sentence Length | -.13 |
| Auditory Memory--Letters | .11 |
| Visual Embedded figure | .10 |
| Visual-Motor Organization | -.10 |
| MA | -.08 |
| Visual Analysis | -.07 |
| Auditory Blending | .06 |
| Visual Synthesis | -.05 |
| Visual Memory | .03 |
| Conceptual Categorization--Form | -.01 |
| Auditory-Visual (A) | .00 |

**Factor 4**

| | |
|---|---|
| Auditory-Visual (B) | .73 |
| Auditory-Visual (A) | .47 |
| Auditory Blending | .39 |
| Auditory Memory--Letters | .32 |
| Visual Memory | .27 |
| Visual Discrimination | .26 |
| Visual Synthesis | .26 |
| Visual Embedded Figure | .19 |
| Visual-Tactile | .14 |
| Visual Wordness | -.14 |
| Expressive Language--Sentence Length | .12 |
| MA | .11 |
| Auditory Discrimination | .11 |
| Visual Analysis | .09 |
| Conceptual Categorization--Form | .07 |
| MAT--Word Knowledge | .04 |
| Learning Sample | -.03 |
| Auditory Memory | -.01 |
| Visual-Motor Organization | .01 |

Table V (continued)

Factor 5

| | |
|---|---|
| Conceptual Categorization--Form | .71 |
| Visual Memory | -.48 |
| Visual Discrimination | -.44 |
| Visual Analysis | -.26 |
| MA | -.26 |
| MAT--Word Knowledge | -.23 |
| Auditory-Visual (A) | -.19 |
| Visual Wordness | -.16 |
| Learning Sample | -.13 |
| Visual Synthesis | -.12 |
| Visual Embedded Figure | .10 |
| Expressive Language--Sentence Length | .06 |
| Visual-Tactile | -.03 |
| Auditory Blending | .02 |
| Visual-Motor Organization | -.02 |
| Auditory Discrimination | -.01 |
| Auditory Memory--Sentences | -.01 |
| Auditory Memory--Letters | .00 |
| Auditory-Visual (B) | .00 |

Factor 6

| | |
|---|---|
| Expressive Language--Sentence Length | .68 |
| Learning Sample | .41 |
| Visual Analysis | .32 |
| Visual Embedded Figure | -.27 |
| MAT--Word Knowledge | .25 |
| Visual-Motor Organization | -.24 |
| Visual Memory | .21 |
| Visual Synthesis | .21 |
| Visual Wordness | .14 |
| Auditory-Visual (B) | .13 |
| Visual Discrimination | .13 |
| Conceptual Categorization--Form | .13 |
| Visual-Tactile | -.11 |
| Auditory Memory--Letters | .09 |
| Auditory Memory--Sentences | -.05 |
| Auditory Blending | -.04 |
| MA | -.02 |
| Auditory Discrimination | -.01 |
| Auditory-Visual (A) | .00 |

Factor 7

| | |
|---|---|
| Auditory Discrimination | .68 |
| MA | .47 |
| Visual Wordness | .45 |
| MAT--Word Knowledge | .39 |
| Auditory Memory--Letters | .30 |
| Visual-Motor Organization | .29 |
| Visual Discrimination | .27 |
| Visual Synthesis | .26 |
| Auditory-Visual (A) | .24 |
| Visual Analysis | .18 |
| Conceptual Categorization--Form | -.11 |
| Auditory-Visual (B) | -.10 |
| Visual Embedded Figure | -.08 |
| Auditory Memory--Sentences | -.06 |
| Expressive Language--Sentence Length | .06 |
| Auditory Blending | .05 |
| Visual-Tactile | .05 |
| Learning Sample | .04 |
| Visual Memory | .02 |

Table VI

Rotated Factor Loadings above .30 of Readiness and Criterion Variables: Mentally Retarded

**Factor 1**

| | |
|---|---|
| Visual Synthesis | .75 |
| Visual Embedded Figure | .55 |
| Auditory Discrimination | .48 |
| Visual Analysis | .45 |
| Visual Discrimination | .44 |
| Visual-Tactile | .44 |
| Auditory Blending | .37 |
| MA | .34 |

**Factor 2**

| | |
|---|---|
| Auditory-Visual (B) | .72 |
| Expressive Language--Sentence Length | -.36 |
| Auditory-Visual (A) | .33 |

**Factor 3**

| | |
|---|---|
| Auditory Memory--Sentences | .68 |
| Expressive Language--Sentence Length | .66 |
| MA | .56 |
| Auditory Memory-Letters | .53 |
| Auditory-Visual (A) | .52 |
| Auditory Blending | .38 |
| Auditory Discrimination | .38 |
| MAT--Word Knowledge | .33 |

**Factor 4**

| | |
|---|---|
| Conceptual Categorization--Form | .71 |
| Expressive Language--Sentence Length | .39 |

**Factor 5**

| | |
|---|---|
| MAT--Word Knowledge | .64 |
| Visual Memory | .59 |
| Visual Wordness | .47 |
| Visual Discrimination | .44 |
| Learning Sample | .44 |
| Auditory Memory--Letters | .41 |
| Auditory Memory--Sentences | .38 |

**Factor 6**

| | |
|---|---|
| Learning Sample | .63 |
| Visual Analysis | .61 |
| Visual-Motor Organization | -.59 |
| Visual Discrimination | .51 |
| Visual Embedded Figure | .48 |
| Auditory-Visual (A) | .40 |
| MAT--Word Knowledge | .34 |

Table VII

Rotated Factor Loadings above .30 of Readiness and Criterion Variables:
Normal

**Factor 1**

| | |
|---|---|
| Visual-Motor Organization | -.67 |
| Visual Synthesis | .65 |
| Visual Embedded Figure | .63 |
| Visual Analysis | .62 |
| Visual Discrimination | .48 |
| Learning Sample | .32 |
| MA | .30 |

**Factor 2**

| | |
|---|---|
| Auditory Memory--Sentences | .75 |
| Auditory Memory--Letters | .63 |
| MAT--Word Knowledge | .51 |
| MA | .43 |
| Learning Sample | .41 |
| Auditory Blending | .40 |

**Factor 3**

| | |
|---|---|
| Visual-Tactile | .77 |
| MAT--Word knowledge | .35 |

**Factor 4**

| | |
|---|---|
| Auditory-Visual (B) | .73 |
| Auditory-Visual (A) | .47 |
| Auditory Blending | .39 |
| Auditory Memory--Letters | .32 |

**Factor 5**

| | |
|---|---|
| Conceptual Categorization--Form | .71 |
| Visual Memory | -.48 |
| Visual Discrimination | -.44 |

**Factor 6**

| | |
|---|---|
| Expressive Language--Sentence Length | .68 |
| Learning Sample | .41 |
| Visual Analysis | .32 |

**Factor 7**

| | |
|---|---|
| Auditory Discrimination | .68 |
| MA | .47 |
| Visual Wordness | .45 |
| MAT--Word Knowledge | .39 |
| Auditory Memory--Letters | .30 |

Table VIII

Comparisons of Normal and Mentally Retarded on Reading and Criterion Measures

| | MR | | Normal | | | |
|---|---|---|---|---|---|---|
| | X | SD | X | SD | t | P |
| MA (PPVT) | 4.77 | 1.12 | 6.57 | 0.93 | -11.30 | .001 |
| MAT--Word Knowledge | 14.58 | 7.70 | 23.94 | 7.44 | - 8.04 | .001 |
| Auditory Blending | 7.97 | 3.14 | 11.10 | 3.01 | - 6.63 | .001 |
| Auditory Discrimination | 10.42 | 4.73 | 14.08 | 3.07 | - 5.85 | .001 |
| Auditory Memory--Letters | 4.44 | 1.92 | 6.40 | 1.72 | - 6.99 | .001 |
| Auditory Memory--Sentences | 10.32 | 5.76 | 18.03 | 4.50 | - 9.62 | .001 |
| Visual Analysis | 12.38 | 4.98 | 16.31 | 2.30 | - 6.41 | .001 |
| Visual Discrimination | 12.30 | 5.23 | 13.87 | 3.61 | - 2.25 | .05 |
| Visual Embedded Figure | 2.73 | 1.68 | 3.58 | 1.23 | - 3.68 | .001 |
| Visual Memory | 3.37 | 1.29 | 3.64 | 1.19 | - 1.44 | NS |
| Visual Synthesis | 5.34 | 4.50 | 9.33 | 3.52 | - 6.38 | .001 |
| Visual Wordness | 2.83 | 1.83 | 3.82 | 1.53 | - 3.81 | .001 |
| Auditory-Visual (A) | 4.01 | 2.98 | 5.55 | 3.73 | - 3.01 | .01 |
| Auditory-Visual (B) | 2.04 | 2.14 | 2.86 | 2.36 | - 2.38 | .05 |
| Visual-Motor Organization* | 21.38 | 23.66 | 11.63 | 5.53 | 3.56 | .001 |
| Visual-Tactile | 2.67 | 1.25 | 3.09 | 1.20 | - 2.25 | .05 |
| Conceptual Categorization--Form | 3.93 | 2.78 | 5.00 | 3.41 | - 2.27 | .05 |
| Learning Sample | 29.52 | 9.26 | 32.91 | 4.11 | - 2.99 | .01 |
| Expressive Language--Sentence Length | 7.14 | 2.99 | 9.50 | 3.53 | - 4.50 | .001 |

* The score is the number of errors committed by Ss.

variables: Visual Memory, .59; Visual Wordness, .47; and Visual Discrimination, .44. Also loading on this Factor are Learning Sample, .44, and the two Auditory Memory measures: Letters, .41; and Sentences, .38.

Factor 1 appears to be primarily a visual perceptual factor as evidenced by the relatively high loadings of the following variables: Visual Synthesis, .75; Visual Embedded Figure, .55; Visual Analysis, .45; Visual Discrimination, .44; and Visual-Tactile, .44. Two auditory variables, Auditory Discrimination, .48 and Auditory Blending, .37 as well as MA, .34 also loaded on this factor.

Factor 2 is taken to represent auditory-visual integrative ability from the loadings on Auditory-Visual (B), .72 and Auditory-Visual (A), .33. A third variable, Expressive Language--Sentence Length, had a marginal negative loading of -.36 on this Factor.

Factor 3 is one of the two factors other than Factor 5 that includes a marginal loading of the criterion variable, MAT Word Knowledge, .33. It is characterized as an auditory perceptual and memory factor from the loadings on the following variables: Auditory Memory--Sentences, .68; Auditory Memory--Letters, .53; Auditory-Visual (A), .52; Auditory Blending, .38; and Auditory Discrimination, .38. The other two variables, Expressive Language--Sentence Length, .66 and MA, .56 also contain substantial auditory and memory components.

Factor 4 is clearly a conceptual factor, since Conceptual Categorization--Form has a major loading of .71 on this Factor. The other variable, Expressive Language--Sentence Length, has a marginal loading of .39.

Factor 6, the other factor on which the reading criterion has a marginal loading (.34), is basically comprised of learning and visual perceptual elements. These include Learning Sample, .63; Visual Analysis, .61; Visual-Motor Organization, -.59; Visual Discrimination, .51; Visual Embedded Figure, .48; and Auditory-Visual (A), .40.

There is a confirmatory trend running through the six factors extracted for the mentally retarded sample. Factor 5, which seems to represent most clearly the reading criterion, includes visual, auditory, and learning variables which are supported by strong underlying memory processes. These apparent bonds between reading and memory-saturated visual, auditory, and learning variables are again suggested on Factors 3 and 6.

For the normal sample, Factor 2 contained the highest loading for the reading criterion variable, MAT Word Knowledge (.51). Loading significantly on the same Factor are three auditory memory and perceptual measures: Auditory Memory--Sentences, .75; Auditory Memory--Letters, .63; and Auditory Blending, .40. Also included in this Factor are MA, .43 and Learning Sample, .41.

Similar to the mentally retarded sample, Factor 1 can be characterized as a visual perceptual factor. The variables include Visual-Motor Organization, -.67; Visual Synthesis, .65; Visual Embedded Figures, .63; Visual Analysis, .62; and Visual Discrimination, .48. Learning Sample, .32 and MA .30 also load marginally on this Factor.

Factor 3 has a marginal loading of the reading criterion (.35), but clearly can be described by the Visual-Tactile cross-modality variable (.77).

Factor 4 can be construed as an auditory-visual integration factor from the loadings Auditory-Visual (B), .73 and Auditory-Visual (A), .47. Supporting auditory overtones are also evident: Auditory Blending, .39 and Auditory Memory--Letters, .32.

Factor 5 is heavily committed to the conceptual variable, Conceptual Categorization--Form, .71. Atypical negative loadings produced by visual perceptual and memory elements, however, are present: Visual Memory, -.48 and Visual Discrimination, -.44.

Factor 6 seems to represent language ability as indicated by the loading of .68 on Expressive Language--Sentence Length. Also included on this factor are Learning Sample, .41 and Visual Analysis, .32.

Factor 7, which has a marginal loading on the reading criterion (.39), appears predominantly concerned with auditory processes: Auditory Discrimination, .68 and Auditory Memory--Letters, .30. Two other variables which also loaded on this factor are MA, .47 and Visual Wordness, .45. On the whole, the reading criterion in the normal sample seems most closely associated with auditory memory and perceptual factors.

Stepwise Regression Analysis The purpose of the above factor analysis was to identify, in a general way, the topography of the reading behavior terrain. As a concurrent validation of the findings of that analysis (Armstrong and Soelberg, 1968), a stepwise regression analysis was performed (Draper and Smith, 1966). The variable selection procedure provided a reliability check on the readiness variables identified with the reading criterion as well as specifying the magnitude of their specific predictive powers.

In this stepwise regression analysis, a selection was made from among the ~~19~~ MA and the 17 readiness variables which best predicted the criterion variable, MAT Word Knowledge. A multiple R of .73 was obtained for the mentally retarded group after five steps. The F value of the last variable entered into the regression was 4.45 ($p < .05$). The five variables which contributed most to the multiple R were, in the descending order of their Beta coefficients: Visual Wordness, .28; Auditory-Visual (A), .24; Learning Sample, .20; Visual Memory, .19; and Auditory Memory--Letters, .16. For the normal subjects, a multiple R of .75 was obtained after four steps. The F value of the last entered variable in the regression was 4.76 ($p < .05$). The four variables which comprised this multiple R, in the descending order of their Beta coefficients, were: Auditory Memory--Letters, .44; Learning Sample, .28; Auditory Discrimination, .18; and Visual Analysis, .18.

For the retarded group, the readiness variables which contributed highly to the reading criterion from the stepwise regression analysis were, with the exception of Auditory-Visual (A), the same variables which loaded heavily on the criterion variable in the factor analysis. For the normals, there was some discrepancy between the factor analysis and the stepwise regression analysis in that two of the variables selected by the stepwise regression analysis, Auditory Discrimination and Visual Analysis, did not load significantly on Factor 2 which contained the highest criterion variable loading. Auditory Discrimination, however, did load significantly on Factor 7 which contained a marginal loading for the reading criterion variable.

Comparisons of Retardates and Normals It may be of interest to note that, as expected because of significantly lower MA levels, the retarded subjects performed more poorly than normal subjects on almost all measures. Means, standard deviations, and *t* tests for all the 19 variables were computed to compare the two groups (Table VIII, page 46). With the exception of Visual Memory, significant differences in favor of the normal group were found. However, when analysis of covariance was also used to compare the two samples, with MA held constant, only four variables were found to differ significantly: MAT-Word Knowledge ($p < .01$), Auditory Blending ($p < .05$), Auditory Memory--Sentences ($p < .01$), and Conceptual Categorization ($p < .05$).

## DISCUSSION

The literature, as evidenced by the previous review section, is replete with studies that have identified a wide variety of visual, auditory, and cross-modal perceptual variables as predictive of reading achievement. None, however, have fully implicated "pan-modal" memory as the predominant process underlying reading. In the factor analysis of the mentally retarded group, the variables such as Visual Memory, Auditory Memory--Letters, and Auditory Memory--Sentences, which all loaded on Factor 5, the reading criterion factor, are obviously memory measures. The Learning Sample, essentially a paired-associate task, certainly includes a memory component. The Visual Wordness test requires the subject to match a series of nonsense words differing in ideographic structure with his own internal schema representing the English ideograph. This task also implies, at least in part, long-term retention ability and functioning retrieval mechanisms.

This interpretation was confirmed by the stepwise regression analysis, in that while Auditory-Visual (A) was the only variable which did not emerge in the factor analysis, nevertheless, contributory memory processes can be clearly construed. With the exception of Visual Discrimination in the factor analysis, therefore, the preeminence of memory, both in the visual and auditory modalities, as well as in their integration, is strongly suggested.

In the factor analysis of the normal group, three of the variables loading on Factor 2, the reading criterion factor, are Auditory Memory--Sentences, Auditory Memory--Letters, and Learning Sample; in all of these, memory is central. MA, a measure of cognitive development, contains a memory component. And, Auditory Blending requires the identification of words that are made by separated sounds. Successful performance on this task is a function of the ability to maintain one or more auditory stimulus traces, on a short-term basis, while the entire word is being composed.

In the stepwise regression analysis, with the exception of Visual Analysis, memory processes permeate the other three selected variables. Auditory Discrimination relies upon the short-term retention of stimulus words in order to differentiate between them. Hence, along with Auditory Memory--Letters and Learning Sample which also appeared in the factor analysis, Auditory Discrimination implicates the memory process.

A case is being made for the saliency of memory processes in reading, as expressed in the auditory and visual perceptual modalities. There is an interesting difference, however, between the perceptual modalities involved in the retarded and normal groups.

In the mentally retarded group, both visual and auditory perceptual variables clustered with the reading criterion. In the normal group, however, auditory perceptual variables were preeminent. This result confirms earlier studies by Monroe (1935), Steinbach (1940), and Alshan (1965) where, among normal first graders, auditory measures were found to be either more highly correlated with or predictive of a reading criterion than visual measures. The finding of the present study can be interpreted as an indication of qualitative differences in the readiness structure underlying reading. Since the mean MA of retardates (4.77) was significantly lower than that of the normals (6.57), the higher developmental status of the latter group may have resulted in most of these children having already surpassed the visual perceptual threshold beyond which these processes are no longer discriminatory for reading. As a corollary to this, auditory perceptual processes must develop more slowly since they still bear a relationship to reading achievement in the higher MA normal group. Hence it is reasonable to assume that whereas both visual and auditory perceptual processes are still germane to the development of early reading behavior in the retarded, only auditory processes are relevant in the normal.

One of the interesting and unanticipated findings of the stepwise regression analysis for the mentally retarded sample was the emergence of Visual Wordness as the most potent contributor to the prediction of the reading achievement criterion. It would appear, therefore, that at this MA level (4.77) and for this mentally retarded sample, the ability of a child to discriminate the ideographic structure of his written language from that of other languages is an important bench mark for reading readiness. Whether this mark is related to MA, the nature of the sample, or some combination of both is unanswerable by the data of this study. The fact that performance on this task may be only an "early sign" which dissipates quickly with increasing cognitive maturity is supported by its total lack of predictive relevance in the higher MA normal group.

An impressively consistent performer for both sample groups and in both forms of data analysis used in this study was the Learning Sample. It demonstrates that learning rate, even as expressed in a simple verbal paired-associate form, bears an unimpeachable relationship to the more complex forms of learning required in the acquisition of reading skills. This confirms earlier results by Cawley, Goodstein and Burrow (1968) who reported associative learning to be one of the important psychological factors related to reading ability among their first grade mentally retarded and normal subjects.

## SUMMARY AND CONCLUSION

"Pan-modal" memory has been implicated through the auditory and visual perceptual modalities as the salient process underlying reading for both mentally retarded and normal samples. Differences in the way that these modalities cluster with reading behavior, however, were found for the two sample groups; auditory and visual skills were dominant for the retarded whereas only auditory skills were pertinent for the normal. Furthermore, certain specific findings among subtests in the readiness battery were of special interest. In particular, the Visual Wordness subtest was shown to have contributed most to the prediction of the reading criterion for the retarded subjects, and the Learning Sample subtest was found to bear a strong relationship to the acquisition of reading skills for both samples. In addition, retarded and normal subjects displayed significant differences on almost all measures. When MA was held constant, however, all differences disappeared with the exception of four variables. The above findings suggest that [redacted] qualitative differences exist between the two groups in the psychological processes related to early reading behavior. Because of the significant MA differences between the retarded and normal groups, however, it cannot be definitively stated that these differences in psychological processes are related to retardation per se or to MA. In either case, the sensitive reading diagnostician should be alert to both mental retardation and MA levels as variables that might affect his decision as to which instruments will offer the most refined estimation of reading readiness. Future research by the investigators will attempt to clarify further the retardation-MA issue.

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