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ABSTRACT

The determination of the relationships among auditory discrimination ability, social class and age group differences, reading skill ability, and visual perceptual skills was the objective of this study. Fifteen New York City public schools provided 180 first, third, and fifth grade white and black males from lower and middle socioeconomic status (SES). A variety of auditory tests were administered as well as a visual discrimination measure, an attention measure, reading tests and an intelligence measure. The results largely support the hypothesis that poor auditory discrimination is a major intervening variable between social conditions and reading retardation. The relationship is stronger for blacks than for whites and decreases with age indicating that teaching and remedial training should be oriented differently for varicus SES, racial and age groups. (TO)

Final Report

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The Development of Auditory Discrimination: Relationship to Reading Proficiency and to Social Class

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Institute for Developmental Studies
New York University
New York, New York

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

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

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It is impossible to acknowledge sufficiently the contributions of my colleagues at the Institute for Developmental Studies during these past 12 years: association with an active and productive research and developmental group contributes immeasurably to the endeavors of each of its members. I would like at least here to say "thank you" to my colleagues and to my husband and colleague, Dr. Martin Deutsch, for the fostering atmosphere which has obtained at the Institute. I should also like to acknowledge the cooperation of the New York City Board of Education in permitting the project to be conducted within the schools, and to express appreciation to the many district superintendents, principals, assistant principals, and teachers in the various schools who were so helpful. As is always the case, the greatest debt goes to the subjects, each of whom submitted to several hours of testing procedures and who must of necessity remain anonymous.

With the cooperation and assistance of so many, I must yet make clear that responsibility for opinions, conclusions -- and errors -- is mine.

Chapter I

Introduction
and
Review of the Literature

Problem and Objectives

The high incidence of reading and other learning disabilities in children from lower socio-economic circumstances is primarily an educational problem. Not only is reading central to the educational process in the first few years, but later subject teaching depends heavily on the student's ability to read. However, reading and other learning disabilities are also potentially severe social problems. The child with a reading disability is likely to experience more failure in school than is the able reader. His failures will more than likely lead him to develop negative attitudes toward school itself and probably a more negative and removed attitude toward other social institutions as well. In addition, in an increasingly industrialized and automated society, there are fewer and fewer jobs for unskilled workers. Any person who does not develop adequate reading skills will find it almost impossible to enter the skilled labor market.

With this awareness of both the greater incidence and serious implications of reading disabilities in the lower socio-economic groups, the task remains to determine the mediating factors between social conditions and learning performance. Since Institute research has shown such striking differences in auditory functioning of lower-class children between good and poor readers (Deutsch, 1964; Katz and Deutsch; 1963b) it is possible that at least a portion of the class discrepancy in reading retardation is attributable to auditory problems, and thus development of auditory discrimination may be one of the mediating factors (cf. argument in C. Deutsch, 1964).

Reading research in general has been primarily directed toward analysis of underlying visual and more recently, linguistic, factors. Investigation of auditory factors in reading has occupied third place. One reason for the relative scarcity of such research prior to initiation of the present study may be that interest mainly focused on normal middle-class populations, in which auditory discrimination problems are neither expected nor found in significant numbers. It was hypothesized by the Principal Investigator that perhaps middle-class children, from their quieter, more speech-directed environments, more frequently attain minimal auditory discrimination levels by the time they enter first grade than do children from lower socioeconomic strata (Deutsch, 1964).

With the high incidence of reading retardation among children from lower-class backgrounds, it is important to learn if a major intervening variable between social conditions and reading retardation is poor auditory discrimination. Thus, a main objective of the present project was to determine if there are social class differences in auditory discrimination ability.

A second objective was to determine the prevalence of auditory discrimination difficulties coincident with different levels of reading skill within and between class groupings. The relationship might differ in different age groups, and this also was investigated.

A third objective was concerned with exploring the possible relationship between levels of auditory discrimination skills and the visual-perceptual skills involved in reading.

Related Research

Socioeconomic status and auditory discrimination ability. It has been suggested (Deutsch, 1964, 1968) that the environment of the lower-class child, who is typically the poorer reader, is an important factor in his ability to develop auditory discrimination skills. Not only does the environment affect the amount and variety of stimuli to which the child is exposed, but it also influences the nature and amount of practice he gets in learning to discriminate stimuli from each other. Higher socioeconomic (SES) children are exposed to a different and richer stimulus environment than are children from less privileged homes. There is likely to be less verbal interaction, and less emphasis on discriminating differences between objects and on attaching appropriate labels to objects in lower-class homes. The environment of the lower-class child might also be characterized as a much noisier one than that of the middle-class child.

Research on the reticular activating system lends cogency to a hypothesized relationship between a noisy environment and auditory discrimination difficulties. The reticular system, which seems to be responsible for a general, over-all activating function in the nervous system without which no stimulus is effective, is able to influence transmission of sensory messages within the central nervous system. Animal experiments show that when the reticular system is directly activated, sensory transmission is inhibited or facilitated depending on where the activating stimulus is applied (Hernández-Peón, 1961). Experiments by Hernández-Peón and others indicate that activation of the brain-stem reticular formation inhibits auditory transmission very early in the path of that transmission. In addition it has been found in cats that auditory evoked potentials are reduced when the animal is attentive to stimuli in other modalities (Bach-y-Rita et al., 1961, reported in Hernández-Peón, 1961). Similarly, the potential in other modalities is reduced when the animal's attention is on an auditory stimulus. It was also found that afferent messages elicited by stimuli which are attended to are facilitated.

While direct inferences from these animal experiments to human behavior are obviously inappropriate, these animal experments do provide hypotheses about functioning in the human nervous system, and these hypotheses can be viewed in the light of available behavioral data. The animal findings on the reticular system are consistent with the information-theory findings that the signal-to-noise ratio is influential in the stimuli perceived and in the responses evoked. The higher the ratio, i.e., the greater the amount of signal as compared with noise, the more likely will be the accurate perception of the signal. One could thus hypothesize that with a low ratio, i.e., with a lot of noise in the system, the excess activation of the reticular system is interfering with travel of the signal up the neural paths.

Thus a child raised in a noisy environment with little directed and sustained speech stimulation might well be deficient in his discrimination and recognition of speech sounds. He could also be expected to be relatively inattentive to auditory stimuli, and further, to have difficulty with another skill, such as reading, which is partially dependent on auditory discrimination skill.

Only a few studies have focused specifically on the auditory perceptual functioning of disadvantaged children as compared with advantaged children. Clark and Richards (1966) administered the Wepman Test of Auditory Discrimination to two groups: 29 paying and 29 non-paying Head Start Children in Madison, Wisconsin. The results showed a significant difference ($p < .001$) between disadvantaged and advantaged groups. McArdle (1965) investigated the auditory discrimination ability of a group of 24 day-care and 24 laboratory nursery-school children in Knoxville, Tennessee. There was a significant difference ($p < .001$) between the groups as measured by a modified form of the Boston University Speech Sound Discrimination Test. The investigators of both studies concluded that the auditory discrimination abilities of disadvantaged preschool children were poorer than the auditory discrimination abilities of those from advantaged environments.

In a study comparing 27 "culturally deprived" 5 year olds from a Project Headstart with 27 middle class children from a nursery school, Giebink and Marden (1968) also found that scores on the Auditory Vocal Automatic Subtest of the Illinois Test of Psycholinguistic Abilities were significantly lower for the so-called "culturally deprived" group.

Auditory discrimination and reading. Several investigators have examined the relationship between auditory perceptual functioning and reading achievement within groups other than the disadvantaged. In order to standardize the Reading Aptitude Test, Monroe (1935) administered a number of readiness tests to children in the primary grades. Correlation coefficients between each of the major types of readiness tests (auditory, language, visual, etc.) and end of first-grade reading achievement were computed for 85 children in four first-grade classrooms. There was a higher correlation between reading and a composite auditory score, including measures of blending, auditory memory, and correct pronunciations (.66) than for any other readiness variable.

Wepman (1960) administered tests of auditory discrimination, articulation, intelligence, and reading to 156 first and second grade children at the end of the school year in Chicago. The Chicago Reading Tests and the Wepman Auditory Discrimination Test were among the tests given. There was a significant relationship between low reading attainment and poor auditory discrimination, but a comparison of the data for the two grades showed that the number of children with poor auditory discrimination decreased in the second grade.

The relationship between prereading measures of auditory discrimination and reading achievement at the end of the first grade was examined by Dykstra (1964) in eight Minneapolis schools. Seven auditory discrimination subtests selected from reading readiness tests were administered at the beginning of the school year and two subtests of the Gates Primary Reading Test were given at the end. Complete data were gathered on 632 pupils. Results indicated that: (a) intercorrelations among auditory discrimination measures and subsequent reading achievement were low; however five of the seven auditory discrimination measures made a significant contribution to a multiple regression equation which was designed to predict reading achievement; and (b) variations in performance on the auditory discrimination and intelligence measures accounted for less than half of the variation in performance on the reading measures.

Harrington and Durrell (1965) tested 500 parochial school, second-grade pupils in Boston. The investigators devised an auditory discrimination instrument to measure the subject's ability to perceive initial consonant sounds, rhyming at the ends of words, final consonants, and a combination of initial and final consonants in words spoken by the examiner. The subjects were matched for mental age, visual discrimination ability, and phonics ability. For each matched pair, a comparison of reading ability between the high- and low-discrimination scorer was made. It was found that the pupils with superior auditory discrimination were also significantly superior in reading ability.

A longitudinal study of the 105 first-grade children who entered the two elementary schools in Oxford, Ohio, in September, 1958, was conducted by Thompson (1963). In the month preceding the first grade and in the eighth month of the second grade, three auditory discrimination tests were administered: the Wepman Auditory Discrimination Test, the Boston University Speech Sound Discrimination Test, and the Auditory Discrimination and Orientation Test. In the ninth month of the second grade, the word recognition and the paragraph reading subtests of the Gates Advanced Primary Reading Tests were administered. Subjects were also given the Wechsler Intelligence Scale for Children (WISC) and an audiometric test. Two criteria were used to select good and poor readers: (a) those 24 who were at the upper and those 24 who were at the lower end of the reading distribution; and (b) those 24 whose reading ability greatly exceeded their mental ability, and those 24 whose mental ability greatly exceeded their reading ability. The findings indicated that: (a) of the 24 best readers, 16 had possessed adequate auditory discrimination upon entering the first grade. Examination of the 24 poorest readers, however, indicated that only one had demonstrated adequate skill in making auditory discriminations at the beginning of the first grade; (b) high auditory discrimination test scores were more likely to be characteristic of the good readers at the upper end of the mental ability distribution than the good readers whose reading ability greatly exceeded their mental ability; and (c) approximately 24 percent of the subjects had inaccurate auditory discriminative ability at the end of the second grade, and one-half of these were classified as poor readers.

Christine and Christine (1964) used the Wepman Auditory Discrimination Test to evaluate subjects from a midwestern school system. They tested 27 subjects in the second and third grades reading at or above grade level; 15 primary-grade subjects reading below grade level; and 11 primary-grade subjects with speech defects. The first group was significantly superior to the second in auditory discrimination ability as measured by the WADT. They concluded that their data supported the hypothesis that poor auditory discrimination is one causal factor in reading retardation.

The auditory abilities of 188 fourth-grade children were investigated by Reynolds (1953) in four schools in Minnesota. The schools were randomly selected, and no attempt was made to separate good and poor readers or hearers. Included among the 14 tests administered were the Gates Basic Reading Test, the Bond Silent Reading Diagnostic Test, the Seashore Pitch Discrimination Test, and the Word Discrimination Test.

Reynolds found that auditory measures used for the prediction of performance on two reading tests - word recognition ability and knowledge of sound values for common word elements - were inconsistent in analyses made separately for each school. In three of the schools, the auditory measure provided a predictive value that was not significantly better than mental age. In a fourth school, it was found that measures of auditory memory span, word discrimination ability, and pitch discrimination, when combined in multiple regression equations, provided significantly better predictions of performance of the two reading tests than mental age alone.

Wheeler and Wheeler (1954) described a study in which 629 children in the fourth, fifth, and sixth grades of the Coral Gables Elementary School were given the Metropolitan Achievement Test, the Seashore Pitch Test, and an auditory discrimination test designed by the investigators to measure a subject's ability to: (a) discriminate typical word-pairs; (b) discriminate between paired sound elements and determine whether each pair was the same or different; (c) select the one word from four which did not rhyme; and (d) select from a list of three sounds the one sound which he had heard in a stimulus word previously pronounced by the examiner. The authors reported the following results: (a) a significant but very low correlation existed between the Seashore Pitch Test and the Wheeler Auditory Discrimination Test. The correlation for the fourth grade was significant at the .05 level and for the fifth and sixth grades at the .01 level; (b) a significant but low correlation (.01 level) existed between pitch discrimination and reading for children in the fifth and sixth grades, while a negligible relationship existed between pitch and reading for children in the fourth grade; and (c) all correlations of the auditory discrimination factor with reading abilities were statistically significant (.01 level); however, these correlations were low.

Templin (1954) measured the ability of the fourth-grade children in five Minneapolis schools to discriminate between consonant sounds. The 26 subjects having the highest scores on the Durrell-Sullivan Reading Test were classified as the upper reading group, and the 26 having the lowest scores were classified as the lower group. The author reported no significant differene between the scores of the upper and lower reading groups on this group test of sound discrimination. She concluded that the test was comparatively easy for fourth-grade pupils as evidenced by the number of subjects who achieved the maximum possible score.

Socioeconomic status, auditory perceptual functioning and reading. While some investigators have examined the relationship of auditory perceptual functioning to reading in disadvantaged subjects, these are few in number.

Katz and Deutsch (1963b) studied the relationship of auditory discrimination to reading among disadvantaged boys. Subjects were black males in the second and fourth grades in two Harlem schools. All students had a Lorge-Thorndike IQ above 70 and evidenced no severe emotional or physical disabilities. The Gates Advanced Primary Reading Test was administered at the beginning of the school year. Two word discrimination tests were administered to 72 subjects: one with 24 English word pairs and the other with 24 Hebrew word pairs. The inclusion of the Hebrew word pairs was to assess whether or not anticipated differences between children were due to differences in discrimination abilities or merely to differences in familiarity with the material. The researchers [illegible] the following: (a) good and poor readers were found to differ significantly on the discrimination tests, with the good readers making fewer errors on both tests; (b) all children responded better to meaningful stimuli. Meaningfulness, however, did not interact significantly with reading level, suggesting that the underlying discrimination skills rather than differences in familiarity with the stimuli differentiated the groups; and (c) the interaction of reading level with age was significant, indicating that discrimination skills differentiated the good and poor readers best at the second grade level. IQ scores were significantly related to auditory discrimination at all age levels.

Robinson and Hanson (1968) compared disadvantaged first, second, and third grade children on reliability of instruments used to measure factors related to reading success. They found that, among other tests, the Metropolitan Readiness Tests and Audiometer test were reliable in all groups; the Word Discrimination Test was reliable with disadvantaged children in the first and third grades and the Wepman was reliable with disadvantaged first, second, and third grade children, and with middle-class children in the first grade.

<u>Socioeconomic status, auditory and visual perceptual functioning, and reading</u>. The ability to make shifts from one sense [illegible] appear to be crucial for the learning of reading. The child must, for example, be able to develop correspondences between his previous auditory perceptions and words on a printed page.

Katz and Deutsch (1963a) studied the ease with which attention is shifted between auditory and visual stimuli in 48 first, third, and fifth grade black children grouped according to reading ability. A bimodal reaction time apparatus was employed. It automatically presented four separate stimuli: a red light, a green light, a high tone of 1200 cps, and a low tone of 400 cps. The subject's task was to lift his finger from a button every time a stimulus was perceived. The results indicated that older children had faster overall reaction times ($p < .001$), and that retarded readers exhibited greater difficulty than normal readers in shifting from one modality to another ($p < .01$).

Raab, Deutsch, and Freedman (1960) had earlier employed the same apparatus and procedure with 14 average readers and 10 poor readers in the fourth and fifth grades from lower-middle and lower-class families. As in the above experiment, the subject was instructed to raise his index finger as quickly as possible whenever any of the stimuli were presented. Reaction time was measured from stimulus onset to the lifting of the finger. Results indicated that poor readers showed significantly greater difficulty in making a crossmodal shift than normal readers and significantly less visual responsiveness and efficiency. No significant differences in reaction time to sound were found. Both good and poor readers formed sets to light but formed no sets to sound.

In a later investigation, Katz and Deutsch (1964) compared auditory, visual, and auditory-visual learning on a serial learning task. The subjects were good and poor readers, male, black, and in the first, third, and fifth grades. An analysis of variance of the number of correct results indicated that: (a) older subjects learned more efficiently under all the stimulus conditions; (b) the differences between good and poor readers, which were evidenced at all age levels, were greatest in younger children; (c) auditory presentation was most difficult for almost all subjects; and (d) an interaction between reading level and mode of presentation suggested that retarded readers had particular difficulty with auditory tasks.

Weiner, Wepman and Morency (1965), studying a sample of 28 good and 28 poor readers in the fourth grade, found that low auditory discrimination and low visual discrimination were both significantly correlated with low reading attainment, although not with each other. The correlation between the two perceptual tests (Wepman Auditory Discrimination Test and the Chicago Test of Visual Discrimination) was extremely low (.05). The authors concluded that there are two different learning types, related to ability to use vision and audition in gaining information: children with auditory problems who have reading difficulties and children with visual problems who have reading dificulties.

Lovell and Gorton (1965) investigated the differences between 50 backward readers, 9 to 10 years of age, and 50 normal readers, both of average intelligence, on a number of selected tests including the ITPA, the Birch and Belmont test of auditory-visual integration, Gorton's test of auditory discrimination, the Bender Visual-Motor Gestalt, Shapiro's test of rotation, a spatial orientation test and a motor impairment test. Backward readers differed from normal in the expected direction on all tests although not significantly on the test of auditory discrimination, the Bender Visual-Motor Gestalt and the Shapiro. When test scores were factor analyzed, the factor patterns of the two groups were different, such that in the backward group reading age was linked most strongly with auditory-visual integration and motor performance. This suggested to the authors that some kind of neurological impairment, not necessarily specific, may be linked with reading skills among backward readers.

Butenica (1968) studied advantaged and disadvantaged first grade youngsters to see if auditory and visual tests were related to socioeconomic background and also to reading achievement and spelling. He found that auditory and visual tests accounted for much more variance in reading than did a group IQ test; that auditory and visual perception were virtually independent of one another; and that middle-class children performed better than lower-class children on all tasks. The tests he used included: the Reversals and Picture Squares, the Visual-Motor Integration Test, the Wepman Test of Auditory Discrimination, and the Non-Verbal Auditory Discrimination Test.

In 1969 Bruininks studied the relationship of auditory discrimination to reading among black disadvantaged boys. His sample of 105 subjects had a mean age of 8 years, 7 months. Subjects were screened to insure that they had adequate auditory and visual acuity. He used a number of perceptual tests, among them the Wepman. There was a significant association between audition and reading, but he did not find a curvilinear relationship between auditory discrimination and reading as he had predicted. He also found that partial correlations between auditory tests and reading decreased markedly when verbal intelligence was controlled. He did find that it was auditory tests rather than visual, which were significantly, though not highly, correlated with reading over and above intelligence.

Weaver and Weaver (1967) reported that disadvantaged black children earn scores on the ITPA which are significantly lower than their mental ages, and that they earn scores on the subtests involving auditory and vocal channels that are significantly lower than scores obtained through visual-motor channels.

Summary

Results from studies investigating the relationship between auditory discrimination and reading with primary-grade, middle-class subjects indicate a significant difference in auditory discrimination abilities between retarded readers and subjects reading at, or above grade level: (with first grade subjects - Monroe, 1935; Dykstra, 1964; with second grade subjects - Harrington & Durrell, 1965; with first and second grade subjects - Wepman, 1960; Thompson, 1963; and with second and third grade subjects - Christine & Christine, 1964). With intermediate grade subjects, however, findings were less consistent. With fourth grade populations, Reynolds (1953), in a predictive study using a non-selected sample, and Templin (1954), in a comparison study of good and poor readers, found no significant relationship between auditory discrimination skills and reading ability; however, Wheeler and Wheeler (1954) reported that with a non-selected sample of fourth, fifth, and sixth graders, there was a low but significant correlation between pitch discrimination skill and reading ability. They found slightly higher correlations with fifth and sixth graders than with fourth graders. Also, Reynolds (1953) found that in one of the four schools in her study, auditory measures provided significantly better predictions of specific reading abilities than were provided by mental age.

In general the literature suggests that with increasing age there is a decreasing number of subjects with poor auditory discrimination (Wepman, 1960 - a decrease from first to second grade; Templin, 1954 - a ceiling effect at the fourth grade level; and Thompson, 1963 - a decrease from first to second grade).

Also, Thompson (1963) found that for good readers, a high auditory discrimination score was not characteristic of subjects whose reading level surpassed their mental age level, and that half the subjects with inaccurate auditory discrimination were poor readers. Dykstra (1964), and Thompson (1963) found significant relationships between intelligence and auditory discrimination ability on the primary grade level. Dykstra (1964) and Wheeler & Wheeler (1954) found low significant intercorrelations among auditory discrimination tests.

The few studies investigating different SES levels in relationship to auditory discrimination were all with nursery school age subjects (Clark & Richards, 1966; McArdle, 1965; and Giebink & Marden, 1968). They all found that the auditory discrimination skills of advantaged subjects were superior to those of disadvantaged subjects.

Several investigators found that the positive relationship between auditory discrimination and reading for middle-class subjects obtained for lower-class subjects as well (Katz & Deutsch, 1963b - with second and fourth graders; Katz & Deutsch, 1964 - with first, third, and fifth graders; Robinson & Hanson, 1968 - with second and third graders; Butenica, 1968 - with first graders; Bruininks, 1969 - with third graders; and Weiner, Wepman & Morency, 1965 - with fourth graders).

The methods and findings relating auditory and visual perceptual functioning to each other and to reading were varied. Generally the relationship between auditory discrimination and visual discrimination was either very slight or absent. Poorer readers among both lower and middle-class groups had more difficulty with cross-modal shifts (Katz & Deutsch, 1963a; Raab, Deutsch & Freedman, 1960).

A positive relationship between auditory discrimination and reading, as well as between visual discrimination and reading but not between auditory discrimination skills and visual discrimination skills was found by Weiner, Wepman & Morency (1965), and Butenica (1968).

In the research on auditory perceptual functioning and reading performance of subjects from advantaged environments, the findings have been inconclusive, perhaps as a result of variability among the studies in methods of sample selection and stimulus presentation. In general, the results indicate that factors such as age, sex, mental age, and auditory perceptual functioning seem to be interacting with reading skill; however, additional research is needed to determine precise relationships.

Studies investigating the auditory perceptual skills of disadvantaged subjects are fewer in number, but the findings are more consistent. Results indicate that subjects from impoverished environments achieve lower auditory discrimination scores than middle-class subjects, exhibit poorer auditory modality functioning in comparison to visual functioning, and reveal inadequate auditory perceptual skills coexistent with retarded reading achievement.

Chapter 2

Method

Subjects

The subjects were 180 white and black males from lower and middle socioeconomic status (SES) backgrounds as measured by the Institute's SES scale. They were drawn from the first, third, and fifth grades in New York City public schools. There were twelve groups of 15 subjects each, categorized as follows:

1. Lower SES, white first grade
2. Lower SES, black first grade
3. Middle SES, white first grade
4. Middle SES, black first grade
5. Lower SES, white third grade
6. Lower SES, black third grade
7. Middle SES, white third grade
8. Middle SES, black third grade
9. Lower SES, white fifth grade
10. Lower SES, black fifth grade
11. Middle SES, white fifth grade
12. Middle SES, black fifth grade

Extensive surveying of a large number of schools in different areas of New York City was necessary to obtain a sufficient [illegible] the comparison groups. Subjects were located in fifteen different schools in the Bronx, Manhattan, and Queens.

Assessment Procedures

Since project emphasis was on the auditory modality, considerable attention was given to auditory testing. The testing proceeded from the level of simply responding to the presence or absence of auditory stimulation (audiometric testing), to the level of perceptual recognition of complex auditory stimuli (IDS Auditory Masking Test), to auditory discrimination among similar sounding words (Wepman Auditory Discrimination Test).

A. Auditory Testing

1. Auditory Screening: A standard audiometric test, to ascertain whether hearing was normal, was administered to those children for whom school authorities had no audiometric record.

2. IDS Pitch Discrimination Test (Pitch Test): After pilot study results indicated that the Seashore Test, which originally was to have been used, would not be appropriate (principally because of the comparative language required in response to test items), the Pitch Discrimination Test was constructed which required the subject to discriminate between two tones 8, 12, 17, or 25 cycles apart. In 15 of the 40 comparisons, the 2nd tone was higher, and in 15 it was lower (8 cycle and 17 cycle

separation blocks of 10 items--4 higher and 4 lower 2nd tones, 2 equal tone items; 25 cycle block of 10 items--3 higher and 4 lower 2nd tones, 3 equal tones; 12 cycle block of 10 items--4 higher and 3 lower 2nd tones, 3 equal tones). The subject had to give a response of "same" or "different" which made the test consistent with the Wepman Auditory Discrimination Test. The scores for the IDS Pitch Discrimination Test included: (1) - (4) the number of correct responses made for each of the four cycle separations (8, 12, 17, and 25 cycles); (5) the total number of correct responses over the four cycle separations (Total cycles); (6) the total number of correct responses made when both tones were the same (Same score); (7) the total number of correct responses made when the second tone was higher than the first (Hi score); (8) the total number of correct responses made when the second tone was lower than the first (Lo score); and (9) the total number of correct responses over scores (6), (7), and (8) (Total Hi/Lo/Same score). Scores 6-9 were corrected for guessing.

3. IDS Auditory Masking Test (Masking Test): After previous masking tests failed to meet certain minimum requirements, three masking tests were constructed for this project. They included:

a. Masking Test I - Word x Noise (WxN): A word was played simultaneously with a white noise mask. The intensity of the white noise was initially at its highest level to make the word unintelligible. The starting point of the mask (the loudest mask) was based on the point at which the word was first recognized in the pilot sample, so that the number of masking steps varied for each item, ranging over the three Masking Tests from 10-16 steps. The noise intensity was reduced by 2 decibel steps until it disappeared altogether and only the stimulus was audible (this was taped for ease of administration). Each stimulus-noise presentation was followed by a 4 second silent period during which the subject was encouraged to identify the stimulus. The test consisted of 12 test items and two practice items. Words were monosyllables from Rineland (1945), and were among the 1,000 most frequently used words by first graders. A subject's score represented the total number of steps over all items required for each item to correctly identify the masked stimulus.

b. Masking Test II - Word x Word (WxW): A word was masked by a word. The procedure was the same as for the previous Masking Test. The test consisted of 13 test items and one practice item. A total score representing the total number of steps over all items required for each item to correctly identify the masked stimulus was again obtained.

c. Masking Test III - Nonsense x Noise (NxN): Nonsense syllables were masked by white noise. CVC consonant-vowel-consonant) trigrams of high meaningfulness (Glaze, 1928; Kreuger, 1934) were employed so as to eliminate age differences due to differential comprehension of words. There were 13 test items and one practice item, and a total score was obtained.

4. The Wepman Auditory Discrimination Test (WADT): The Wepman Auditory Discrimination Test (WADT-Special), Form II, was administered to all subjects. This test evaluates ability to perceive fine differences between similar-sounding English words. Forty word pairs are used. Ten of these are same word pairs. Of the 30 different word pairs, 13 differ in initial phoneme only (e.g., map, nap), 13 differ in final phoneme only (e.g., shot, shop), and 4 pairs differ in medial phoneme only (e.g., pet, pit). For the present study, the word pairs were prerecorded on tape to insure standardization of procedure and to avoid contamination by the varied speech characteristics of different examiners. Earphones were used for each subject, who was instructed to listen carefully, and to indicate whether the two words in each pair were the same or different. Four scores were obtained: (1) the number of correct responses when the word pairs were different in the initial phoneme; (2) the number of correct responses when the word pairs were different in the final phoneme; (3) the number of correct responses when the word pairs were different in the middle phoneme; and (4) the total number of correct responses over (1), (2), and (3).

B. Visual Discrimination and Memory Measure

The Multiple-Choice Bender-Gestalt Test (Chicago adaptation): In the first part of the test (the memory portion), after exposure to two practice items, 15 designs were shown one at a time to the subject. After each design was exposed from 3 to 5 seconds, it was removed and replaced by a card containing four designs, one of which was identical to and three of which were similar to the presented standard. The S was instructed to select the one that was the same as the one he had just seen. The second part of the test was a Matching task. After one practice trial, the same 15 stimuli used in the Memory subtest were presented. Here, however, the standard and the choices were presented simultaneously. The total number of correct responses was computed for each part of the test and could be compared with the tentative norms available. This test requires no drawing or other reproductive motor skills--only visual perception and memory are involved.

C. Attention Measure

The IDS Revision of the Continuous Performance Test (CPT): The Institute version of the Continuous Performance Test is used to measure vigilance or attention. Previous Institute studies (Deutsch, 1964 reviews this research), have shown a distinct positive relationship between performance on this test and good reading performance. This test presents, via tape recordings, a 72 item series of color names. The subject is required to respond only to the one color name, "red," by pressing a button which is linked to a timer which records his response latency. Four scores were obtained for each subject: (1) median of reaction times that fell between 100-1000 milliseconds; (2) median of reaction times that fell between 100-2000 milliseconds; (3) percent of reaction times that fell between 100-1000 milliseconds; and (4) percent of reaction times that fell between 100-2000 milliseconds.

D. Reading Tests

1. Gates Diagnostic Battery: These are widely available standard tests. The appropriate forms were selected for the third and fifth grade children. The third grade was given the Gates Advanced Primary Reading Test, Type APR, Form 2, "Reading for Grade 2 (second half) and Grade 3." This test consists of 24 paragraphs accompanied by illustrations which are to be marked in such a way as to indicate the meaning of the paragraph. A maximum of 32 correct markings is possible. The fifth grade was given the Gates Basic Reading Survey, Type GS, "Reading to Appreciate General Significance for Grade 3 (second half) through 8," which measures speed and accuracy of reading. Three scores were obtained for each subject in the third and fifth grades: Raw Score, Reading Age, and Reading Grade.

2. The IDS Reading Prognosis Test: This test was used with the first grade children who had not yet learned to read. It was designed to tap skills that are involved in the reading process for use as a predictor of reading success. It consists of six subtests grouped in three areas as follows: (1) Beginning Reading (alphabet letters, sight vocabulary); (2) Perceptual Discrimination (auditory discrimination, visual discrimination); and (3) Language (vocabulary, story telling). Total scores for each subject for each of the three areas were obtained.

E. Intelligence Measure

The Lorge-Thorndike Intelligence Tests: The Lorge-Thorndike Intelligence Tests were administered to all subjects. The first grade was given Primary Battery, Level 1, Form A; the third grade received Primary Battery, Level 2, Form A; the fifth grade was given Verbal Battery, Level 3, Form A.

Using the preceding instruments, six test batteries were administered to all subjects. The batteries are as follows:

Battery I

- IDS Pitch Discrimination Test
- Multiple-Choice Bender-Gestalt Test
- Wepman Auditory Discrimination Test

Battery II

- The Gates Diagnostic Battery (3rd & 5th grades)
- IDS Reading Prognosis Test (1st grade)

Battery III

- IDS Auditory Masking Test I
- Institute Revision of the Continuous Performance Test

Battery IV

- IDS Auditory Masking Test II

Battery V

- Lorge-Thorndike Intelligence Test

Battery VI

- IDS Auditory Masking Test III

Batteries were individually administered except for the Gates Diagnostic Battery and the Lorge-Thorndike Intelligence Test which were administered to groups of five. Each battery required approximately thirty minutes.

Chapter 3

Results

Statistical Analyses

The data were analyzed by means of correlational and analysis of variance techniques.

Correlations. A number of intercorrelation matrices was constructed in order to analyze the data: (1) an overall matrix of intercorrelations between the individual variables (See Table 1 for a listing of these) -- a total of 961 correlations; (2) two matrices (one for each SES group) intercorrelating all variables within SES--a total of 1922 correlations; (3) three intercorrelation matrices (one for each grade) comparing all variables within grade--a total of 2883 correlations; and (4) two intercorrelation matrices (one for each race) comparing all variables within race--a total of 1922 correlations. Thus, there were literally thousands of intercorrelations.

Since by chance alone there would be some significant correlations out of so large a number, in order to evaluate the significance of those obtained, patterns of correlations were looked for which made psychological sense. Certain criteria were used as guides to the selection of such patterns. Correlations which related to the hypotheses advanced were focused on first. Then, those correlations significant at $p < .05$ between demographic parameters and other variables, and between reading scores and other variables were examined.

Analyses of variance. Several analyses of variance were carried out on the Pitch Test, the Wepman Auditory Discrimination Test, and the Masking Test. These included: 1) two four-factor analyses of variance with repeated measurements on the Pitch Test; 2) a three-factor analysis of variance with repeated measurements on the Wepman Auditory Discrimination Test; and 3) nine two-factor analyses of variance on the Masking Test.

Findings

Socioeconomic status and auditory discrimination ability. It will be recalled that a major objective of this study was to determine if there were social class differences in auditory discrimination ability. Several significant correlations from the overall intercorrelation matrix (See Appendix I, Table A) tended to support the existence of differences in performance on auditory discrimination tasks according to social class. Socioeconomic Status (SES) was significantly correlated with initial phoneme (IP) and middle phoneme (MP) scores on the WADT ($r=.18$, $p < .05$ in both cases). There was a correlation of .18 ($p < .05$) between SES and Total scores on the WADT. SES was also significantly and positively

Table 1

Variables Included in Correlational Matrices

A. Multiple Choice Bender Gestalt Test:
   1. Memory Score
   2. Matching Score
B. Wepman Auditory Discrimination Test (WADT):
   1. Initial Phoneme Score (IP)
   2. Middle Phoneme Score (MP)
   3. Final Phoneme Score (FP)
   4. Total Score
C. IDS Pitch Discrimination Test:
   1. 3 Cycle Score
   2. 12 Cycle Score
   3. 17 Cycle Score
   4. 25 Cycle Score
   5. Total Cycle Score
   6. Hi Score
   7. Lo Score
   8. Same Score
   9. Total Hi/Lo/Same Score
D. IDS Auditory Masking Test (MT):
   1. Word x Noise Score (WxN)
   2. Word x Word Score (WxW)
   3. Nonsense x Noise Score (NxN)
E. IDS Revision of the Continuous Performance Test (CPT):
   1. Median Reaction Time: 100-1000 Milliseconds (RT 100-1000)
   2. Median Reaction Time: 100-2000 Milliseconds (RT 100-2000)
   3. Percent Reaction Time: 100-1000 Milliseconds (% 100-1000)
   4. Percent Reaction Time: 100-2000 Milliseconds (% 100-2000)
F. IDS Reading Prognosis Test (RPT):
   1. Beginning Reading Score
   2. Language Score
   3. Perceptual Discrimination Score
   4. Total Score
G. Gates Diagnostic Battery:
   1. Raw Score
   2. Reading Grade Score
   3. Reading Age Score
H. Lorge-Thorndike IQ Score
I. Chronological Age
J. Race
K. Socioeconomic Status (SES)
L. Grade in School

correlated with a number of Pitch Test measures (25 cycles[1]: r = .16, $p < .05$; 17 cycles: r = .21 $p < .01$; 12 cycles: r = .19, $p < .05$; and Total cycles: r = .19, $p < .05$), indicating that at least some auditory discrimination skills are better developed in middle-class children than in lower-class children. On the other hand, there were no significant correlations between SES and any of the Masking Test (MT) or Continuous Performance Test (CPT) scores.

Among blacks (see Table 2) there were significant correlations between SES and Total WADT scores (r = .23, $p < .05$), and between SES and Total Hi/Lo/Same Pitch Scores (r = .24, $p < .05$) as well as between SES and three Pitch subtest scores (17 cycles:

Table 2

Correlations Between SES and Auditory Discrimination Measures According to Racial Groups

	Blacks	Whites
Wepman Auditory Discrimination Test:		
Initial Phoneme	.21	.15
Middle Phoneme	.19	.17
Final Phoneme	.19	.08
Total	.23*	.13
[illegible]		
Word x Noise	.03	.20
Word x Word	.04	.19
Nonsense x Noise	.02	.07
IDS Pitch Discrimination Test:		
25 cycles	.15	.18
17 cycles	.30**	.13
12 cycles	.20	.18
8 cycles	.07	.03
Total cycles	.20	.19
Hi	.21*	.07
Lo	.28*	.11
Same	.12	.07
Total Hi/Lo/Same	.24*	.10
Continuous Performance Test:		
R T 100-1000 msecs.	.13	.16
R T 100-2000 msecs.	.15	.17
% 100-1000 msecs.	.01	.21
% 100-2000 msecs.	.04	.22*

*$p < .05$
**$p < .01$

[1] These numbers, it will be recalled, refer to the number of cycles separating the two tones presented.

r = .30, $p < .01$; Hi:[2] r = .21, $p < .05$; Lo: r = .28, $p < .05$). Thus, middle SES black children did better on these tests than did lower SES black children. There were no significant correlations on the intercorrelation matrix within the black group between SES and any of the Masking Test or CPT measures.

The only significant correlation between SES and any of the auditory discrimination measures for whites was between SES and the CPT %100-2000 scores ($r = .22$, $p < .05$).

The relationship between SES and auditory discrimination was strongest for grade one and diminished from then to grade three and further from grade three to grade five (See Table 3).

Table 3

Correlations Between SES and Auditory Discrimination Measures According to Grades

	Grade 1	Grade 3	Grade 5
Wepman Auditory Discrimination Test:			
Initial Phoneme	.25*	.28*	.07
Middle Phoneme	.25	.22	.08
Final Phoneme	.21	.10	.05
Total	.27*	.14	.16
Auditory Masking Test:			
Word x Noise	.05	.23	.01
Word x Word	.17	.05	.18
Nonsense x Noise	.04	.02	.17
IDS Pitch Discrimination Test:			
25 cycles	.13	.15	.21
17 cycles	.20	.26*	.18
12 cycles	.24	.10	.23
8 cycles	.24	.07	.14
Total cycles	.19	.18	.22
Hi	.22	.15	.05
Lo	.31*	.13	.16
Same	.07	.07	.28*
Total Hi/Lo/Same	.12	.14	.24
Continuous Performance Test:			
R T 100-1000 msecs.	.25*	.17	.06
R T 100-2000 msecs.	.27*	.22	.04
% 100-1000 msecs.	.22	.15	.12
% 100-2000 msecs.	.20	.10	.15

*$p < .05$
**$p < .01$

[2]Hi refers to the number of correct responses made when the second tone was higher than the first; Lo to the number of correct responses when the second tone was lower than the first.

At the first grade level there were significant correlations between SES and WADT initial phoneme and Total scores ($r = .25$, $p < .05$; and $r = .27$, $p < .05$, respectively), as well as between SES and one Pitch Test score (Lo: $r = .31$, p .05), and two CPT scores (RT 100-1000: $r = .25$, $p < .05$; RT 100-2000: $r = .27$, $p < .05$). In the third grade, SES was significantly correlated with WADT initial phoneme scores ($r = .28$, $p < .05$), and one Pitch Test score (17 cycles: $r = .26$, $p < .05$), whereas the only auditory discrimination scores that were related to SES at the fifth grade level were the Pitch Test Same scores ($r = .28$, $p < .05$). Thus, as on the overall intercorrelation matrix, neither the MT scores, final phoneme (FP) scores, 8 cycle Pitch Test scores, Total Hi/Lo/Same Pitch Test scores, nor either of the CPT % scores were related in any grade to SES. While the two CPT RT scores were significantly correlated with SES at the first grade level, there were no significant correlations between SES and the CPT at the third and fifth grade levels. While IP and Total WADT scores were significantly correlated with SES at the first grade level, only the SES-IP correlation was significant at the third grade level. No significant correlations between SES and the WADT were obtained at the fifth grade level.

A three factor analysis of variance on the Wepman data--the factors were SES, race and initial/final phoneme--with repeated measurements for first grade subjects only[3] yielded a significant main effect of SES ($F = 4.20$, $p < .05$), but no other significant main or interaction effects (See Table 4).

Table 4

Analysis of Variance for the Wepman Auditory Discrimination Test Scores for the First Grade in Different SES Groups and Racial Groups over Phonemes (Initial and Final)

Source	df	MS	F
Between Ss	59		
A (SES)	1	27.07	4.20*
B (Race)	1	11.41	1.77
AB	1	8.01	1.24
Error (between)	56	6.44	
Within Ss	60		
C (Phoneme)	1	5.21	2.51
AC	1	.01	<1
BC	1	.01	<1
ABC	1	.01	<1
Error (within)	56	2.08	

*$p < .05$

[3] Third and fifth grade scores were excluded because they clustered around the ceiling of the test.

The analyses of variance for the Pitch Test also supported the hypothesis. Two four-factor analyses of variance--grade by socioeconomic status by race by pitch cycle (Table 5), and grade by socioeconomic status by race by Hi/Lo trials (Table 6)--were performed on the data. SES was one of the main significant effects: $F = 8.44$, $p < .01$, and $F = 7.70$, $p < .001$ respectively. An examination of means (Table 7) showed that middle-class children made a greater number of correct responses over cycles ($\bar{X} = 25.76$) than did lower-class children ($\bar{X} = 22.87$). Middle class children also made more correct responses over Hi/Lo/Same trials than did lower-class children ($\bar{X} = 14.20$ vs. 11.53). These results tend to isolate poorer auditory discrimination as a major characteristic of lower SES children.

Table 5

Analysis of Variance for IDS Pitch Discrimination Test Scores in Different Grades, SES Groups, and Racial Groups over Cycles

Source	df	MS	F
Between SS	179		
A (Grade)	2	30.56	2.84#[a]
B (SES)	1	91.02	8.44**
C (Race)	1	5.69	< 1
AB	2	1.70	< 1
AC	2	32.23	2.99#
BC	1	4.67	< 1
ABC	2	11.79	1.09
Error (between)	168	10.78	
Within Ss	540		
D (Cycle)	3	332.30	95.83**
AD	6	3.37	< 1
BD	3	10.09	2.91*
CD	3	17.18	4.96**
ABD	6	3.09	< 1
ACD	6	3.15	< 1
BCD	3	2.65	< 1
ABCD	6	.74	< 1
Error (within)	504	3.47	

# $p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$

[a]Correlations significant at the $p < .10$ level were considered non-significant in the interpretation of results, but are noted in the tables for purposes of additional understanding of findings.

Table 6

Analysis of Variance for IDS Pitch Discrimination Test Scores in Different Grades, SES Groups and Racial Groups over Hi/Lo Trials

Source	df	MS	F
Between Ss	179		
A (Grade)	2	7.24	< 1
B (SES)	1	60.84	7.70***
C (Race)	1	.40	< 1
AB	2	4.94	< 1
AC	2	24.03	3.04#
BC	1	14.40	1.82
ABC	2	27.30	3.46*
Error (between)	168	7.90	
Within Ss	180		
D (Hi/Lo)	1	24.54	13.89***
AD	2	6.01	3.40*
BD	1	2.50	1.42
CD	1	.28	< 1
ABD	2	.53	< 1
ACD	2	1.48	< 1
BCD	1	1.34	< 1
ABCD	2	1.74	< 1
Error (within)	168	1.77	

#p< .10
*p< .05
***p< .001

Table 7

Mean Number of Correct Responses for the IDS Pitch Discrimination Test for Lower and Middle Socioeconomic Groups

	Socioeconomic Group	
IDS Pitch Discrimination Test:	Lower	Middle
25 cycles	7.09	7.87
17 cycles	5.93	7.04
12 cycles	5.64	6.57
8 cycles	4.20	4.27
Total over cycles	22.87	25.76
Hi trials	1.72	2.33
Lo trials	2.14	3.06
Same trials	7.67	8.76
Total over Hi/Lo/Same trials	11.53	14.20

Reading skill and auditory discrimination ability. A related hypothesis stated that in order for a child to begin to learn to read, a basic level of auditory discrimination must be attained. It was not possible to include reading performance as one of the variables in the overall intercorrelation matrix because different reading tests were used in each of the three grades (the IDS Reading Prognosis Test at the first grade level; the Gates Advanced Primary Reading Test, Type APR, Form 2 at the third grade level; and the Gates Basic Reading Survey, Type GS at the fifth grade level). Reading performance, however, was included as a variable in each of the three grade intercorrelation matrices, so that the relationship between reading and other variables could be evaluated within each grade level.

Examining the grade intercorrelation matrices confirmed a relationship between reading and auditory discrimination ability in all three grades, however, this relationship was strongest in the first grade (See Table 8). Here, the language scores on the IDS Reading Prognosis Test (RPT) were significantly correlated with scores on the MT Word x Word (WxW) ($r = -.32$, $p < .05$) and Nonsense x Noise (NxN) ($r = -.34$, $p < .01$) Tests; WADT IP scores ($r = .42$, $p < .01$), FP scores ($r = .26$, $p < .05$), and Total scores ($r = .36$, $p < .01$); and the CPT % 100-1000 ($r = .26$, $p < .05$). Beginning reading scores were significantly correlated with WADT IP ($r = .32$, $p < .01$), and Total scores ($r = .26$, $p < .05$); Pitch Test 25 cycle ($r = .25$, $p < .05$), and Same scores ($r = .29$, $p < .05$); and with two CPT measures (% 100-1000: $r = .38$, $p < .01$; % 100-2000: $r = .36$, $p < .01$).

There were no significant correlations between any of the first grade Reading Prognosis Test scores and the WADT middle phoneme scores, MT Word x Noise (WxN) Test scores, any of the Pitch Test 17, 12, or 8 cycle scores, Total cycle, Hi scores, Lo scores, Total Hi/Lo/Same scores, or either of the CPT RT measures. Language scores were also not significantly correlated with Pitch Test Same scores or CPT % 100-2000 scores. Beginning Reading scores were also not significantly related to either WADT final phoneme scores, or to the Masking Test WxW and NxN scores.

As would be expected, there were several significant correlations between the Perceptual Discrimination scores of the RPT and auditory discrimination measures. Perceptual Discrimination scores were significantly correlated with WADT IP ($r = .48$, $p < .01$), FP ($r = .26$, $p < .05$), and WADT Total scores ($r = .39$, $p < .01$); Masking Test WxW ($r = -.38$, $p < .01$), and NxN scores ($r = -.36$, $p < .01$); Pitch Test Same scores ($r = .31$, $p < .05$); and CPT % 100-1000 ($r = .46$, $p < .01$) and % 100-2000 ($r = .48$, $p < .01$) scores.

Total reading scores were significantly correlated with WADT IP ($r = .49$, $p < .01$), FP ($r = .28$, $p < .05$), and WADT Total scores ($r = .40$, $p < .01$); with Masking Test NxN scores ($r = -.28$, Tabl 8

Correlations Between the I S Reading Prognosis Test (First Grade) and Audito y Discrimination Scores

	Begin ng Read g	Language	Perceptual Discrimination	Total Score
Wepman Auditory Discrimination Test:				
Initial Phoneme	.32**	.42**	.48**	.49**
Middle Phoneme	.10	.21	.23	.21
Final Phoneme	.18	.26*	.26*	.28*
Total	.26*	.36**	.39**	.40**
Auditory Masking Test:				
Word x Noise	.15	-.08	-.01	.05
Word x Word	.05	-.32*	-.38**	-.23
Nonsense x Noise	-.06	-.34**	-.36**	-.28*
IDS Pitch Discrimination Test:				
25 cycles	.25*	.15	.19	.25*
17 cycles	.07	.04	.03	.05
12 cycles	.12	.18	.22	.20
8 cycles	-.04	.07	.07	.03
Total cycles	.04	.14	.13	.12
Hi	-.06	-.04	-.04	-.06
Lo	-.09	-.03	.02	-.05
Same	.29*	.11	.31*	.30*
Total Hi/Lo/Same	.18	.06	.23	.20
Continuous Performance Test:				
R T 100-1000 msecs.	-.11	-.04	-.15	-.13
R T 100-2000 msecs.	-.15	-.09	-.21	-.19
% 100-1000 msecs.	.38**	.26*	.46**	.46**
% 100-2000 msecs.	.36**	.20	.48**	.43**

*p< .05
**p< .01

p .05); with Pitch Test 25 cycle ($r = .25$, $p < .05$) and Same scores ($r = .30$, $p < .05$); and with CPT % 100-1000 ($r = .46$, $p < .01$) and % 100-2000 ($r = .43$, $p < .01$) scores. In addition to the above mentioned auditory measures that were not significantly related to any of the reading measures, Total reading scores were also not significantly related to Masking Test WxW scores.

In the third grade there were several significant correlations between reading scores on the Gates Advanced Primary Reading Test and auditory discrimination scores (see Table 9). Gates Reading Grade scores were significantly correlated with WADT IP, MP and Total scores ($r = .25$, $.26$, and $.29$ respectively, $p < .05$); Gates Raw scores were also significantly correlated with Wepman IP, MP and Total scores ($r = .27$, $.25$, and $.29$ respectively, $p < .05$). Reading Grade scores were also significantly correlated with Masking Test WxN and WxW scores (for both, $r = .25$, $p < .05$). There were significant correlations between reaction time scores on the CPT and reading scores. Gates Reading Grade scores were significantly correlated with RT 100-1000 ($r = -.32$, $p < .05$), and with RT 100-2000 ($r = -.34$, $p < .01$). Gates Raw Scores were also significantly correlated with CPT reaction time scores (RT 100-1000: $r = -.36$, $p < .01$; RT 100-2000: $r = -.39$, $p < .01$). There were no significant correlations in the third grade between Reading Age and any of the auditory discrimination measures. Neither Gates Reading Grade nor Gates Raw Scores were significantly correlated with either WADT FP scores, Masking NxN scores, any of the Pitch Test scores or either of the CPT % scores. Gates Raw Scores were also not significantly correlated with the Masking Test WxW or WxN scores.

In the fifth grade (See Table 9), 13 of the 27 correlations between the Pitch Test and the Gates Basic Reading Survey were significant, with r s ranging from .25 to .41. However, the five significant correlations between the Reading Grade scores and the Pitch Test (17 cycles; $r = .25$, $p < .05$; Total cycles: $r = .33$, $p < .01$; Lo: $r = .34$, $p < .01$; Same: $r = .29$, $p < .05$; Total Hi/Lo/Same: $r = .33$, $p < .01$) were the only significant correlations between Reading Grade scores and any of the auditory discrimination measures. Similarly, the eight significant correlations between Gates Raw Scores and the Pitch Test (25 cycles: $r = .32$, $p < .01$; 17 cycles: $r = .34$, $p < .01$; 12 cycles: $r = .32$, $p < .05$; Total cycles: $r = .41$, $p < .01$; Hi: $r = .32$, $p < .05$; Lo: $r = .38$, $p < .01$; Same: $r = .36$, $p < .01$; and Total Hi/Lo/Same: $r = .41$, $p < .01$) were the only significant correlations between Gates Raw Scores and any of the auditory discrimination measures. Gates Reading Age was significantly correlated only with WADT Total scores ($r = .27$, $p < .05$). Although not as substantial as the first grade findings, these data supported the notion that auditory discrimination is one of the factors mediating between social class and reading performance.

Table 9

Correlations Between the Gates Diagnostic Battery[a] (Third and Fifth Grades) and Auditory Discrimination Scores

	Third Grade			Fifth Grade		
	Reading Grade	Raw Score	Reading Age	Reading Grade	Raw Score	Reading Age
Wepman Auditory Discrimination Test:						
Initial Phoneme	.25*	.27*	.02	.10	.14	.22
Middle Phoneme	.26*	.25*	.06	.07	.07	.03
Final Phoneme	.18	.17	-.10	.02	.04	.08
Total	.29*	.29*	-.04	.14	.18	.27*
Auditory Masking Test:						
Word x Noise	-.25*	-.22	.01	.01	-.01	.14
Word x Word	-.25*	-.22	-.14	-.05	-.07	-.01
Nonsense x Noise	.01	.01	-.18	.07	.05	.08
IDS Pitch Discrimination Test:						
25 cycles	.11	.10	-.14	.24	.32**	.10
17 cycles	.09	.11	-.05	.25*	.34**	.03
12 cycles	.01	.01	-.21	.22	.32*	-.06
8 cycles	-.03	-.04	.13	.13	.02	-.04
Total cycles	.07	.07	-.11	.33**	.41**	-.01
Hi	-.05	-.06	.04	.22	.32*	-.10
Lo	.09	.10	.00	.34**	.38**	.09
Same	-.03	-.02	-.18	.29*	.36**	.02
Total Hi/Lo/Same	-.01	.00	-.13	.33**	.41**	.00
Continuous Performance Test:						
R T 100-1000 msecs.	-.32*	-.36**	-.06	-.08	.06	.06
R T 100-2000 msecs.	-.34**	-.39**	-.06	-.08	.06	.05
% 100-1000 msecs.	.15	.19	-.04	.16	.15	.15
% 100-2000 msecs.	.12	.15	-.02	.16	.10	.22

*$p < .05$
**$p < .01$

[a]The Gates Advanced Primary Reading Test, Type APR, Form 2 was administered at the first grade level; the Gates Basic Reading Survey, Type GS was administered at the fifth grade level.

Relationship between Visual and Auditory Discrimination Skills. Another objective of this study was concerned with exploring the possible relationship between levels of auditory discrimination skills and the visual perceptual skills involved in reading. Examining the overall intercorrelation matrix again (Appendix I, Table A), it can be seen that all of the correlations between the Multiple Choice Bender-Gestalt and the WADT were significant: the range of correlations was from $r = .19$, p .05 (Matching with MP) to $r = .45$, $p < .01$ (Matching with IP). All the correlations between the Multiple Choice Bender-Gestalt and the CPT were also significant, ranging from $r = .22$ to $.37$, $p < .01$; as were all the correlations with the Masking Test ($r = .23$ to $.38$, $p < .01$). There were only four significant correlations between the Multiple Choice Bender-Gestalt and the Pitch Test and these all involved the Matching subtest (25 cycles: $r = .22$, $p < .01$; Total cycles: $r = .19$, $p < .05$; Same scores: $r = .18$, $p < .05$; and Total Hi/Lo/Same scores: $r = .16$, $p < .05$).

At the first grade level (See Table 10), there were three significant correlations between the Memory subtest of the Multiple Choice Bender-Gestalt and the WADT (IP: $r = .30$, FP: $r = .26$, and Total: $r = .31$, $p < .05$); and one significant correlation between the Matching subtest and the WADT (IP: $r = .30$, $p < .05$). There were three significant correlations between the Memory subtest of the Multiple Choice Bender-Gestalt and the CPT (RT 100-2000: $r = .29$, $p < .05$; % 100-1000: $r = .32$, $p < .05$; % 100-2000: $r = .26$, $p < .05$). There were no significant correlations at the first grade level between the Multiple Choice Bender-Gestalt and any of the Masking Test or Pitch Test scores. The other nonsignificant correlations were the Memory subtest scores with the WADT MP scores, Matching scores with WADT MP, FP, and Total scores, Memory scores with CPT RT 100-1000 scores and Matching scores with all CPT scores.

At the third grade level (Table 10) there were two significant correlations between the Multiple Choice Bender-Gestalt Matching scores and the WADT IP and MP scores ($r = .27$, $p < .05$, $r = .36$, $p < .01$ respectively), and one between the Memory subtest scores and the CPT RT 100-2000 scores ($r = .27$, $p < .05$). There were no significant correlations between the Multiple Choice Bender-Gestalt scores and either the Masking Test or Pitch Test scores, nor were the Memory subtest scores significantly correlated with any of the WADT scores, the CPT RT 100-1000 scores or either of the CPT % scores. Matching scores were not significantly related to WADT FP and Total scores nor to any of the CPT scores.

In the fifth grade, three WADT scores were significantly related to the Multiple Choice Bender-Gestalt: IP scores with Memory scores and Matching scores ($r = .28$, $p < .05$; and $r = .50$, $p < .01$ respectively) and FP scores with Memory scores ($r = .29$, $p < .05$). The Memory subtest scores were also significantly corre-

Table 10

Correlations Between Auditory Discrimination Measures and Visual Discrimination Measures (Multiple Choice Bender-Gestalt) for Each Grade

	Grade 1		Grade 3		Grade 5	
	Memory	Matching	Memory	Matching	Memory	Matching
Wepman Auditory Discrimination Test:						
Initial Phoneme	.30*	.30*	.21	.27*	.28*	.50**
Middle Phoneme	.17	.02	.10	.36**	.09	.07
Final Phoneme	.26*	.10	.14	.02	.29*	.09
Total	.31*	.19	.06	.23	.14	.19
Auditory Masking Test:						
Word x Noise	.01	.04	.21	.14	.03	.06
Word x Word	.02	.01	.16	.16	.20	.22
Nonsense x Noise	.08	.06	.03	.18	.15	.06
IDS Pitch Discrimination Test:						
25 cycles	.02	.23	.04	.03	.22	.22
17 cycles	.24	.02	.12	.04	.30*	.22
12 cycles	.15	.07	.08	.03	.23	.07
8 cycles	.13	.07	.08	.09	.21	.20
Total cycles	.11	.09	.07	.01	.24	.19
Hi	.17	.02	.10	.08	.19	.15
Lo	.23	.00	.06	.03	.27*	.10
Same	.02	.17	.00	.05	.22	.21
Total Hi/Lo/Same	.11	.13	.05	.01	.26*	.20
Continuous Performance Test:						
R T 100-1000 msecs.	.21	.14	.22	.04	.16	.13
R T 100-2000 msecs.	.29*	.18	.27*	.07	.15	.12
% 100-1000 msecs.	.32*	.24	.07	.15	.16	.13
% 100-2000 msecs.	.26*	.21	.01	.14	.24	.21

*$p < .05$
**$p < .01$

lated with three Pitch Test scores: 17 cycle scores, Lo scores, and Total Hi/Lo/Same scores ($r = .30$, $.27$, and $.26$, respectively, $p < .05$). There were no significant correlations between the Multiple Choice Bender-Gestalt and either the Masking Test or CPT scores. Neither Memory nor Matching scores were significantly correlated with either WADT MP or Total scores. Matching scores were, in addition, not significantly correlated with WADT FP scores. There were no significant correlations between the Matching subtest scores and any of the Pitch Test scores. Memory subtest scores were not significantly correlated with either 25, 12, or 8 cycle scores, Hi scores, or Same scores.

The relationship between auditory and visual discrimination was about as strong for middle as for lower SES children (See Table 11). There were 21 significant correlations out of 22 for lower SES children and 17 out of 22 for middle SES children between the Memory and Matching scores of the Multiple Choice Bender-Gestalt and the WADT, Masking Test, and CPT scores. However, there were only three significant correlations between Pitch Test scores and the Matching scores for middle SES children and none between Pitch Test scores and either the Memory or Matching scores for lower SES children.

The relationship between auditory and visual discrimination was also about equally as strong for black as for white subjects (Table 12). There were 21 significant correlations out of 22 for blacks and 19 out of 22 for whites between the Memory and Matching scores of the Multiple Choice Bender-Gestalt and the WADT, Masking Test, and CPT scores. Again, however, while there were no significant correlations between the Multiple Choice Bender-Gestalt and the Pitch Test for blacks, there were eight significant correlations between the Multiple Choice Bender-Gestalt and the Pitch Test for whites.

It would seem from the results cited above that the relationship between auditory and visual discrimination skills is a linear and positive one, at least for the subjects in this study.

Related findings. Although not central to the hypotheses of this study, a number of other findings are of peripheral interest. There were several significant correlations between reading test scores and visual discrimination scores, IQ, Race, and SES (Table 13). At the first grade level there were significant correlations between all of the reading test scores and both Multiple Choice Bender-Gestalt subtests, i.e., eight significant correlations ranging from $r = .36$ to $.58$, $p < .01$). There were also significant correlations between all of the reading test scores and SES (range: $r = .26$, $p < .05$ to $r = .38$, $p < .01$); Race (range: $r = .27$, $p < .05$ to $r = .47$, $p < .01$); and IQ (range: $r = .33$ to $r = .45$, $p < .01$). At the third grade level there were four significant correlations out of six correlations between the Multiple Choice Bender-Gestalt and the reading test

Table 11

Correlations Between Auditory Discriminatio Measures and Visual Discrimination Measures (Multiple Choice Bender-Gest lt) According to SES Groups

	Memo		Matching	
	Lower SES	iddle SES	Lower SES	Middle SES
Wepman Auditory Discrimination Test:				
Initial Phoneme	.38**	.38**	.38**	.52**
Middle Phoneme	.24*	.12	.22*	.01
Final Phoneme	.32**	.23*	.21	.27*
Total	.27*	.38**	.23*	.48**
Auditory Masking Test:				
Word x Noise	.25*	.29**	.22*	.23*
Word x Word	.36**	.38**	.36**	.32**
Nonsense x Noise	.26*	.25*	.27*	.24*
IDS Pitch Discrimination Test:				
25 cycles	.13	.11	.16	.25*
17 cycles	.01	.08	.04	.17
12 cycles	.01	.11	.09	.08
8 cycles	.03	.03	.07	.13
Total cycles	.05	.18	.14	.20
Hi	.05	.06	.04	.02
Lo	.00	.01	.08	.06
Same	.12	.12	.02	.34**
Total Hi/Lo/Same	.08	.10	.05	.24*
Continuous Performance Test:				
R T 100-1000 msecs.	.35**	.17	.30**	.09
R T 100-2000 msecs.	.44**	.23*	.38**	.13
% 100-1000 msecs.	.43**	.40**	.41**	.40**
% 100-2000 msecs.	.37**	.30**	.34**	.40**

*p < .05
**p < .01

Table 12

Correlations Between Auditory Discrimination Measures and Visual Discrimination Measures (Multiple Choice Bender-Gestalt) According to Racial Groups

	Memory		Matching	
	Blacks	Whites	Blacks	Whites
Wepman Auditory Discrimination Test:				
Initial Phoneme	.33**	.50**	.43**	.46**
Middle Phoneme	.23*	.22*	.14	.29*
Final Phoneme	.30**	.25*	.25*	.19
Total	.35**	.25*	.36**	.24*
Auditory Masking Test:				
Word x Noise	.34**	.23*	.31**	.16
Word x Word	.43**	.29**	.38**	.30**
Nonsense x Noise	.34**	.18	.26*	.27*
IDS Pitch Discrimination Test:				
25 cycles	.09	.16	.15	.28*
17 cycles	.03	.18	.03	.26*
12 cycles	.04	.22*	.02	.22*
8 cycles	.00	.00	.09	.08
Total cycles	.06	.21	.12	.28*
Hi	.06	.14	.00	.12
Lo	.08	.18	.08	.25*
Same	.04	.18	.12	.20
Total Hi/Lo/Same	.02	.22*	.06	.25*
Continuous Performance Test:				
R T 100-1000 msecs.	.28*	.34**	.23*	.24*
R T 100-2000 msecs.	.35**	.42**	.30**	.30**
% 100-1000 msecs.	.38**	.47**	.44**	.36**
% 100-2000 msecs.	.29**	.43**	.38**	.34**

*p < .05
**p < .01

Table 13

Correlations Between Reading Measures and Visual Discrimination Measures (Multiple Choice Bender-Gestalt), IQ, Race, and SES for Each Grade

	Memory	Matching	IQ	Race	SES
First Grade:					
Beginning Reading	.36**	.44**	.39**	.27*	.26*
Language	.38**	.38**	.37**	.47**	.33**
Perceptual Discrimination	.48**	.58**	.33**	.37**	.34**
Total	.50**	.58**	.45**	.44**	.38**
Third Grade:					
Reading Grade	.26*	.27*	.54**	.04	.49**
Raw Score	.24	.25*	.51**	.04	.47**
Reading Age	.15	.31*	.00	.16	.05
Fifth Grade:					
Reading Grade	.11	.04	.56**	.34**	.28*
Raw Score	.06	.10	.61**	.42**	.21
Reading Age	.07	.02	.17	.35**	.16

*$p < .05$
**$p \leq .01$

scores (range: r = .25 to r = .31, p < .05). Two of the three correlations between SES and reading test scores were significant (r = .49 and .47, p < .01), as were two of the three correlations between IQ and reading test scores (r = .54, and .51, p < .01). There were no significant correlations between race and reading test scores at the third grade level. At the fifth grade level there were no significant correlations between the Multiple Choice Bender-Gestalt and any of the reading test measures. There was one significant correlation, however, between SES and reading test scores (r = .28, p < .05), three significant correlations between race and reading test scores (range: r = .34 to r = .42, p < .01), and two significant correlations between IQ and reading test scores (r = .56 and .61, p < .01).

On the overall intercorrelation matrix (Appendix I, Table A) there was a number of significant correlations between auditory discrimination measures and age, grade, and IQ, while there were only a few between auditory discrimination measures and race. Older children, as opposed to younger ones, did better on all four WADT scores (range: r = .21 to r = .35, p < .01), on the three Masking Test scores (range: r = .35 to r = .51, p < .01), on the Total cycles Pitch Test scores (r = .22, p < .01), and on the four scores of the CPT (range: r = .39, to r = .52, p < .01). This same cluster occurred for the grade variable: children in the higher grades had higher scores than children in the lower grades on all WADT scores (range: r = .22 to r = .34, p < .01), all Masking Test scores (range: r = .36 to r = .52, p < .01), the Total cycles Pitch Test score (r = .22, p < .01), and all CPT scores(range: r = .38 to r = .52, p < .01). IQ was related to auditory discrimination as indicated by the correlations between IQ and all four WADT scores (range: r = .16 to r = .19, p < .05), one of the Masking Test scores (WxW: r = .25, p < .01), the Total cycles Pitch Test scores (r = .25, p < .01), and the Total Hi/Lo/Same Pitch Test scores (r = .29, p < .01), and the two % CPT scores (% 100-1000: r = .18, p < .05; % 100-2000: r = .16, p < .05). The only significant correlations between race and auditory discrimination scores were with three subtest scores of the Pitch Test (25 cycle and 8 cycle scores: r = .17, p < .05 in both cases) and Same scores: r = .23, p < .01).

There were also several significant correlations between visual discrimination measures and age, grade, IQ, and SES (Appendix I, Table A). The correlations between age and the Memory and Matching subtests of the Multiple Choice Bender-Gestalt were respectively r = .54 and .52, p < .01; between the Memory and Matching subtests and grade the correlations were r = .56 and .53, p < .01. Similarly, IQ and the Memory and Matching subtests were significantly correlated (r in both cases = .36, p < .01). While there were no significant correlations between the Multiple Choice Bender-Gestalt and race, the Matching test of the Multiple Choice Bender-Gestalt was significantly correlated with SES (r = .18, p < .05).

The results were also examined in a very general way to see if, over all scores, differences between SES groups' scores were greater within the black groups or within white samples, and also to see whether the differences between black and white groups were greater for the lower SES Samples or for the middle SES samples.

Conflicting results are to be found in the literature for such comparisons. A study which attempted to tease out ethnic and class variables in level and patterning of mental ability was reported by Lesser, Fifer, and Clark (1965). They studied middle and lower-class samples of first grade children in each of four different ethnic-racial groups: Blacks, Chinese, Jews, and Puerto Ricans. They found that both SES and cultural background were related to level of score on the Hunter tests, a specially constructed scale that yielded ratings of verbal ability, space conceptualization, reasoning and numerical ability. Within each ethnic group the middle-class children did better than the lower-class children. While the ethnic groups differed in their performance levels, for the entire sample, middle-class children were significantly superior to lower-class children on all scales and subtests. Within the black group there was a greater difference in scores between class levels than was true for any of the other three groups. Within class groups and across ethnic groups there was a greater similarity among the four ethnic groups than among the lower-class groups. In a replication of this study by Stodolsky and Lesser (1967) with lower and middle-class Chinese, black, and Irish Catholic children in Boston, results were again that SES differences within the black group were greater than those within either of the other two groups.

These findings are in contrast to the results of studies reported by the Institute for Developmental Studies (Deutsch & Brown, 1964; Whiteman, Brown & Deutsch, 1967; Whiteman & Deutsch, 1967) which compared classes and races on IQ scores and on a number of skills thought to underlie and/or relate to intellective functioning. Using the Lorge-Thorndike Test (non-verbal form) and the Vocabularly subtest from the Wechsler Intelligence Scale for Children (WISC), Deutsch and his associates gathered data on 543 children in a random stratified sample including equal subsamples of black and white, first grade and fifth grade children at SES levels I, II, and II on the Institute's SES scale. They found, in contrast to the Lesser, Fifer, and Clark (1965) and the Stodolsky and Lesser (1967) findings, that black and white groups were farther apart at each higher SES level, and that there was less differentiation between SES groups in the black, as opposed to the white sample.

Results for the present project are more in accord with the Institute's previous findings (Table 14). At the first grade level the differences between lower and middle-class groups were greater for whites than for blacks on 18 out of 27 scores and at the third grade level on 18 of the 28 scores. Thus on approximately two-thirds of the scores there were greater differences between lower and middle-class groups' scores for whites than for blacks, i.e., there was less differentiation between SES groups in the black as opposed to the white sample at both the first and third grade levels. At the fifth grade level, however, on 19 of the 28 scores, differences between lower and middle SES groups' scores were greater for blacks than for whites.

Table 14

Frequencies of Differences Between SES Groups Within Race, and Between Racial Groups Within SES[a]

			Grade	
		First	Third	Fifth
Number of Differences Between SES Groups Within Racial Groups				
Black (LvsM) White (LvsM)		9/27	10/28	19/28
White (LvsM) Black (LvsM)		18/27	18/28	9/28
	X^2	3.00	2.28	3.58
Number of Differences Between Racial Groups Within SES Groups				
Lower-Class (BvsW) Middle-Class (BvsW)		11/27	8/28	15/28
Middle-Class (BvsW) Lower-Class (BvsW)		16/27	20/28	13/28
	X^2	.92	5.14*	.14

*$p < .05$

[a]Included in this analysis were scores on the WADT, Masking Test, Pitch Test, CPT, reading tests, Multiple Choice Bender-Gestalt Test, and Lorge-Thorndike Intelligence Test.

Results also indicated that, at the first and third grade levels, at least, differences between black and white scores were greater for middle-class groups than for lower-class groups. Thus, at the first and third grade levels, on only 11 out of the 27 scores respectively, were the differences between black and white scores greater for the lower-class groups than for the middle-class groups. At the fifth grade level, however, again the trend was reversed. On fifteen out of the 28 scores, differences between racial groups were greater at the lower SES level than at the middle SES level.[4]

Most of the auditory discrimination measures were intercorrelated. The Wepman Auditory Discrimination Test was included in this study as a basic measure of auditory discrimination. Standardization data are available for the WADT, and in earlier studies at the Institute for Developmental Studies (Deutsch (1964) reviews some of this research) this test significantly discriminated good from poor readers. The reliability (Kuder-Richardson formula) for first graders[5] on the WADT was .85. The Wepman was significantly correlated (Appendix I, Table A) with scores on the Masking Test (11 of the 12 correlations were significant -- range: $r = .16$, $p < .05$ to $r = .32$, $p < .01$); with the CPT scores (12 of the 16 correlations were significant -- range: $r = 17$, $p < .05$ to $r = .48$, $p < .01$); and with the Pitch Test scores (15 of the 36 correlations were significant -- range: $r = .16$, $p < .05$ to $r = .28$, $p < .01$).

The IDS Pitch Discrimination Test was developed specifically for this study. It was included in the test battery so that auditory discrimination could be broken down into "purer" sound discrimination ability as distinguished from the verbal discrimination tapped by the WADT. However, as was just noted, there was a number of significant and positive correlations between subtests on the WADT and subtests on the Pitch Test (15 out of the 36 correlations -- Appendix I, Table A). Nine of the 27 correlations between the Pitch Test and the Masking Test were significant (range: $r = .16$, $p < .05$ to $r = .26$, $p < .01$), as were 16 of the 36 correlations between the Pitch Test and the CPT (range: $r = .16$, $p < .05$ to $r = .28$, $p < .01$). In a sense, these correlations serve to validate the Pitch Test as a measure of auditory discrimination. The reliability of the Pitch Test as given by the Kuder-Richardson formula was .85.

Some interesting findings about the Pitch Test and subjects' responses to it emerged from the analyses of variance performed on the Pitch Test data (See Tables 5 and 6). In the first analysis of variance, the variables were Grade, SES, Race, and Pitch Cycle. There were two significant main effects: SES ($F = 8.44$, $p < .01$) noted earlier, and Cycle ($F = 95.83$, $p < .001$). The Cycle finding indicated that subjects made the greatest mean number of correct responses discriminating between tones separa-

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[4]Chi square analyses were run on these difference frequencies at each grade level. Only at the third grade level were the differences significant ($X^2 = 5.14$, $p < .05$).

[5]As has already been noted, third and fifth grade scores were excluded because they clustered around the ceiling of the test.

ted by 25 cycles, mean number of correct responses diminishing successively from 17, to 12, to 8 cycles (the mean scores were 7.48, 6.49, 6.12 and 4.23 respectively -- Appendix II, Table A. Many subtest scores on the Pitch Test were significantly correlated with each other (Appendix I, Table A). So, for example, among cycle responses, the number of correct responses made when two tones were separated by 12 cycles was significantly correlated with the number of correct responses made when two tones were separated by 17 cycles ($r = .75$, $p < .01$), and by 25 cycles ($r = .62$, $p < .01$). Seventeen and 25 cycle responses were also significantly correlated with each other($r = .68$, $p < .01$). There was a noticeable lack of significant correlations, however, between 8 cycle responses and responses made at any other cycle level. From this it may be inferred that it was very difficult for subjects to discriminate two tones only 8 cycles apart. The interaction between SES and Cycle was also statistically significant ($F = 2.91$, $p < .05$). While the number of correct responses to each cycle level successively decreased from the 25 cycle to the 8 cycle level, the decrease was more dramatic for middle-class children than for lower-class children (See Table 7).

In the second analysis of variance on the Pitch Test scores in which the variables were Grade, SES, Race and Hi/Lo (the last dimension, it will be remembered, refers to the number of correct discriminations made when the second of two tones presented was either higher or lower than the first), the main effect of Hi/Lo was statistically significant ($F = 13.89$, $p < .001$), i.e., subjects who made a greater number of correct responses when the second tone was lower than the first discriminated better generally than did those who made a greater number of correct responses when the second tone was higher than the first.

The Masking Tests included in the battery were adaptations of masking tests used in earlier research at the Institute for Developmental Studies. They represented experimentally controlled variations in the signal-to-noise ratio. It was expected that children from noisy environments, ones with low signal-to-noise ratios, would take longer to identify the masked stimuli in each test. As was pointed out earlier, such youngsters would be those from a low SES background and might well be those who suffer from reading retardation. It turned out, as has already been noted, that, contrary to expectations, there were no significant correlations between any of the Masking Test scores and either SES or race. However, analyses of variance were performed on the Masking Test data for each of the three grades (Tables 15-23). Because noise level and amount of disruption varied among schools, school was included as an independent variable. Nine tests were performed in all: Word x Noise by School, Nonsense x Noise by School, and Word x Word by School for each of the three grades. In two cases, significant school effects were found. These were in the first grade on the Word x Noise test ($F = 2.64$, $p < .05$), and in the fifth grade on the Word x Word test ($F = 3.02$, $p < .05$).

As has already been reported, there were significant correlations between the Masking Test and the WADT scores (11 out of 12); and the Masking Test and the Pitch Test (9 out of 27). There were also 11 significant correlations out of the 12 correlations between the Masking Test and the CPT (range: $r = .16$, $p < .05$ to $r = .31$, $p < .01$). These correlations offered some evidence for the validity of the Masking Test as a measure of auditory discrimination.

As has been mentioned, scores on the CPT were significantly correlated with WADT scores (11 out of 16), Masking Test scores (11 out of 12) and Pitch Test scores (16 out of 36). Its correlations with other measures of auditory discrimination would seem to indicate that the CPT, while a measure of attention and vigilance, is also a good measure of auditory discrimination.

Table 15
Analysis of Variance of IDS Auditory Masking Test Scores, Word x Noise, First Grade[a]

Source		df	MS	F
Between		4	615.620	2.638*
Within		51	233.360	
	Total	55		

*$p < .05$

[a]Four subjects were omitted from the first grade Masking Test analyses of variance: one because scores were not obtainable on one of the three Masking Tests, and three because they were the only subjects from one of the schools represented.

Table 16
Analysis of Variance of IDS Auditory Masking Test Scores, Word x Word, First Grade

Source		df	MS	F
Between		4	275.247	0.658
Within		51	418.120	
	Total	55		

Table 17
Analysis of Variance of IDS Auditory Masking Test Scores, Nonsense x Noise, First Grade

Source	df	MS	F
Between	4	317.453	.419
Within	51	756.909	
Total	55		

Table 18
Analysis of Variance of IDS Auditory Masking Test Scores, Word x Noise, Third Grade

Source	df	MS	F
Between	5	69.04	.296
Within	54	232.84	
Total	59		

Table 19
Analysis of Variance of IDS Auditory Masking Test Scores, Word x Noise, Third Grade

Source	df	MS	F
Between	4	325.17	1.134
Within	55	286.67	
Total	59		

Table 20
Analysis of Variance of IDS Auditory Masking Test Scores, Nonsense x Noise, Third Grade

Source	df	MS	F
Between	4	127.78	.482
Within	55	264.69	
Total	59		

Table 21
Analysis of Variance of IDS Auditory Masking Test Scores, Word x Noise, Fifth Grade[a]

Source	df	MS	F
Between	3	346.113	.564
Within	50	204.372	
Total	53		

[a]Six subjects were omitted from the fifth grade Masking Test analyses of variance because they represented two schools with only four subjects in one and two subjects in the other.

Table 22
Analysis of Variance of IDS Auditory Masking Test Scores, Word x Word, Fifth Grade

Source	df	MS	F
Between	3	681.891	3.017*
Within	50	225.963	
Total	53		

*$p < .05$

Table 23
Analysis of Variance of IDS Auditory Masking Test Scores, Nonsense x Noise, Fifth Grade

Source	df	MS	F
Between	3	19.235	.081
Within	50	237.195	
Total	53		

Chapter 4

Discussion and Conclusions

In view of the large number of correlations reported in the results section, it may aid the reader to glance at the following summary of results principally connected with the hypotheses of this study.

Results Supporting a Relationship Between SES and Auditory Discrimination

Number of significant correlations between SES and auditory discrimination:

	WADT	Masking	Pitch	CPT	Total
All Subjects:	3	0	5	0	8
First Grade:	2	0	2	2	6
Third Grade:	1	0	1	0	2
Fifth Grade:	0	0	1	0	1
Black Subjects:	1	0	4	0	5
White Subjects:	0	0	0	1	1
Total	7/24	0/18	13/54	3/24	23/120

Analyses of Variance:

WADT: SES main effect for first grade analysis
Pitch Test: SES main effect -- Grade x SES x Race x Cycles
SES main effect -- Grade x SES x Race x Hi/Lo Trials

Results Supporting a Relationship Between Auditory Discrimination and Reading

Number of significant correlations between reading scores and auditory measures:

	WADT	Masking	Pitch	CPT	Total
First Grade:	11	5	3	7	26
Third Grade:	6	1	0	4	11
Fifth Grade:	1	0	13	0	14
Total	18/40	6/30	16/90	11/40	51/200

Results Supporting a Relationship Between Visual and Auditory Discrimination

Number of significant correlations between the ltiple Choice Bender-Gestalt and auditory measures:

	WADT	Masking	Pitch	CPT	Total
All Subjects:	8	6	4	8	40
First Grade:	4	0	0	3	7
Third Grade:	2	0	0	1	3
Fifth Grade:	3	0	0	0	3
Black Subjects:	7	6	0	8	21
White Subjects:	6	4	8	8	26
Lower-Class Subjects:	7	6	0	8	21
Middle-Class Subjects:	6	6	3	5	20
	43/64	28/48	15/144	41/64	127/320

Results Supporting a Relationship Between Auditory Discrimination and IQ, Race, and Grade

Number of significant correlations between auditory measures and IQ, Race, and Grade:

	IQ	Race	Grade
All Subjects:	9/20	3/20	12/20

Results Supporting a Relationship Between Visual Discrimination and IQ, Race, SES, and Grade

Number of significant correlations between visual discrimination measures and IQ, Race, SES, and Grade:

	IQ	Race	SES	Grade
All Subjects:	2/2	0/2	1/2	2/2

Results Supporting a Relationship Between Reading and IQ, Race, SES, and Visual Discrimination

Number of significant correlations between reading scores and IQ, Race, SES, and the Multiple Choice Bender-Gestalt:

	IQ	Race	SES	Multiple Choice Bender-Gestalt
First Grade:	4	4	4	8
Third Grade:	2	0	2	4
Fifth Grade:	2	3	1	0
Total	8/10	7/10	7/10	12/20

While the experimental design of this study does not permit the definition of cause-effect relationships, it does make possible some pinpointing of attributes more characteristic of one experimentally defined group than of another, and of those variables more closely associated with one area of ability than with another.

The results tend to confirm the expectation that poor auditory discrimination is one factor distinguishing lower SES children from middle SES children. That a relationship between SES and auditory discrimination exists in the data is seen in the significant correlations on the overall matrix between SES and the Wepman Test of Auditory Discrimination (WADT), and the IDS Pitch Discrimination Test, as well as in the significant main effect of SES in the analyses of variance of the Pitch Test and the WADT. These findings are consistent with the expectation of greater difficulty with these tests for children from noisy slum environments with a low rate of verbal interchange, and a high noise/low signal ratio. Such conditions are not conducive to the early development of good auditory discrimination skills. The findings are also consistent with the literature. Those studies reviewed in the Introduction which investigated the relationship between SES and auditory discrimination ability (Clark & Richards, 1966; McArdle, 1965; Giebink & Marden, 1968), though few in number, all found that middle-class nursery school children did better on auditory discrimination tasks than did their disadvantaged counterparts. The current results lend support to those earlier findings by extending them to older age groups.

The stronger relationship between SES and auditory discrimination for blacks than for whites may reflect the possibility that a disadvantaged environment has more deleterious effects for the black child than for the white child. Also possible, and more likely, is that the disadvantaged black child's environment may be more disadvantaged than the disadvantaged white child's, creating a greater difference between SES groups for blacks than for whites, and thus the possibility of a stronger correlation between SES and auditory discrimination for black children.

The decrease with age of the relationship between SES and auditory discrimination may reflect gains in general discrimination ability acquired perhaps through school learning experiences. The ceiling effect on the WADT also suggests this interpretation.

Neither the Masking Test nor the Continuous Performance Test yielded the SES discrimination that had been anticipated. The WADT is more dependent than the Masking Test or the CPT on verbal discrimination as opposed to sound discrimination, and this dependence on verbal stimuli might account for its differentiating between social class groups. In addition, the WADT differs from the CPT and Masking Tests in its demand for refined discriminations between vowel and consonant sounds as opposed to discriminations which locus on different levels of meaningfulness of materials. The Masking Test, for example, was constructed in part in fact along a dimension of meaningfulness (word by noise, word by nonsense syllable, word by word). Lower SES children, as compared to middle SES children, then, do not have greater difficulty discriminating between words of highly differentiated meanings which also sound quite different. On the CPT, the sounds were quite distinct as were the meanings. The Pitch Test, while not concerned with meaningful discriminations, did require a finer sound discrimination than did the other measures.

An SES by initial/final phoneme interaction was anticipated in the analysis of variance for the WADT first grade data, because of earlier findings at IDS, but none was obtained. The significant correlations between SES and the WADT involved initial and medial phoneme scores but not final phoneme scores; i.e., lower-class children had more difficulty with initial and medial phonemes than did middle-class children. This relationship between initial phoneme and SES was significant in the first and third grades but not in the fifth grade. Since previously it was found that the final parts of word pairs cause lower-class children greater difficulty, this issue would warrant further exploration in future studies.

The analyses of variance on the Masking Tests did yield two significant effects for school (words masked by noise in the first grade; and words masked by words in the fifth grade -- both at the $p < .05$ level). One can speculate that perhaps the immediate environment plays a more important role in auditory discrimination than has been thought. Does the pattern of the classroom or the noise level of the neighborhood play a part in this result? Again this finding must be considered a lead for future study when classroom organization can be measured as a variable and when the classroom noise level can be measured as well.

The second objective of this project was to explore the relationship between auditory discrimination and reading and, further, to examine if age differences exist in this hypothesized relationship. As indicated in the results section, the within-grade correlation matrices confirmed the existence of a relationship between auditory discrimination skill and reading ability in all three grades. The relationship was strongest in the first grade, where reading was significantly correlated with the WADT, Masking Test, Pitch Test, and CPT (there were 26 significant correlations out of the 80 correlations between reading and auditory discrimination measures at the first grade level). In the third grade, reading scores were significantly correlated with the WADT, Masking Test, and CPT (11 significant correlations out of 60); and the Pitch Test and one WADT measure (14 significant correlations out of 60). It would seem that it is at the most significant phase of learning to read -- i.e., the beginning -- that auditory discrimination ability is critical. Over all three grades the two tests on which poorer performance was associated with lower SES were also associated with poorer reading performance: the WADT and the Pitch Test. These tests would seem to be the strongest indicators of auditory discrimination ability as well as of potential reading difficulty. They may in fact represent measures of a mediating variable between SES level and reading skill.

The finding of 11 significant correlations between Pitch Test scores and reading in the fifth grade, none in the third grade, and only three in the first grade, together with many more significant correlations between WADT scores and reading scores for first and third graders than for fifth graders, suggests that auditory discrimination of verbal stimuli is a cruder and less complex skill than fine auditory discrimination of pure tones. Pitch discrimination may not have been sufficiently developed in the first and third grades to have been reflected in a correlation with reading, while discrimination of verbal stimuli was apparently sufficiently developed in first and third graders to be reflected in correlations with reading. By fifth grade, however, the level of discrimination of verbal stimuli is generally high enough so that the WADT no longer discriminates between reading level groups. It may also be that the significant correlations between Pitch Test scores and reading scores at the fifth grade level reflect better concentration and attending abilities of older children, such abilities facilitating both reading and tone discrimination.

While those studies cited in the Introduction suggest the existence of a similar relationship between auditory discrimination and reading, i.e., a decreasing one with age, there is no clear pattern to be derived from the literature reviewed that would indicate the kinds of auditory discrimination skills that would contribute to the decrease in that relationship. The studies which demonstrated a positive relationship between auditory discrimination and reading with first, second, and/or third grade subjects (Monroe, 1935; Dykstra, 1964; Harrington & Durrell, 1965; Wepman, 1960; Thompson, 1963; Christine & Christine, 1964) used auditory measures involving blending of sounds, auditory memory, pronunciation, and discrimination of initial and final consonant sounds as in the WADT. With fourth, fifth, and sixth grade subjects a positive relationship between auditory discrimination, and reading was not found by either Reynolds (1953), or Templin (1954) using pitch tests, word discrimination tests, and consonant sound tests, while Wheeler and Wheeler (1954) did find a relationship between Seashore Pitch Test scores and reading ability.

The present data in general supported a relationship between levels of auditory discrimination skill and the visual perceptual skills involved in reading. The Multiple Choice Bender-Gestalt was significantly correlated with the WADT, Masking Test, Pitch Test and CPT, as indicated on the overall correlation matrix. At the first and third grade levels the significant relationship between auditory and visual discrimination skills involved the WADT and the CPT, although the number of significant correlations declined from seven at the first grade level to three at the third grade. At the fifth grade level, the Multiple Choice Bender-Gestalt was significantly correlated with the WADT and the Pitch Test, rather than with the CPT (six significant correlations). It is of note that at the first grade level most of the significant correlations between the Multiple Choice Bender-Gestalt and the CPT involved the Memory subtest of the Multiple Choice Bender-Gestalt. Both attention and memory are important factors in both of these tests and probably are characteristics in which there is a great deal of variability at the first grade level. At the fifth grade level, the CPT was not significantly correlated with the Multiple Choice Bender-Gestalt, possibly because attention was no longer a differentiating variable.

The significant correlations between the Multiple Choice Bender-Gestalt and the WADT, most of them at the $p < .01$ level, are somewhat surprising in view of the finding reported by Weiner, Wepman, and Morency (1965), of only a low correlation between the two tests, and by Butenica who found no relationship between auditory and visual perceptual skills. These authors argue that good (or poor) auditory discrimination and good (or poor) visual discrimination are not related; children with auditory problems who have reading difficulties are a different group from those children who have visual problems and reading difficulties. However, in the present study it would seem that there is a relationship between auditory and visual discrimination skills and it is a linear and positive one. What may well be reflected here is the difference between a public school and a clinic population, the latter being referred for reading problems. The typology of reading disability may be very different from the typology of reading-perceptual relationships in a normal sample.

The finding of a decrease in the relationship between visual discrimination and reading as grade level advanced is consistent with the observed relationship between auditory discrimination and reading. It is difficult, however, to assess which relationship is strongest from the data, since the number of measures is so disparate. Nonetheless it would appear that auditory discrimination is more closely related to reading ability since by the fifth grade there were no correlations between visual discrimination and reading, while there was still a number of correlations between auditory discrimination test measures and reading scores. Scores from a larger battery of visual discrimination tests would be required before any valid conclusion comparing the relative strengths of these relationships could be drawn, however.

Since a positive relationship was found between SES and auditory discrimination and between auditory discrimination and reading, the significant relationship between SES and reading would be expected. The findings of high correlations between IQ and reading ability are consistent with the literature, which indicates that a number of factors such as age, IQ, and auditory and visual perceptual functioning interact with reading skill. The association of race with reading ability at the first and fifth grade levels but not at the third grade level may be simply a function of the different reading tests employed. This finding warrants further exploration as it may well be spurious.

The finding that auditory discrimination was, in general, highly and positively correlated with school grade level is consistent with that of Wepman (1960), Templin (1954), and Thompson (1963), who found that with increasing age there was a decreasing number of subjects with poor auditory discrimination, and with Katz and Deutsch (1963), who found a stronger relationship between auditory discrimination and reading at the second than at the fourth grade level.

Previous Institute findings are supported by the present results showing that for first and third grades black and white groups were farther apart at each higher SES level. (At the fifth grade level the differences between racial groups were about the same at each SES level). These data also indicate less differentiation between SES groups in the black as opposed to the white sample, at the first and third grade levels. (At the fifth grade level this relationship was reversed). These results, together with previous Institute work, conflict with findings of Lesser, Fifer, and Clark (1965) and Stodolsky and Lesser (1967) whose studies are described in the Results section of this report. The sources of the discrepancy might well be so much variation on so many procedural and methodological dimensions as to render the studies almost fully noncomparable. Thus, the samples employed by the Lesser, Fifer and Clark and the Stodolsky and Lesser studies involved racial-ethnic groups of Blacks, Chinese, Jews, Puerto Ricans and Irish Catholics, whereas the Institute's samples were groups designated as blacks and whites. While Lesser, Fifer, and Clark, and Stodolsky and Lesser used only lower- and middle-class first graders, the Institute's studies employed lower- and middle-class first, third, and fifth grade subjects. It may be that a variable such as age interacts in different ways at different SES levels, and that the explanation for the discrepancy will ultimately lie within a complex interactive framework.

An example of how mode of data analysis may be responsible for such discrepancies can be seen in a study by Tulkin (1968). He assigned 389 fifth and sixth grade children to one of two SES groups, based on an adaptation of Hollingshead's ratings. School records provided scores for all subjects on the Lorge-Thorndike Intelligence Test and the Iowa Test of Basic Skills. The experimenter developed and administered a questionnaire on family background which yielded information on family participation, cultural participation, and family structure, including number of siblings, crowdedness of family living conditions, maternal employment, and marital status of parents. Results were analyzed in terms of racial differences within SES, and in terms of SES differences within racial groups as in the previous studies mentioned. On every measure, SES differences within racial groups were significant beyond the .001 level of confidence. For the race-within-class comparisons, there were more significant differences in the upper SES group than in the lower (three-fourths of the measures vs. one-half). Thus in this respect the Tulkin findings are consistent with the Institute findings: SES was a more differentiating factor than was race. However, Tulkin then used his environmental measures as covariates to determine their role in producing the racial differences, and found that the covariates reduced the Fs in the upper SES group but not in the lower SES group. On this basis, Tulkin concluded that his results were not consistent with the finding that racial differences are greater at the higher SES levels, and suggested that the different SES scales may be a source of the inconsistency. But had Tulkin interpreted only the results of his initial analyses and not continued to the covariate analysis, his findings would have been consistent with the earlier work: there were substantially more race-within-class differences at the upper SES level than at the lower. Since the earlier investigators do not report covariance analyses of the same type, it does not seem possible to determine on the basis of current data that the two findings are inconsistent. Other differences between the Tulkin and Institute studies include the different ages of the subjects (fifth and sixth graders vs. first, third and fifth graders); the different geographical locations (in dealing with environmental variables there is no reason to assume that suburban Maryland and metropolitan New York City are comparable); the different SES measures employed, and the different family background measures. In the face of these differences, it should be noted that they came to the same broad conclusions: that SES is highly related to performance measures in children, and that, overall, SES is more highly related to both performance and environmental variables than is race. What is unanswered is whether race is a more potent variable at different SES levels, and if so, at what levels.

<u>Summary</u>

The results obtained in the present study do for the most part support the hypothesis that poor auditory discrimination is a major intervening variable between social conditions and reading retardation. While these results were not obtained on each measure of auditory discrimination applied, they did hold consistently for the WADT, especially at the lowest age level. Since the WADT is a word discrimination measure, it seems clear that the auditory discrimination of words is related to their visual discrimination. Since this effect was weaker in older children, it also seems clear that auditory discrimination of verbal stimuli can mature, with or without concomitant reading skill. It is, however, interesting to note that for the older children pitch discrimination is related to reading skill. Whether this is because both reading and pitch discrimination require a high level of attention, or whether some more complicated relationship between fine auditory discrimination and reading skill is indicated, cannot be answered at this point.

A strong picture of the developmental process emerges from these data. Reference to the tables at the beginning of this chapter shows very clearly that different relationships among variables obtain at the different age groups of subjects. Apart from the theoretical interest of this finding, it has a pointed practical implication: teaching and remedial training must be oriented differently for children of different ages. The child in the fifth grade who cannot read is likely to show a vastly different pattern of auditory skills, for example, than the child in the third grade with a reading problem. These different patterns must be taken into account in any remedial program if it is to be successful. This finding points up the reasoning in an earlier IDS-sponsored study in which negative results were found for the training of auditory skills in retarded readers, without the concomitant teaching of the application of the auditory skills to their reading (Feldmann & Deutsch, 1966). The point is also made by Deutsch and Deutsch (1967) that any compensatory training must take into account age and developmental level, not just for the selection of content but for understanding of the relationships among basic processes, which they hypothesized would be different at different ages. The present results certainly seem to confirm that approach.

In a sense, the present study also illustrates the truth of the understanding that one can tap into the developmental process [illegible] skill, and that the data which result will enhance our knowledge of the process.

As is typically true of research, each study raises and spotlights as many questions as it may answer; the present one is no exception. It points clearly to the need for more studies of the relationships among perceptual and linguistic skills, and between social-environmental-experiential factors and basic psychological and behavioral processes.

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Appendix 1
Overall Intercorrelation Matrix

Abbreviations Used

L-T: Lorge-Thorndike Intelligence Test

B-G: Multiple Choice Bender-Gestalt Test
a. Mem. - Memory Subtest
b. Match. - Matching Subtest

WADT: Wepman Auditory Discrimination Test
a. IP - Initial Phoneme Score
b. MP - Middle Phoneme Score
c. FP - Final Phoneme Score
d. Tot. - Total Score

Masking Test: IDS Auditory Masking Test
a. WxN - Word x Noise Score
b. WxW - Word x Word Score
c. NxN - Nonsense x Noise Score

Pitch Test: IDS Pitch Discrimination Test
a. 25 - 25 Cycle Score
b. 17 - 17 Cycle Score
c. 12 - 12 Cycle Score
d. 8 - 8 Cycle Score
e. Tot. - Total Cycle Score
f. Hi - High Score
g. Lo - Low Score
h. Same - Same Score
i. Tot. - Total Hi/Lo/Same Score

CPT: IDS Revision of the Continuous Performance Test
a. RT 100-1000 - Median Reaction Time: 100-1000 ms.
b. RT 100-2000 - Median Reaction Time: 100-2000 ms.
c. % 100-1000 - Percent Reaction Time: 100-2000 ms.
d. % 100-2000 - Percent Reaction Time: 100-2000 ms.

CA: Chronological Age

SES: Socioeconomic Status

Overall Correlation Matrix

		L-T					B-G		WADT				Masking Test		
		IQ	CA	Race	SES	Grade	Mem.	Match.	IP	MP	FP	Tot.	WxN	WxW	NxN
L-T	IQ		-.12	.29	.29	.17	.36	.36	.19	.16	.19	.19	-.10	.25	-.15
	CA			-.02	-.02	--	.54	.52	.35	.21	.33	.33	.35	.51	.33
	Race				--	--	-.15	-.12	-.14	.00	-.09	-.03	-.04	-.07	.00
	SES					--	-.15	.18	.18	.18	-.08	.18	-.09	-.11	-.05
	Grade						.56	.53	.34	.22	.30	.30	.37	.52	.36
B-G	Mem.							.23	.40	.22	.29	.32	.28	.38	.26
	Match.								.45	.19	.24	.32	.23	.35	.26
WADT	IP									.39	.54	.77	.16	.32	.28
	MP										.63	.62	-.11	.27	.23
	FP											.80	.23	.32	.30
	Tot.												.18	.32	.28
Masking Test	WxN													.51	.44
	WxW														.54
	NxN														

Overall Correlation Matrix (Continued)

		Pitch Test									CPT			
		25	17	12	8	Tot.	Hi	Lo	Same	Tot.	RT 100-1000	RT 100-2000	% 100-1000	% 100-2000
Pitch Test	25		.68	.62	-.15	.78	.51	.54	.68	.80	-.12	.17	.27	.25
	17			.75	-.04	.83	.68	.70	.54	.79	-.14	.17	.19	.18
	12				-.02	.82	.73	.67	.54	.79	-.13	.16	-.14	-.14
	8					-.16	.35	.31	.36	-.08	-.13	.15	-.07	-.01
	Tot.						.77	.75	.53	.81	-.15	.19	.21	.18
	Hi							.64	.27	.66	.16	-.19	-.08	-.05
	Lo								.19	.60	-.05	.19	-.10	-.06
	Same									.87	-.06	-.08	.23	.28
	Tot.										-.10	-.14	.22	.24
CPT	RT 100-1000											.97	.48	.39
	RT 100-2000												.60	.47
	% 100-1000													.95
	% 100-2000													

Overall Correlation Matrix (Continued)

		Pitch Test									CPT			
		25	17	12	8	Tot.	Hi	Lo	Same	Tot.	RT 100-1000	RT 100-2000	% 100-1000	% 100-2000
L-T	IQ	.29	.22	.20	-.01	.25	.19	-.14	.26	.29	-.15	-.17	.18	.16
	CA	-.15	-.14	-.12	-.05	.22	-.06	-.05	-.14	-.13	.39	.45	.52	.45
	Race	.17	-.07	-.04	.17	-.08	-.04	-.01	.23	-.16	-.13	-.09	-.08	-.10
	SES	.16	.21	.19	-.02	.19	-.14	.20	-.09	-.17	-.14	-.45	-.11	-.09
	Grade	-.16	-.15	-.14	-.05	.22	-.09	-.07	-.13	-.14	.38	.45	.52	.44
B-G	Mem.	-.14	-.07	-.08	-.03	-.14	-.02	-.02	-.13	-.11	.28	.36	.42	.36
	Match.	.22	-.13	-.12	-.01	.19	-.05	-.05	.18	.16	.22	.28	.41	.37
WADT	IP	-.14	-.16	-.12	-.01	.18	.00	-.09	-.13	-.12	-.15	.22	.46	.48
	MP	-.04	.18	-.16	-.10	.17	-.15	-.13	-.04	-.11	-.10	.17	.31	.32
	FP	.17	.20	.16	-.01	.20	-.09	-.13	-.14	.17	-.12	.20	.37	.38
	Tot.	.23	.24	.21	-.01	.26	-.09	.16	.18	.20	-.12	.21	.42	.44
Masking Test	WxN	.22	-.09	.22	-.11	.23	.16	-.12	-.14	.18	.19	.22	.22	.16
	WxW	-.08	-.14	.18	-.13	.20	-.15	-.09	-.11	-.15	.19	.24	.31	.28
	NxN	-.10	-.15	-.15	-.01	-.15	-.04	-.07	.18	.16	-.15	.18	.27	.26

Appendix II
Mean Scores

Table A
Mean Scores for All Subjects and for Each Grade, Socioeconomic Status, and Race on Each Measure

	Grade			SES		Race		
	First	Third	Fifth	Lower	Middle	Black	White	All Subjects
N	60	60	60	90	90	90	90	180
Chronological Age (months)	82.47	106.47	105.05	106.90	106.24	106.13	107.01	106.57
Lorge-Thorndike:	99.28	97.43	105.05	96.64	104.53	96.66	104.52	100.59
IDS Reading Prognosis Test[a]: (First Grade Only)								
Total Score	44.38							
Beginning Reading Score	14.22							
Language Score	13.60							
Perceptual Discrim. Score	16.55							
Gates Diagnostic Battery:								
Raw Score		18.22	9.67					
Reading Age		106.73	128.00					
Reading Grade		37.78	53.02					
Wepman Auditory Discrimination Test:								
Initial Phoneme	10.92	12.13	12.30	11.48	12.09	11.56	12.01	11.78
Middle Phoneme	3.68	3.90	3.95	3.76	3.93	3.84	3.84	3.84
Final Phoneme	10.50	11.78	11.75	11.21	11.48	11.19	11.50	11.34
Total	25.10	27.82	27.67	26.22	27.50	26.59	27.13	26.86
Bender-Gestalt:								
Memory Score	6.85	9.07	10.92	8.50	9.39	8.49	9.40	8.94
Matching Score	10.15	12.33	13.78	11.60	11.58	11.76	12.42	12.09

[a]All scores represent mean number of correct responses unless otherwise indicated.

Table A (continued)

	Grade			SES		Race		All Subjects
	First	Third	Fifth	Lower	Middle	Black	White	
Masking Test[a]:								
Word x Noise Score	82.85	73.23	66.27	75.72	72.51	73.33	74.90	74.12
Word x Word Score	104.05	92.73	77.28	93.72	88.99	92.86	89.86	91.36
Nonsense x Noise Score...	100.77	89.53	80.92	91.55	89.28	90.44	90.37	90.41
Pitch Discrimination Test:								
25 cycle score	6.93	7.65	7.87	7.09	7.87	7.07	7.90	7.48
17 cycle score	6.10	6.33	7.03	5.93	7.04	6.31	6.67	6.49
12 cycle score	5.75	6.00	6.57	5.64	6.57	6.01	6.20	5.12
8 cycle score	4.02	4.45	4.23	4.20	4.27	4.54	3.92	4.23
Total cycles score	22.32	24.43	25.70	22.87	25.76	23.93	24.69	24.24
Hi Scores	1.83	1.92	2.33	1.72	2.33	2.11	1.94	2.03
Lo Scores	2.25	2.93	2.62	2.14	3.06	2.62	2.58	2.60
Same Scores	7.50	7.80	9.33	7.67	8.76	6.83	9.59	8.21
Total Hi/Lo/Same Scores..	11.65	12.65	14.30	11.53	14.20	11.62	14.11	12.87
IDS Revision of the Continuous Performance Test[b]:								
Median RT 100-1000......	569.22	554.50	500.40	551.69	531.06	532.02	550.72	541.37
Median RT 100-2000......	599.98	569.58	506.00	571.84	545.20	550.38	566.67	541.37
% of Responses 100-1000.	77.12	84.60	92.73	83.50	86.13	83.81	85.82	84.82
% of Responses 100-2000.	85.62	90.58	96.12	89.94	91.60	89.81	91.73	90.77

[a]Masking Test scores refer to the number of steps required to correctly identify the masked stimulus.
[b]CPT scores refer to the median of reaction times that fell between the indicated range of milliseconds, or the percent of reaction times that fell between the indicated range of milliseconds.

Table B
Mean Scores for the First Grade for Each Race and SES and for Each Race-SES Combination on All Measures

	Race-SES				SES		Race	
	White Low	Black Low	White Middle	Black Middle	Low	Middle	White	Black
N	15	15	15	15	30	30	30	30
Lorge-Thorndike:								
CA	82.67	82.87	83.60	80.73	82.77	82.17	83.13	81.80
IQ	101.07	90.47	104.13	101.47	95.77	102.80	102.60	95.97
IDS Reading Prognosis Test:								
Total Score	43.93	36.07	55.07	42.47	40.00	48.77	49.50	39.27
Beg. Read. Score	13.53	11.73	18.20	13.40	12.63	15.80	15.97	12.57
Language Score	14.00	10.67	18.00	12.93	12.33	15.47	16.00	11.80
Perceptual Discrim. Score	16.40	13.67	20.00	16.13	15.03	18.07	18.20	14.90
Wepman Auditory Discrimination Test:								
Initial Phoneme	11.00	9.87	11.47	11.33	10.43	11.40	11.23	10.60
Middle Phoneme	3.67	3.33	3.80	3.93	3.50	3.87	3.73	3.63
Final Phoneme	10.60	9.46	11.00	10.93	10.03	10.96	10.80	10.20
Total	25.27	22.66	26.27	26.19	23.96	26.23	25.76	24.43
Bender-Gestalt:								
Memory Score	7.13	5.00	8.00	7.27	6.07	7.63	7.57	6.13
Matching Score	10.47	8.33	11.47	10.33	9.40	10.90	10.97	9.33
Masking Test:								
Word x Noise	95.86	80.53	80.47	83.47	87.93	81.97	87.90	82.00
Word x Word	110.71	105.60	94.33	106.67	108.07	100.50	102.24	106.13
Nonsense x Noise	111.21	100.06	96.40	102.80	105.45	99.60	103.55	101.43

Table B (continued)

	Race-SES				SES		Race	
	White Low	Black Low	White Middle	Black Middle	Low	Middle	White	Black
Pitch Discrimination Test:								
25 cycle score	6.80	6.40	8.13	6.40	7.37	8.37	8.47	7.27
17 cycle score	5.60	6.13	6.53	6.67	6.57	7.50	7.67	6.40
12 cycle score	5.20	5.20	6.53	6.07	5.97	7.17	7.30	5.83
8 cycle score	3.13	4.00	4.13	4.80	4.43	4.03	4.17	4.30
Total cycles scores	20.73	21.20	25.33	23.93	20.97	24.63	23.03	22.57
Hi Scores	1.13	1.53	2.13	2.53	1.33	2.33	1.63	2.03
Lo Scores	1.00	2.07	2.67	3.27	1.53	2.97	1.83	2.67
Same Scores	8.60	7.20	9.20	5.00	7.90	7.10	8.90	6.10
Total Hi/Lo/Same Scores	10.73	10.80	14.00	11.07	10.76	12.53	12.37	10.93
IDS Revision of the Continuous Performance Test:								
Median RT 100-1000	600.53	575.00	568.93	539.07	587.77	554.00	584.73	557.03
Median RT 100-2000	627.87	613.33	598.07	567.33	620.60	582.70	612.97	590.33
% of Responses 100-1000	73.53	74.87	83.07	77.00	74.20	79.90	78.30	75.93
% of Responses 100-2000	82.27	84.67	90.07	85.47	83.47	87.77	86.17	85.07

Table C
Mean Scores for the Third Grade for Each Race and SES
and for Each Race-SES Combination on All Measures

	Race-SES				SES		Race	
	White Low	Black Low	White Middle	Black Middle	Low	Middle	White	Black
N	15	15	15	15	30	30	30	30
Lorge-Thorndike:								
CA	107.53	106.27	105.87	106.20	106.90	106.03	106.70	106.23
IQ	93.40	93.40	106.47	96.47	93.40	101.47	99.93	94.93
Gates Diagnostic Battery:								
Reading Age	104.00	104.33	117.80	100.80	104.17	109.30	110.90	102.57
Reading Grade	29.73	35.27	46.60	39.53	32.50	43.07	38.17	37.40
Raw Score	12.73	16.53	24.33	19.27	14.63	21.80	18.53	17.90
Wepman Auditory Discrimination Test:								
Initial Phoneme	11.80	11.80	12.46	12.46	11.80	12.47	12.13	12.13
Middle Phoneme	3.73	3.93	3.94	4.00	3.83	3.96	3.83	3.96
Final Phoneme	12.20	11.60	11.53	11.80	11.90	11.67	11.86	11.70
Total	27.73	27.33	27.92	28.26	27.53	28.10	27.82	27.79
Bender-Gestalt:								
Memory Score	8.80	8.60	10.07	8.80	8.70	9.43	9.43	8.70
Matching Score	11.47	11.87	13.53	12.47	11.67	13.00	12.50	12.17
Masking Test:								
Word x Noise Score	85.13	69.53	64.93	73.33	77.33	69.13	75.03	71.43
Word x Word Score	94.53	92.47	88.73	95.20	93.50	91.97	91.63	93.83
Nonsense x Noise Score	92.87	85.67	89.00	90.60	89.27	89.80	90.93	88.13

Table C (continued)

	Race-SES				SES		Race	
	White Low	Black Low	White Middle	Black Middle	Low	Middle	White	Black
Pitch Discrimination Test:								
25 cycle score	7.73	6.87	7.80	8.20	7.30	8.00	7.77	7.53
17 cycle score	6.33	5.20	6.47	7.60	5.77	7.03	6.40	6.40
12 cycle score	5.47	6.07	5.40	7.07	5.77	6.23	5.43	6.57
8 cycle score	4.27	4.93	3.67	4.93	4.60	4.30	3.97	4.93
Total cycles score	23.53	23.07	23.33	27.80	23.30	25.57	23.43	25.43
Hi Scores	2.00	1.20	1.20	3.27	1.60	2.23	1.60	2.23
Lo Scores	3.00	2.27	2.27	4.20	2.63	3.23	2.63	3.23
Same Scores	8.60	6.20	8.00	8.40	7.40	8.20	8.30	7.30
Total Hi/Lo/Same Scores	13.47	9.67	11.47	15.87	11.57	13.67	12.47	12.77
IDS Revision of the Continuous Performance Test:								
Median RT 100-1000	571.20	560.93	536.73	549.13	566.07	542.93	553.97	555.03
Median RT 100-2000	586.80	585.40	549.47	556.67	586.10	553.07	568.13	571.03
% 100-1000	83.33	82.47	88.93	83.67	82.90	86.30	86.13	83.07
% 100-2000	90.00	89.27	94.67	88.40	89.63	91.53	92.33	88.83

Table D
Mean Scores for the Fifth Grade for Each Race and SES and for Each Race-SES Combination on All Measures

	Race-SES				SES		Race	
	White Low	Black Low	White Middle	Black Middle	Low	Middle	White	Black
N	15	15	15	15	30	30	30	30
Lorge-Thorndike:								
CA	132.13	129.93	130.27	130.80	131.03	130.53	131.20	130.37
IQ	107.13	94.40	114.93	103.73	100.77	109.33	111.03	99.07
Gates Diagnostic Battery:								
Reading Age	136.40	112.67	136.93	126.00	124.53	131.47	136.67	119.33
Reading Grade	61.53	42.20	61.93	53.07	51.86	57.50	61.73	47.63
Raw Score	11.13	6.47	11.73	10.00	8.80	10.87	11.43	8.23
Wepman Auditory Discrimination Test:								
Initial Phoneme	12.67	11.73	12.67	12.13	12.20	12.20	12.67	11.93
Middle Phoneme	3.93	3.93	4.00	3.93	3.93	3.67	3.67	3.93
Final Phoneme	11.40	11.40	11.66	11.93	11.70	11.80	11.83	11.66
Total	28.00	27.06	28.33	27.99	27.83	27.87	28.17	27.52
Bender-Gestalt:								
Memory Score	11.07	10.40	11.33	10.87	10.73	11.10	11.20	10.63
Matching Score	13.67	13.87	14.00	13.67	13.77	13.83	13.83	13.77
Masking Test:								
Word x Noise Score	63.67	68.53	68.27	64.60	66.10	66.43	65.97	66.57
Word x Word Score	77.33	82.80	74.60	74.40	80.07	74.50	75.97	78.60
Nonsense x Noise Score	79.80	87.00	80.33	76.53	83.40	78.43	80.07	81.77

Table D (continued)

	Race-SES				SES		Race	
	White Low	Black Low	White Middle	Black Middle	Low	Middle	White	Black
Pitch Discrimination Test:								
25 cycle score............	7.93	6.80	9.00	7.73	7.37	8.37	8.47	7.24
17 cycle score............	7.40	5.73	7.93	7.07	6.57	7.50	7.67	6.40
12 cycle score............	6.60	5.33	8.00	6.33	5.97	7.17	7.30	5.83
8 cycle score............	4.53	4.33	3.80	4.27	4.43	4.03	4.17	4.30
Total cycles score	26.47	22.20	28.73	25.40	24.33	27.07	27.60	23.80
Hi Scores	2.27	2.20	2.93	1.93	2.23	2.43	2.60	2.07
Lo Scores	3.00	1.53	3.53	2.40	2.27	2.97	3.27	1.97
Same Scores	10.40	5.00	12.73	9.20	7.70	10.97	11.57	7.10
Total Hi/Lo/Same Scores ...	15.67	8.73	19.20	13.53	12.20	16.37	17.43	11.13
IDS Revision of the Continuous Performance Test:								
Median RT 100-1000	517.67	490.80	515.27	477.20	504.23	496.23	516.47	484.00
Median RT 100-2000	523.87	493.80	520.60	485.73	508.83	503.17	522.23	489.77
% of Responses 100-1000..	93.13	93.67	92.93	91.20	93.40	92.07	93.03	92.43
% of Responses 100-2000..	96.73	96.73	96.67	94.33	96.73	95.50	96.70	95.53