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An Analysis Of The Relationship Between Auditory Processing Skills And Reading Achievement At The Kindergarten And First Grade Levels.

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AN ANALYSIS OF THE RELATIONSHIP BETWEEN AUDITORY PROCESSING SKILLS AND READING ACHIEVEMENT AT THE KINDERGARTEN AND FIRST GRADE LEVELS

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by

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AN ANALYSIS OF THE RELATIONSHIP BETWEEN AUDITORY PROCESSING SKILLS AND READING ACHIEVEMENT AT THE KINDERGARTEN AND FIRST GRADE LEVELS

Abstract of the Dissertation

PURPOSE: This study was designed to measure the effects of an auditory training program. The primary goal was to investigate whether auditory skills can be taught. A secondary goal was to determine if these auditory processing skills, as defined in the training program, facilitated growth in overall reading achievement.

PROCEDURE: Students from seventeen kindergarten and first grade classrooms in the Branford Public School System were chosen to participate in this study. Schools were randomly assigned to the experimental and control groups. The experimental group participated in the Auditory Processing Training Program, an instructional system using audio taped lessons and worksheets, five to fifteen minutes in length, three times weekly for a period of seven months. Both the experimental and control groups were exposed to the traditional basal program of reading instruction (Ginn 360). In order to equalize treatment among the experimental classrooms, controls were implemented regarding the environment, the teacher's role and the student aides. Three test measures were administered to assess growth in the student's auditory processing, visual perception, and reading achievement skills: the Auditory Processing Test, the Motor-Free Visual Perception Test, and the Metropolitan Achievement Test. Analyses of covariance were utilized to examine differences between the two groups. The Pearson product-moment correlation coefficient was computed to analyze the relationship between auditory and visual perception for the experimental and control groups. In addition, the treatment group was divided into three levels: high, middle, and low on initial reading achievement scores to determine which group was most affected by the instructional program.

FINDINGS:
1) The improvement in auditory processing scores for the treatment group was significantly higher than the control group, at the first grade level. The results at the kindergarten are mixed, due to methodological problems which prevented collection of valid pretest data. Therefore all inferences about experimental effects are based on an analysis of post-test scores among students of different socioeconomic levels. These results indicated that the Auditory Training program was effective in developing sound blending skills among kindergarten children, but was not effective in the development of auditory discrimination.
2) There were significant interactions between the treatment group and sex on subtests of the Auditory Processing Test, with boys showing greater improvement than girls.
3) The treatment program was most effective among low or middle levels of reading achievement.
4) There were no significant differences in improvement in reading achievement between the treatment and control group at the first grade level. However, at the kindergarten level, the control group scored significantly higher than the treatment group on the Sound-Symbol Relationship subtest of the Metropolitan Reading Readiness Test.
5) Auditory and visual perceptual skills were highly correlated in both treatment and control groups.

CONCLUSIONS: Results of this experiment indicated that auditory skills can be taught. Improvements in Auditory Sound Blending, Auditory Sequential Memory and Auditory Visual Integration were significatnly higher for the treatment group in the first grade. This was especially true for children at the low and middle levels of reading achievement. This improvement in auditory skills however, did not translate into increased reading achievement within the experimental period. It could be that significant effects will be in evidence later on, but further research will be necessary to explore this possibility.

Difficulties in testing these skills among kindergarten children severely limit the ability to measure treatment effects at this age level. A different experimental design will be necessary if further research is to proceed successfully.

RECOMMENDATIONS: Replications of this study using a heterogeneous population would augment the inferential conclusions drawn from this study. In addition, a simplified version of the program for the pre-kindergarten and kindergarten levels would allow for a true test of the usefulness of auditory processing training. However, due to the general finding that auditory processing skills are not transferable to reading achievement, new avenues of research emphasizing language improvement, particularly at the kindergarten level, are recommended.

ACKNOWLEDGMENTS

The author wishes to express her sincere gratitude to Dr. Hugh McBride for his long distance help on this project. In addition, I would like to thank Dr. Bobby Hopkins, for making the field of research and statistics so exciting and understandable.

Dr. Ernest Weeks deserves special mention for his vital help in the Branford Public Schools. I would also like to thank all the enthusiastic teachers and wonderful student aides who participated in the study.

My husband, Russell, who has so patiently helped me with the computer analysis and who has supported me throughout this project, deserves my deepest appreciation. Finally I would like to dedicate this study to a wonderful man, Dr. Walter McHugh, who has had a major influence in my professional ideals and career goals.

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THE RESEARCH PROBLEM

Few people will dispute the central importance of reading instruction in elementary education today. Even with a modern curriculum which includes many nonreading experiences, reading remains the main source of knowledge, stimulation and pleasure. Trace states:

> Reading is not merely a basic subject in school; it is the basic subject. Reading is the base upon which virtually all formal learning rests; so that if a student can read well, he can learn much, and if he reads badly, he will learn very little.[1]

One of the principle foci of reading research over the past several decades has been auditory discrimination and its effect on reading achievement. Investigations have approached this issue from a number of distinct methodological strategies. One conclusion has been consistently forthcoming: if a child is unable to hear and distinguish separate sounds, he will have difficulty in reading.[2] Authorities agree that these skills are developmental in nature.[3] Unless there is a specific impairment, usually there is a consistent increase in auditory ability with age. Children, though, vary in their rate of development. Sometimes these skills do not appear until

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[1]Arthur Trace Jr., Reading Without Dick and Jane (Chicago: Henry Regnery Co., 1965) p. 26

[2]Anne Morency, "Auditory Modality--Research and Practice," Perception and Reading, Helen K. Smith Ed. (Newark: International Reading Association, 1968,) Pp. 11-13.

[3]Alex Bannatyne, "The Transfer From Modality Perceptual to Modality Conceptual," Perception and Reading (Newark, International Reading Association 1968), pp. 7-17.

nine years of age. As a result, when children come to school, there may be sounds that they may not be able to hear or reproduce. Thus, unless the maturing factor can be hastened, there will be a part of the code in his beginning reading program which the child will not be able to master. There is a lack, however, of consensus in regard to the strength of the relationship between auditory skills and reading achievement. Durrell and Murphy studied the relationship of ability to identify sounds in spoken words and reading achievement in grades one through three. Correlations between the auditory analysis ability and achievement were reported high in each case. The authors believe that ability to notice the separate sounds in spoken words is a highly important factor in determining a child's success in learning to read.[4]

On the other hand, Dykstra examined the relationship between prereading measures of auditory discrimination and reading achievement at the end of the first grade. He found a relatively low correlation between auditory abilities and success in reading. He concludes that the first grade teacher should not expect that the development of auditory discrimination skills will be sufficient at that age to ensure their success in mastering the reading task.[5]

Perhaps one reason for the apparent disagreement between these two sources is the fact that the skills being analyzed and tested here, as

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[4]Donald D. Durrell and Helen Murphy, "The Auditory Discrimination Factor in Reading Readiness and Reading Disability," Education,73, (May, 1963) pp. 556-60.

[5]Robert Dykstra, "Auditory Discrimination Abilities and Beginning Reading Achievement," Reading Research Quarterly, 1, (Summer, 1966) pp.5-34.

well as the majority of research, are concerned with discrimination skills only, rather than higher order integrative abilities which appear to influence learning success in a more specific manner. An appraisal of the auditory processing skills by Lerner[6] reveals such skills as: auditory sensitivity, auditory attention, auditory discrimination, auditory memory, and auditory-visual integration. Thus auditory discrimination is only one of six important skills that have been identified as integral to the reading process. Therefore, in order to analyze the importance of auditory perception and its relationship to reading, it seems that these skills should be included as well.

While studies involving a more complex analysis of auditory perceptual skills are now being conducted, comparisons are still difficult due to the imprecision of our understanding of the subskills that make up auditory perception. For example, Witkin's interpretation of auditory processing skills includes the following subskills, which have been incorporated in the Auditory Perceptual Training Program funded through a Title III project grant:

1. Selective Listening
2. Discrimination of Speech Sounds
3. Identification of Intonation Patterns
4. Recognition of Standard subject/verb agreement
5. Recognition of the order in which speech sounds are presented

The Auditory Perceptual Training Program does not directly teach reading skills or listening comprehension, but concentrates on those processes

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[6]Janet W. Lerner, Children With Learning Disabilities, Second Edition, (Boston: Houghton Mifflin Co., 1976) pp. 178-79.

which underlie the cognitive listening skills.[7]

It is difficult to compare this concept of auditory perception with one such as Rosner's Auditory Analysis Program--a component of the Perceptual Skills Curriculum developed by the Research and Development Center at the University of Pittsburgh.[8] Rosner defines auditory analysis as the "resolution of spoken words into their phonemic parts."[9] A question might be raised as to whether Rosner is referring simply to a new phonic technique or perhaps a more sophisticated linguistic approach. Rosner states that the general goal of the program is to teach those skills used in analyzing spoken words into their component parts: words within phrases, syllables within words; ultimately phonemes within increasingly complex contexts.[10] He lists the terminal objectives as:

1. Reproduction of sound patterns
2. Substitution of sounds in the beginning, middle and final position
3. Short-term memory using numeral and words

Both Witkin's and Rosner's programs are comparable in several ways: Students are taught to identify sounds, blend sounds together to form words and recognize language units and structures.

And yet in some major aspects these programs are quite dissimilar. Clearly, Witkin emphasizes language and listening skills; in fact four-

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[7]Belle Ruth Witkin, Project Director, "The Auditory Perceptual Training Program," ESEA Title III Project 0471, June 1973.

[8]Jerome Rosner, "Auditory Analysis Traing With Prereaders," Reading Teacher, 27, 4, January 1974, pp. 379-84.

[9]Ibid. , p. 379.

[10]Ibid. , p. 381.

teen out of thirty-five lessons focus on "competing messages"--the ability to attend to one sound rather than another. On the other hand, Rosner stresses auditory discrimination and reading. Witkin's program might be called a modality processing approach, which evaluates and analyzes the processing abilities that underlie the learning task, while Rosner's program stresses a skill sequence approach, one which analyzes and evaluates the task to be learned. Therefore, in research one might find conflicting results as to the benefits of auditory perceptual training due to the fact that these programs and others like them are emphasizing quite different skills.

Furthermore, in many research designs investigating the relationship between auditory perception and reading achievement, a standardized measure has not been utilized. Witkin, in a study of 117 second graders measured differences in auditory perception for the experimental and control groups with the Composite Auditory Perception Test (CAPT)--a criterion measure developed by the authors.[11] This test, while using different pictures, is remarkably similar to the program itself. It is no surprise that the experimental group which has received six months of training, scored significantly higher on the CAPT than the control group. Clearly program familiarity has become a threat to external validity, and thus the results, that the experimental group was superior in auditory perception, must be suspect.

Rosner also used a criterion measure to test auditory analysis abilities with 145 preschool and kindergarten children.[12]

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[11] Witkin

[12] Rosner, op. cit., pp. 379-83.

Students in the experimental group made significant gains over the control; however, again, these results could possibly be attributed also to program familiarity.

In both cases, no standardized measures have been used to determine change in auditory perception, or reading achievement. One could argue on the basis of familiarity alone, the experimental group was favored. Furthermore, professionals must begin to ask whether perceptual training leads to overall reading achievement. If it does not, one must question the usefulness of these programs in elementary education today.

II. THE PROBLEM

Statement of the Problem

Techniques of phonic instruction and auditory discrimination have been the subject of research for many decades. However, the broader concept of auditory perception as a major pathway for learning has been relatively neglected. Thus, when a child is unable to succeed in phonic instruction in school, this could be due not to an impairment in hearing or inattentiveness, but a disability in auditory perception--the ability to recognize and interpret what is heard.

The strength of the relationship between auditory perception and reading has not yet been determined. Research in this area has been delayed because of inadequate test measures, and the lack of a clear definition of the subskills which encompass auditory perception.

This study analyzed seventeen kindergarten and first grade classrooms in order to determine the relationship between auditory perception and reading achievement. The investigator utilized the analysis of covariance to measure change in auditory perceptual skills

and overall reading achievement over a period of eight months.

III. SIGNIFICANCE OF THE STUDY

Visual perceptual training has received wide attention, mainly through the efforts of Marianne Frostig. However, little information is known about auditory processing skills and their relationship to academic achievement. Dunn[13] and others[14,15] state that perhaps the auditory channel is, in fact, more important for school instruction than the visual channel. Thus, the specific benefits and results of this research will include:

1. An indepth study of the various levels of auditory perception

2. An analysis of the relationship between auditory and visual perception.

3. The development of a useful group measure which may be used by the classroom teacher in determining auditory deficiencies.

4. The use of a standardized achievement test to determine the relationship of auditory perceptual skills and reading achievement for the kindergarten and first grade levels.

5. The development of an auditory perceptual training program, which may be used by the total classroom, the individual student who has been assessed to have auditory difficulties, or by the remedial student.

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[13]Lloyd Dunn, "Special Education for the Mildly Retarded--Is Much of It Justifiable," Exceptional Children, September, 1968, pp. 5-22.

[14]Joseph Wepman, "Auditory Discrimination, Speech and Reading," Elementary School Journal, 1960, pp. 325-333.

[15]Thomas Oakland and Fern C. Williams, Auditory Perception, (Seattle: Special Child Publications, Inc., 1971) pp. 7-9.

IV. PURPOSE OF THE STUDY

The purpose of this study was to explore and analyze auditory processing skills to determine if these skills can be taught, and if they positively effect reading achievement. More specifically, the study addressed the following issues:

1. Can auditory processing skills be taught using the Auditory Processing Training Program?

2. To what extent do auditory processing skills effect reading achievement?

3. Is their a relationship between auditory processing training and reading achievement?

4. Is their an interaction between auditory processing training and socioeconomic status with respect to auditory processing skills and reading achievement?

5. Is the effectiveness of the auditory processing training program related to the achievement level of the pupil?

6. Is there a difference between kindergarten and first grade pupils in their ability to develop auditory perceptual skills?

With these objectives in mind, the following experimental hypotheses were generated:

1. Students participating in the Auditory Processing Training Program demonstrate greater improvement in auditory skills in the kindergarten and first grade levels as measured by the Auditory Processing Test, than those using regular basal instruction.

2. Students participating in the Auditory Processing Training Program demonstrate greater improvement in reading achievement, as measured by the Metropolitan Readiness Test for the Kindergarten

classrooms, and the Metropolitan Achievement Test for the first grade classrooms, than those using regular basal instruction.

3. Students in the treatment program show greater improvement in visual perceptual abilities as measured by the Motor-Free Visual Perception Test, than students using basal instruction alone.

4. The boys in the treatment program exhibit higher scores on the Auditory Processing Test, than the boys using basal instruction alone.

5. The boys in the treatment program exhibit higher scores on the Metropolitan Achievement Test, than the boys using basal instruction alone.

6. Students of the low and middle socioeconomic status groups who participate in the treatment program show greater growth in auditory skills as measured by the Auditory Processing Test, and reading achievement , as measured by the Metropolitan Achievement Test, than do similar pupils who use basal instruction alone.

7. Students in the low and middle achievement groups, as measured by the Metropolitan Achievement Test, receiving the supplemental auditory training program demonstrate higher auditory processing scores than students at these levels receiving basal instruction alone.

V. ASSUMPTIONS AND LIMITATIONS

The assumptions upon which this study was based are as follows:

1. Reading is a major source of attaining knowledge, thus the acquisition of skills at the kindergarten and first grade levels is imperative for overall academic achievement.

2. At the initial stages of reading acquisition, perceptual skills are prerequisite to conceptual development. Thus, perceptual

demands are the most acute at the earlier stages of school training.[16]

3. Auditory perceptual skills can be identified, analyzed, and tabulated.[17,18]

4. The definition of the subskills which encompass auditory perception provide an acceptable foundation for this study.[19]

5. While auditory perceptual skills are thought to be developmental in nature, all children do not necessarily attain them, or develop them at the same time.[20]

6. The Motor-Free Visual Perception Test, the Metropolitan Readiness Test, the Metropolitan Achievement Test, and the Auditory Processing Test are valid and reliable measures.

7. The reliability of two subtests, the Auditory Sequential Memory Subtest, and the Auditory Sound Blending Subtest, of the Auditory Processing Test have been established using the Kuder-Richardson Formula. Since the content was not changed, it is assumed that the validity of these tests remains the same.

8. Based on a complex prescreening procedure conducted by the Branford Board of Education, all students involved in this study demon-

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[16]Doris Johnson, and Helmer R. Myklebust, Learning Disabilities: Educational Principles and Practices, (New York: Grune and Stratton, 1964) pp. 30-36.

[17]Ibid., pp. 66-136.

[18]Janet Lerner, Children With Learning Disabilities, Second Edition, (Boston: Houghton Mifflin Co., 1976) pp. 178-79.

[19]Ibid., pp. 178-80.

[20]Alex Bannatyne, "The Transfer From Modality Perceptual to Modality Conceptual," Perception and Reading, Helen K. Smith Ed. (Newark: International Reading Association, 1968) pp. 7-17.

strated normal hearing acuity, and language ability. All students with visual problems were given corrective prescriptions. Children with language difficulties were directed to a developmental kindergarten, and thus not included in this study.

9. The data collected from this study may be of value to educators, publishers, and parents.

Limitations

This investigation was also based upon certain limitations which restrict the applicability of the researcher's findings:

1. The experiment is based in Branford, Connecticut, an average surburban community in New England. This community contains no signiicant minority population. While one can safely generalize from the findings of this school district to other average communities, the robustness of these findings must await further replications.

2. The Auditory Processing Test is a group measure designed to assess children's performance in the classroom setting. It is thus not as sensitive as an individual test measure might be. Two of the subtests used in the Auditory Processing Test have been adapted as group measures from the Illinois Test of Psycholinguistic Abilities: The Auditory Sequential Memory and the Auditory Sound Blending Subtests. The Kuder-Richardson Formula was applied to establish reliability. However, since the content remained the same, the validity was not redetermined.

3. No attempt was made to equate the teachers in the experimental and control group, in terms of years of experience, educational background or age.

4. All of the seventy six lessons in the Auditory Processing

Training Program were not completed. This was caused by the following reasons: faulty tapes, minimum school days, special events, lack of student aides, and the delay of the program at the beginning of the school year. In addition several of the tapes which were originally fifteen minutes in length were shortened in order to allow all reading groups to participate in the alloted time period.

5. Only children with complete test information were included in the analysis of data.

VI. DEFINITIONS OF TERMS USED

The following definitions of terms have been used throughout this study:

1. Auditory Acuity: The ability to detect the presence of sounds at various levels of intensity and frequency, and to transmit them to the brain.[21]

2. Auditory Attention: The ability to direct and sustain attention to sounds.[22]

3. Auditory Blending: The ability to blend single phonic elements or phonemes into a complete word.[23]

4. Auditory Closure: The ability to recognize a whole or Gestalt, especially when one or more parts of the whole are missing or when the continuity is interrupted by gaps.[24]

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[21]Thomas Oakland and Fern C. Williams, Auditory Perception, (Seattle: Special Child Publications, Inc., 1971) p. 10.

[22]Ibid. , p. 11.

[23]Janet Lerner, Children With Learning Disabilities, Second Edition, (Boston: Houghton Mifflin Co., 1976) p. 179.

[24]Ibid., p. 425.

5. Auditory Comprehension: The ability to decode and derive meaning from auditory stimuli.[25]

6. Auditory Discrimination: The ability to recognize a difference between phoneme sounds and to identify words that are the same or words that are different.[26]

7. Auditory Figure-Ground: The ability to distinguish an auditory message (figure) from other sounds or messages present at the same time (ground); the ability to concentrate on the message and to shut out distraction.[27]

8. Auditory Memory: The ability to store and recall what one has heard.[28]

9. Auditory Perception: Receiving, processing and classifying sensory information for coding into familiar symbols.[29]

10. Auditory Processing: The ability to obtain meaning from auditory stimuli. The specific abilities include: analysis, synthesis, storage and retrieval.[30]

11. Auditory Sequencing: The ability to remember the order of items given orally in a sequential list.[31]

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[25]Oakland and Williams, p. 10.

[26]Lerner, op. cit., p. 178.

[27]Belle Ruth Witkin, Project Director, "The Auditory Perceptual Training Program, " ESEA Title III, Project 0471, June 1973, Teacher's Manual, p. 12.

[28]Lerner, op. cit. p. 178.

[29]David F. Barr, Auditory Perceptual Disorders, (Springfield: Charles C. Thomas, 1972) p. 3.

[30]James C. Chalfant, and Margaret A. Schefflin, Central Processing Dysfunctions in Children: A Review of Research, (Washington, D.C.: U.S. Department of Health, Education, and Welfare, 1969) p. 9.

[31]Lerner, op. cit., p. 178.

12. Auditory Synthesis: The ability to combine smoothly all the sounds or syllables of words to make them a whole, or the ability to analyze a word into its separate sounds.[32]

13. Auditory-Visual Integration: The ability to integrate both visual and auditory abilities.[33]

14. Intonation system: The linguistic system within any particular language that has to do with the pitch (melody), stress (accent), and juncture (pauses) of the spoken language.[34]

15. Modality: The pathway through which an individual receives information and thereby learns. The modality concept postulates that some individual's learn better through one modality than through another.[35]

16. Phoneme: The smallest unit of sound in any particular language.[36]

17. Temporal Sequencing: The ability to distinguish and remember the order of occurrences of a series of sounds.[37]

18. Visual Perception: The identification, organization, and interpretation of sensory data received by the individual through the eye.[38]

VI. SUMMARY

Auditory processing skills are generally believed to precede the acquisition of phonics, and later, reading achievement. Recently, the subskills within auditory perception have become more clearly defined.

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[32]Lerner, op. cit., p. 178.

[33]Oakland and Williams, p. 11.

[34]Lerner, op. cit., p. 178.

[35]Ibid., p. 428.

[36]Ibid., p. 428.

[37]Witkin, p. 12.

[38]Witkin, p. 12.

However, research studies testing the relationship between these skills and reading achievement have been inconclusive. There are several reasons for this: 1) there is a lack of reliable group test measures, 2) there are few instructional programs which attempt to teach these skills, 3) researchers have not used standardized reading achievement tests to measure overall effectiveness of these skills on academic achievement.

Therefore, the purpose of this study is to analyze if auditory processing skills can be taught, using the Auditory Processing Training Program, developed by the investigator, and to explore the relationship between improvement in auditory processing and reading achievement.

Chapter 2

REVIEW OF THE LITERATURE

The literature in the field of auditory perception is, at times, self-contradictory, and appears to be less clear-cut than in many other areas of reading research. The literature involves various fields of study: audiology, cognitive psychology, reading, and psycholinguistics. As a result, it lacks a unified paradigm or model to aide instruction. There is, in fact, no precisely accepted definition of the term auditory perception itself. Research often includes auditory discrimination, auditory perception, and auditory processing as interchangeable terms. Clearly then, a clarification of the nature of auditory processing skills is necessary. Therefore, this review will attempt to confront the following issues in the literature:

1. An underlying language model which defines the auditory process
2. Levels of auditory processing and their relationship to reading
3. The modality concept
4. Auditory-Visual integration and its relationship to reading achievement

An Underlying Language Model

Any analysis of auditory processing skills must first be preceded by a conceptual understanding of language functioning.

Osgood's model of normal language development is behavioristic in nature and involves SS and RR associations and the typical S-R bonds. This model has had a significant impact on research in this area, and thus serves as a general overview of the process of language development. It encompasses two dimensions of language behavior: language processes and levels of organization (see figure 1)[1].

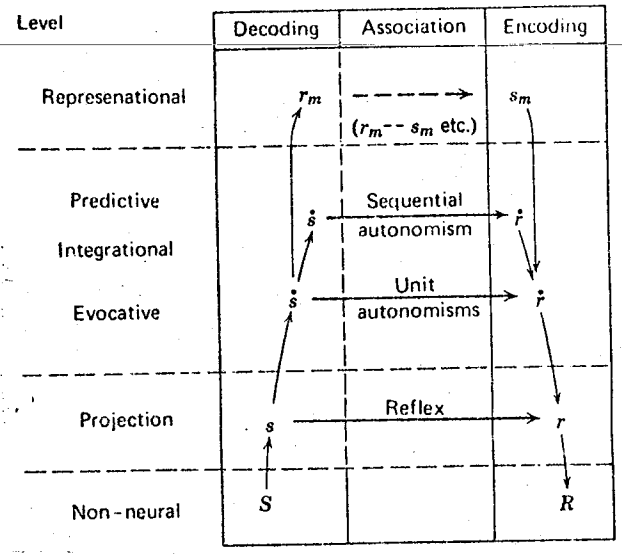

Figure 1

Osgood's Model of Normal Language Behavior

The language processes include:

1. Decoding--receiving stimuli

2. Association--mediating between decoding process and expressive behavior

3. Encoding--using the language for the expression of ideas

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[1]Patricia I. Myers, and Donald D. Hammill, Methods For Learning Disorders, (New York: John Wiley and Sons, Inc. 1969) p. 31.

There are three levels of neural organization:

1. Projection--relating receptor and muscle events to the brain

2. Integration--sequencing and organization of incoming and outgoing messages.

3. Representational--the cognitive level

Thus the child receives a sensory signal at the projection level. The interpretation of the physical stimuli occurs at the integration level. At the representational level, the person responds to the sensory integration. This is the point in the model at which meaning is decoded. The meaning is then processed through the integration level leading to encoding which then elicits a set of automatic and sequential motor elements.[2]

Wepman's model of language development, although similar to Osgood's in major aspects, takes into account memory, internal and external feedback and modalities of transmission. (see figure 2).[3]

This model indicates that a developmental hierarchy exists in each child where he proceeds from birth through approximately eight years using his concurrently expanding neurological potential for more and more complex behaviors. Three levels of gradation of behaviors are identified: the reflex, the perceptual, and the conceptual. Each level depends for its complete maturation and function upon the preceding level. At each level the various sensory pathways (modalities) are

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[2] Ibid., p. 31.

[3] Ibid., p. 33.

independent, all feeding into a common central process, which in turn elects the mode of output. At the perceptual level the child learns to discriminate, retain, recall, sequence, and orient auditory, visual, tactile, kinesthetic stimuli. His capacity to perform these manipulations of signals improves as his neurological system becomes differentiated. Finally, he develops his conceptual abilities. Only when his perceptual abilities have been refined can he reach the conceptual level involved in language comprehension and use.[4]

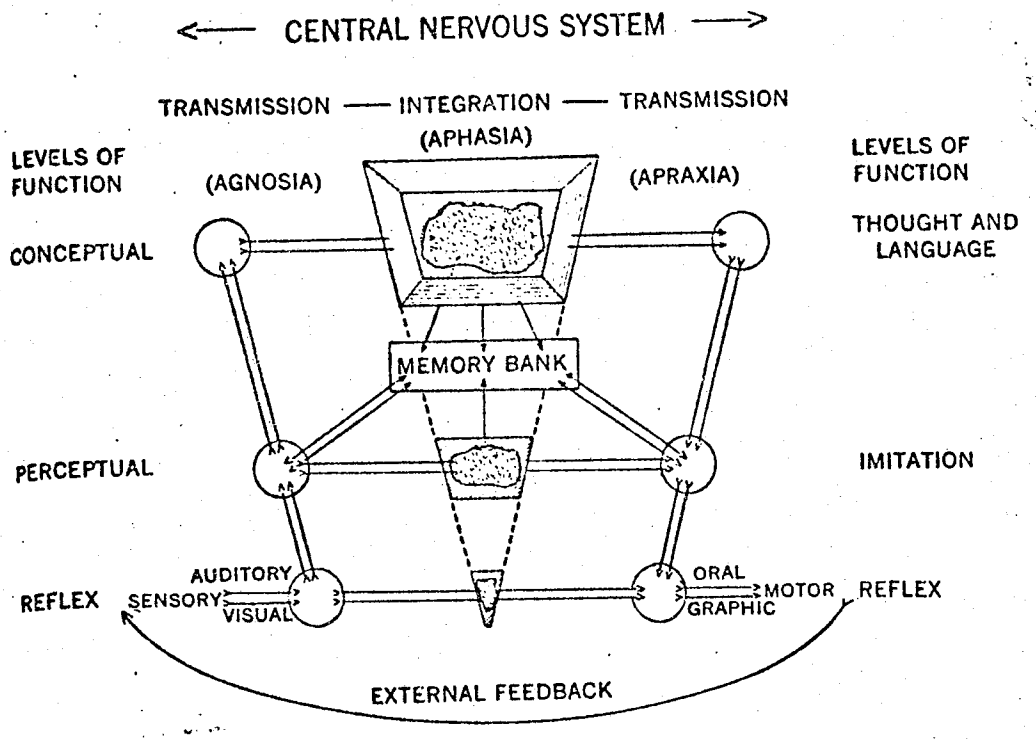

Figure 2

Wepman's Model of Language Development

These two models of language development serve as the major underlying rationale for most of the research and instructional programming

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[4]Joseph Wepman, "The Perceptual Basis for Learning," pp. 25-43 in H. Alan Robinson (ed.) Meeting Individual Differences in Reading, (Chicago: University of Chicago Press, 1964)

in the area of auditory and visual perception. Each model assumes that both modalities must be intact in order to achieve the highest level--cognition--needed to comprehend and use language effectively. If one of these modalities is impaired, according to these theories, language functioning will be inhibited.

Auditory Functioning and its Relationship to the Reading Process

Learning to read is a skill involving the ability to associate patterns of sound with graphic presentations.[5] According to Myklebust, this skill must be preceded by many stages of language behavior (see Figure 3)[6]

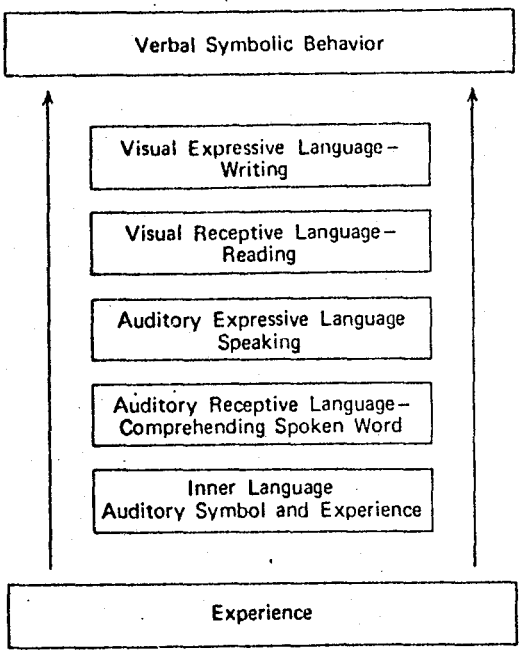

Figure 3

Myklebust's Hierarchy of Language Behavior

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[5]Rachel Burkholder, "The Improvement in Reading Ability Through the Development of Specific Underlying or Associated Mental Abilities," Unpublished Doctoral Dissertation, University of Arizona, 1968) p. 1.

[6]Myers, and Hammill, op. cit., p. 169.

The first level is acquisition of meaning or inner language. Next, auditory symbols and experiences are associated, resulting in the child's comprehension of spoken words, or receptive language. The following level is auditory expressive language, as evidenced in speech. Comprehension of printed words or reading (visual receptive language) is followed by expression of printed words in writing (visual expressive language).[7] As is true of all developmental theories of learning, all levels build upon one another. Thus, reading skills are mastered by superimposing visual symbols on the already firmly established auditory base.[8]

Most often, auditory capacities develop as part of the behavior of the maturing child and become the foundation upon which language is built. However, an undetermined number of children who appear to hear normally enter school with perceptual problems. These children have difficulty interpreting, and understanding sounds or categorizing and structuring their auditory world. Therefore, they respond inconsistently and inappropriately to auditory stimuli.[9]

Sabatino describes the process as having four steps:

1. The child must be able to differentiate sounds of the language.

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[7] Ibid., p. 169.

[8] Doris Johnson and Helmer R. Myklebust, Learning Disabilities: Educational Principles and Practices, (New York: Grune and Stratton, 1964) pp. 30-38.

[9] James C. Chalfant and Margaret A. Schefflin, "Central Processing Dysfunctions in Children: A Review of Research," (Washington, D.C: U.S. Department of Health, Education and Welfare) NINDS, Monograph No. 9, 1969, p. 91.

2. He must be able to link these sounds as symbols with an experience.

3. The child must note that the symbol and experience being isolated represent a new concept.

4. The child must remember the spoken word, the experiences, and the contexts in which it and its associations fit, and then reproduce the word at the right time.[10]

Chalfant and Schefflin describe a simplified information processing model:[11]

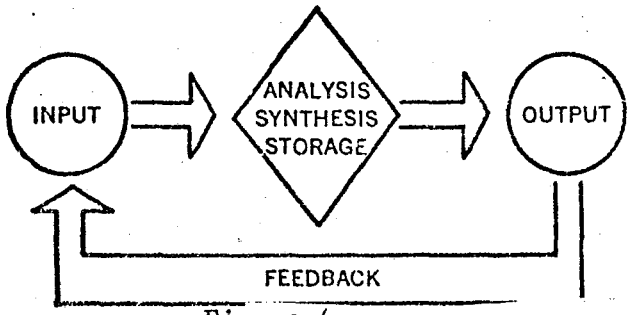

Figure 4

An Information Processing Model

Input represents the sensory system responsible for receiving auditory and visual stimuli through the sensory organs. Analysis, synthesis, storage, and retrieval represent the central processing system which occur in the brain during the processing of sensory information. Output is the behavioral response of the individual. It is not possible to observe these processes directly; only the behaviors which make demands on them.[12]

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[10]David A. Sabatino,"Auditory Perception--Development, Assessment, and Intervention," pp. 50-51, in L. Mann and D. Sabatino (eds), The First Review of Special Education, Volume 1, (New York: Grune and Stratton, 1973).

[11]Chalfant and Schefflin, op. cit., p. 3.

[12]Ibid., p. 3.

Flowers has defined these central processing functions in terms of auditory perception as the following: 1) auditory sensitivity, 2) auditory attending, 3) auditory discrimination, 4) auditory memory, 5) auditory integration, and 6) auditory-visual integration. He believes that a careful appraisal of auditory processing skills should be an important feature of the assessment of every child with reading difficulties.[13]

While auditory perceptual skills are beginning to become more clearly defined, the extent of the relationship of these skills to reading achievement is still not known.

The Relationship Between Auditory Skills and Reading Achievement

The theoretical models presented in the previous section suggest that particular auditory skills, such as discrimination, sound blending, auditory-visual integration, are prerequisites for mastering reading, and that deficiencies in these skills may actually cause reading failure. Hammill and Larsen reviewed thirty-three studies, using correlational statistical procedures, which dealt with the relationship in reading achievement with measures in auditory perception, in order to test this hypothesis. Using a combined criterion for predictive usefulness of .35 from Guilford, and Garret[14], they found that:

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[13]Richard M. Flowers,"The Evaluation of Auditory Abilities in the Appraisal of Children with Reading Problems,"" pp. 21-22 in Helen K. Smith (ed) Perception and Reading, (Newark: International Reading Association, 1968).

[14]Donald D. Hammill and Stephen C. Larsen, "The Relationship of Selected Auditory Perceptual Skills and Reading," Journal of Learning Disabilities, No. 7, p. 430.

1. The median coefficient between reading and combined auditory skills was not significant at the .05 level.

2. There was no significant relationship between specific auditory skills to various subskills in reading.

3. There was an insufficient number of correlation coefficients to permit analysis of longitudinal research as well as the relationship of auditory skills at particular grade intervals.

Hammill and Larsen concluded that the measured auditory skills are not usefully related to reading. Furthermore, the time and expense currently devoted to auditory training in the schools should be re-evaluated, if the purpose of such training is to improve reading proficiency.[15]

There are several important issues needed to be raised regarding this review:

1. The coefficient of .35, specified as the criterion of predictive usefulness is arbitrary at best. Several studies (Harrington and Durrell,[16] Kahn and Birch,[17] Birch and Belmont,[18]

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[15] Ibid., p. 430.

[16] Sister Mary Jane Harrington, and Donald D. Durrell, "Mental Maturity Versus Perception Abilities in Primary Reading," Journal of Educational Psychology, 46, 1955, pp. 375-80.

[17] Dale Kahn and Herbert G. Birch, "Development of Auditory-Visual Integration and Reading Achievement," Perceptual and Motor Skills, 20, 1965, pp. 295-305.

[18] Herbert G. Birch, and I. Belmont, "Auditory-Visual Integration, Intelligence, and Reading Ability in School Children," Perceptual and Motor Skills, 27, 1968, pp. 459-468.

Chall[19]) which reported highly significant correlations at the .01 level or better, only ranged in the .23 to .28 intervals. In addition, the magnitude of the relationship is partially based on sample size. Therefore, the sample size in many studies limited the capacity of the coefficient. Hammill and Larsen also neglect to report all correlation coefficients in the tables given.

2. Several studies included in the analysis have limited value due to the sample size. Nine of the thirty three studies have less than fifty students in their total sample. Even studies which report larger samples are often hindered because of the number of groups used in the analysis. For example, Oakland's study attempts to determine the relationship between reading achievement, auditory discrimination, and social class. Twenty children are randomly assigned to each of three socioeconomic groups. He concludes that there is a direct correspondence between social class status and reading achievement.[20] The usefulness of this research is questionable due to the sample size of the participant groups.

3. Most authorities agree that perceptual demands at the initial stages of reading are the greatest.[21,22] After a period

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[19]Jeanne Chall, R. Roswell, and S. Blumenthal, "Auditory Blending Ability: A Factor in Success in Beginning Reading," The Reading Teacher, 1963, 17, pp. 113-118.

[20]Thomas D. Oakland, "Auditory Discrimination and Socio-Economic Status as Correlates of Reading Ability," Journal of Learning Disabilities, 1969, 2, pp. 326-329.

[21]Naomi Zigmond, "Auditory Processes in Children With Learning Disabilities, 1969, 2, pp.326-329, Perceptual Motor Skills.

[22]Chalfant and Schefflin, p. 48.

of three years the relationship between reading and perception appears to diminish. And yet, sixteen out of the thirty three studies reviewed involve intermediate students who have already mastered the process of forming generalizations about printed words.

4. Many of the testing measures used to determine auditory perceptual ability are inadequate. Dykstra found, in his study of auditory discrimination and reading achievement, that intercorrelations among auditory discrimination measures were very low considering the similarity of the task the tests were designed to evaluate.[23]

5. The population from which the samples in various studies were widely divergent. Birch and Belmont, in a study of the relationship between I.Q. and Auditory-visual integration, and reading achievement, selected students with a mean I.Q. of 120.[24] Chall, on the other hand, tested sixty-two Negro boys, low to lower-middle class in New York City.[25] DeHirsch et. al. selected fifty-

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[23]Robert Dykstra, "Auditory Discrimination Abilities and Beginning Reading Achievement," Reading Research Quarterly,1, 1966, pp. 5-33.

[24]Herbert G. Birch and L. Belmont, "Auditory-Visual Integration, Intelligence, and Reading Ability in School Children," Perceptual Motor Skills, 1965, 20, pp. 295-305.

[25]Jeanne Chall, R. Roswell, and S. Blumenthal, "Auditory Blending Ability: A Factor in Success in Beginning Reading," The Reading Teacher, 1963, 17, pp. 113-118.

three prematurely born children who were predominantly lower middle class.[26] Thus, the generalizability of research based on such a homogeneous population is hampered.

6. Finally, Hammill and Larsen's conclusion that auditory perceptual skills are not usefully related to reading is an over-generalization. Methodological difficulties in many of the individual studies inhibit a true test of this relationship. It would have been more appropriate to conclude that the extent of the relationship between auditory perceptual skills and reading achievement is still at the present time not known.

Predictive Studies

Included in the literature devoted to the study of auditory perception and reading are a substantial number of studies which report the predictive relationship of performance on specific tasks of auditory perception given during the initial stages of reading and subsequent success in later reading achievement. Dykstra found that five auditory discrimination measures made a significant contribution to the prediction of reading achievement in over six hundred first grade children.[27]

McNinch explored the important relationship between a proposed auditory perceptual skill model and later reading achievement within a first grade population. Auditory perceptual instruments were selected to evaluate levels of skills in the hierarchy proposed

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[26]Katherine de Hirsch, J. Jansky, and W. Langford, Predicting Reading Failure, (New York: Harper and Row, 1966)

[27]Dykstra, op. cit., pp. 5-33.

by Flowers, along with readiness and intelligence tests. At the end of the year, a standardized reading achievement test was given. Results indicated that prediction did not seem to be enhanced by adding an auditory skill model to readiness testing.[28]

However, the lack of a relationship between auditory perceptual skills and reading achievement might be due to the inherent difficulties in the test instruments. McNinch and Richmond developed their own test instrument the following year, again to determine the predictive relationship between auditory perception and reading. Multiple regression analysis indicated that the experimental battery could predict first grade success.[29]

Hartlage and Lucas constructed an auditory and visual perceptual screening test for early measurement of various aspects in reading achievement. The five part test included visual sequencing, auditory sequencing, visual motor space, auditory space, and visual and auditory space. The test was administered to two first grade classes, and correlated at significant levels with the Wide Range Achievement Test (WRAT). As part of the analysis, the investigator deleted two tests in order to determine if the high correlations found in the combined battery could be maintained. The correlation remained practically the same as before.[30] However, a question must be raised

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[28]George McNinch, "Auditory Perceptual Factors and Measured First Grade Reading Achievement," Reading Research Quarterly, 1971, 6, pp.472-92.

[29]George McNinch and M. Richmond, "Auditory Perceptual Tasks as Predictors of First Grade Success," Perceptual Motor Skills, 1972, pp.7-13.

[30]L.C. Hartlage and D.G. Lucas, "Predicting Reading Ability in Grade One, Perceptual Motor Skills, 1967, 24, pp. 831-41.

as to what skills these researchers were testing. If both the auditory space and visual sequencing subtests can be deleted without differences in correlations, then this test cannot be a fine discriminator of particular learning deficits, and thus not highly useful for the teacher in terms of remediation.

A strong predictive relationship between auditory perception and reading achievement does not seem to be consistent in the literature, at least at the present time with the instruments being used. Flowers argues that the difficulty in research is due to the fact that the test instruments now being used are often contaminated with demands on other processes. Therefore, while the correlational model is useful in demonstrating variables that are related, it must be kept in mind that a high correlation between test variables and reading does not indicate that poor performance on test variables can cause poor reading ability nor that remediating the areas of weakness as reflected in test performance will improve the child's reading skills.

Auditory Perceptual Programs

A number of research studies have emerged which have attempted to teach perceptual skills as a means of effecting reading performance.

A study of this type was reported by Mayo, who tested two techniques of teaching auditory blending skills to 117 kindergarten children. The children were divided into three groups: the first group received eighteen programmed lessons in a linguistic approach, the second group received eighteen programmed lessons utilizing a phonics approach and the third group which was the control, was told eighteen narratives of the appropriate level. While there was no significant

differences between the two experimental groups, both treatments were superior to the control at the .01 level of significance. Mayo concludes that the students at the kindergarten level can be taught auditory blending skills.[31]

One must review this study cautiously for several reasons which are often endemic of this kind of research:

1. The two treatment groups are not clearly distinct.

2. The time given for reading instruction among the groups was not equal: Treatment 1 received 12.8 minutes daily; Treatment 2, 12.1 minutes, and the control group, 8.6 minutes daily.

3. The specific materials and lessons used by the teachers are not described.

Rosner attempted to teach inner city preschool children auditory analysis skills, which included processes such as auditory discrimination, auditory blending and auditory memory. The rationale for selecting children prior to school instruction was that it gives them more time to become familiar with the accoustical elements of the reading-spelling code before being expected to associate the sounds to printed symbols. He found that after a period of six months of instruction, the children in the experimental group scored significantly higher on the Auditory Analysis Test designed by the investigator. Unfortunately, no standardized measure was used in the study. However, it does pont out that children even at the preschool level can benefit from auditory training.[32]

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[31] Jean Mayo, "Two Techniques of Teaching Auditory Blending Skills to Kindergarten Children," Summary of a Doctoral Dissertation, presented to the University of Colarado, 1971.

[32] Jerome Rosner, "Auditory Analysis Training With Prereaders," The Reading Teacher, 27,4, January, 1974, pp. 379-85.

Burkholder hypothesized that a student's inability to acquire reading skills may be based on auditory and visual memory deficiencies. Taking a sample of 20 second and third grade students, she devised a program to train these areas. Ten students were given exercises individually over a three month period for forty-five minutes daily. The ten matched control subjects did not receive any special practice or instruction. She found the experimental group superior in areas of oral reading, memory skills, and psycholinguistic skills as measured by the Illinois Test of Psycholinguistic Abilities (ITPA).[33]

While the results do suggest that remediation in auditory memory skills is possible, the study lacks generalizability due to the specific manner in which each child was taught. The results, in fact, could be attributed to individualized instruction alone.

Halliwell and Solan,[34] and Feldman,[35] in similar studies of retarded readers found no significant differences between groups having perceptual training or traditional basal instruction. Unfortunately, both of these studies, Feldman's in particular, use very small samples.

A study employing a sample of over six hundred first grade students was directed by Rosen. Three hundred students were randomly

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[33] Rachel Burkholder, "The Improvement in Reading Ability Through the Development of Specific Underlying or Associated Mental Abilities," (unpublished Doctoral Dissertation, University of Arizona, 1968) p. 1.

[34] Joseph W. Halliwell and Harold A. Solan, "The Effects of a Supplemental Perceptual Training Program on Reading Achievement," Exceptional Children, April, 1972, pp. 342-345.

[35] Shirley Feldman, "A Study of the Effects of Auditory Training on Remedial Reading," paper presented at the American Educational Research Association Conference, 1966.

assigned to an experimental groups; three hundred to a control group. Then for a period of thirty days, the experimental group received a half hour of perceptual training each day in addition to reading. The control group received thirty additional minutes of reading instruction daily, but no perceptual training, At the end, the experimental group demonstrated superiority to the control group on a retest using the Frostig Visual Perception Test. However, the control group showed significant gains in reading over the experimental group. In other words, the gains as a result of the perceptual training did not seem to transfer to the academic task of reading, while instruction in reading did improve reading achievement.[36]

At this point, no clearly defined conclusions can be reached in regard to auditory training and reading achievement. There are an increasing number of studies that question the magnitude of the relationship. Groff, in a review of research in auditory skills has called for a continuing attitude of inquiry in order to carefully evaluate and expand the concept of auditory processing and its relationship to reading achievement.[37]

The Modality Concept

Reading is often considered primarily to be a visual act. The

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[36] C.L. Rosen, "An Experimental Study of Visual Perceptual Training and Reading Achievement in First Grade," Perceptual and Motor Skills, 22, June 1966, pp. 979-86.

[37] Patrick Groff, "Reading Ability and Auditory Discrimination: Are They Related," Reading Teacher, 28,8, May 1975, pp. 742-48.

student must be able to discern the difference between letters in order to read words. However, reading is also, clearly, an auditory task, for it involves oral communication written down. For years, it has been argued that the visual modality is the most prominent--thus the preponderance of research in that area. More recently, the emphasis has turned to the auditory modality, and its importance in the area of beginning reading. It is now being recognized that children receive and process stimuli differently, often relying on one particular sensory channel. Thus, it is important in an instructional program to be aware of the individual child's preferred learning pattern.

According to Wepman, a child's learning type, his maximal modality or pathway of learning needs to be understood before a particular approach to reading can be determined. When a child shows his best ability to be visual and his lesser ability to be auditory, the visual approach in reading is suggested with immediate auditory reinforcement, and in addition, auditory training to improve that capacity. The opposite approach would be used for the child who demonstrates ability in auditory perception, but only fair in visual skills.[38]

The research in modal preference and its relationship to reading has been comprehensively explored. One of the first studies which focused attention on the modality concept was by deHirsch, Jansky, and Langford, who used a number of tests to identify seven pupils with

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[38]Joseph Wepman, "The Perceptual Basis for Learning," in H. Alan Robinson (ed) Meeting Individual Differences in Reading, (Chicago: University of Chicago Press, 1964) pp. 270-80.

auditory strengths and three with visual strengths from a sample of 53 subjects. The three visual strength pupils were considered superior readers, five of the auditory strength pupils were rated good readers, while two of them failed a comprehensive battery of reading tests. Further investigation of the auditory strength pupils revealed that the five successful auditory readers learned to read using a phonics approach while the two reading failures had been taught by a sight word technique. The results led the authors to conclude that modality strength should largely determine teaching method.[39] However, Jones argues that conclusions concerning these subjects cannot be drawn because no controls for methodology or teacher variables were employed.[40]

Bateman studied the relative effectiveness of visual and auditory approaches in teaching beginning reading. The sample consisted of 182 children in eight kindergarten classes. All the classes received the Detroit Group Intelligence Scale and the Metropolitan Reading Readiness Test. The ITPA was administered to four of the classes in order to divide them into auditory and visual preference groups. In the first grade, half of the auditory subjects were taught using an auditory method; the other half with a visual method. The same procedure was followed with the two visual classes and the four nonplacement classes which did not receive the ITPA. The visual method em-

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[39]Katherine deHirsch, J. Jansky, and W. Langford, Predicting Reading Failure, (New York: Harper and Row, 1966)

[40]John Paul Jones, "Learning Modalities--Should They Be Considered?" in Althea Beery et. al., Elementary Reading Instruction: Selected Materials, (Boston: Allyn and Bacon, Inc., 1974) p. 191.

ployed Scott Foresman materials, and the auditory method used Lippincott materials. Analysis of variance was used in the statistical treatment. The auditory method produced superior reading and spelling achievement when compared with the visual method. The subjects labeled auditory learners made significantly greater gains than did the subjects labeled visual learners. A significant interaction between modal preference and instructional method was not found.[41]

A study by Robinson explored the modality concept by classifying over four hundred first grade pupils as either: 1) high visual--high auditory, 2) low visual--low auditory, 3) high visual--low auditory, and 4) low visual--high auditory. This categorization was based on three separate tests of visual discrimination and the Wepman Test of Auditory Discrimination. The children were then assigned to either a sight word approach (Scott-Foresman) or a phonics approach (Hay Wingo). On later testing using the Gray Oral Reading Test, the results indicated no differences between groups or methods employed.[42]

These studies according to Bruininks,[43] and Jones,[44] are subject to the following methodological limitations:

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[41]Barbara Bateman, "The Efficacy of an Auditory and a Visual Method of First Grade Reading Instruction with Auditory and Visual Learner," in Helen K. Smith (ed.), Perception and Reading (proceedings of the International Reading Association, 12 (4), 1968, pp. 105-12.

[42]Helen Robinson, "Modalities and Beginning Reading," Reading Research Quarterly, 8, 1, Fall, 1972, pp. 1-33.

[43]Robert Bruininks, "Teaching Word Recognition to Disadvantaged Boys With Variations in Auditory and Visual Perceptual Abilities," (Washington, D.C.: Bureau of Educationally Handicapped, N. 332189, October, 1970.

[43]John Paul Jones, op. cit., p. 194.

1. The number of measures used to classify subjects according to perceptual dominance was quite limited, probably resulting in the establishment of groups with inconsequential differences in basic auditory and visual perceptual skills. Jones points out in Robinson's study that many, if not the majority of the children in the visual group actually scored higher on the auditory memory subtest of the ITPA, than on the visual memory subtest of that same measure. In addition, the probability that fifty percent of all incoming first graders prefer the visual mode and fifty percent prefer the auditory mode is very small. However, this is exactly what the researcher assumed in assigning subjects to auditory and visual learning groups.

2. Teaching procedures and the influence of teacher effectiveness were not controlled systemmatically.

3. Teaching approaches did not differ enough in instructional emphasis to test adequately the relationship of matching teaching methods to the perceptual characteristics of children.

With these limitations in mind, Bruinink's study sought to determine whether subjects who show a preference for either the auditory or the visual mode also show a preference for certain methods of learning unknown words. Over one hundred Negro boys from the second and third grades were administered a battery of six auditory and six visual tests. Students whose visual over auditory scores were in the upper 25 percent were designated visual learners; the students with auditory over visual scores, the auditory learners. An attempt was then made to recognize fifteen unknown words using a look/say approach for the visual learners; a phonics approach for the auditory learners. Im-

mediate learning and delayed recall (after one week) were tested using analysis of variance. Neither group demonstrated a preference for either method of teaching new words.[45] A serious limitation of this study, according to Jones,[46] is the misclassification and employment of the Birch and Belmont test as one of the auditory perceptual tasks, since it involves visual perception and intersensory association in addition to auditory perception. However, two other studies by Cooper,[47] and Williams, Oakland, and Harmer[48] using similar populations also found no significant differences linking instructional tasks to modality preference.

Hare, using a different methodological technique, sampled second grade students in both modality preference and reading achievement. She hypothesized that students who had scored below 83 on the Frostig Visual Perception Test, but were reading successfully must have adequate or even compensatory skills in audition.[49] A battery of auditory tests was administered, including the Wepman Auditory Discrimination Test, and the Auditory Sequential Memory and Auditory Sound Blending

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[45]Bruininks, op. cit., p. 16.

[46]John Paul Jones, op. cit., p. 194.

[47]David Cooper," A Study of the Learning Modalities of Good and Poor First Grade Readers," (Paper presented at the International Reading Conference, Annaheim, California, 1970).

[48]Fern Williams, Thomas Oakland, William Harmer, "Auditory Discrimination and First Grade Reading Success," (paper presented at the Annual Meeting of the American Educational Research Association, Chicago, Illinois, April, 1972).

[49]Betty A. Hare, "Perceptual Deficits are not a Cue to Reading Problems in Second Grade," The Reading Teacher, 30, 6, March 1977 pp. 624-29.

from the ITPA. She found that the second grade children did not function above expected levels on any three auditory tasks, in fact, their mean performance suggests that their auditory skills were as deficient as their visual abilities.

Jones reviewed additional studies of the modality concept and its relationship to instructional techniques and reading success, and found only one, Bursuk, which firmly supported the theory that the modal preference of an individual should be considered in teaching children to read. The remaining studies he reviews either show no advantage to the assessment of modal preference in planning remediation or produce conflicted results.[50] Wepman states that the lack of research evidence is due to the inability of researchers to use instructional methods which are purely auditory or visual in nature.[51] Still others suggest that new test measures must be developed which discriminate auditory and visual learners more precisely. However, based on the research to date, one must view the modality concept with reservation.

Auditory-Visual Integration and Its Relationship To Reading Success

Intersensory integration is the processing of multiple stimuli which are being transmitted through different modalities.[52] According

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[50] Jones, op. cit., pp. 192-93.

[51] Wepman, op. cit., pp. 41-3.

[52] James Chalfant and Margaret A. Schefflin, "Central Processing Dysfunctions in Children: A Review of Research," (Washington, D.C.: U.S. Department of Health, Education and Welfare, NINDS, Monograph No.9 1969,p. 51)

to Wepman, in order to gain comprehension from any input signal, a child must use that signal to evoke previously learned symbols received along many input pathways to form the associations necessary for comprehension. This act of arousal and integration is the final stage of perceptual behavior before comprehension is accomplished.[53] Thus a child who sees the printed word "dog" must evoke not only previously received visual stimuli of printed forms but life forms as well; he must shift from the visual input to previously received and stored auditory patterns making "dog" in order for the printed word to have full meaning from him. Without this shift to other modal learning, little integrative meaning may be attached to the printed word.[54]

Piaget believes that the use of these integrated systems is necessary to the development of intelligence. Children begin to learn by acquiring schema, which are cognitive structures of similar action sequences. There are schemas of vision, hearing, touch, taste, developed through assimilation and accomodation. As the child grows older, these initially separate schema become integrated into new higher order schema which in turn go through a process of reciprocal assimilation. These intersensoral coordinations are necessary to the development of intelligence.[55]

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[53]Joseph Wepman, "Auditory Discrimination, Speech and Reading," Elementary School Journal, 1960, 60, pp. 325-333.

[54]Ibid., pp. 326-27.

[55]Oliver Hurly, "Intersensory Integration and Reading: A Theory," (University of Illinois Institute for the Research for Exceptional Children, 1966)

Bruner, in delineating these stages (action, iconic, symbolic) emphasizes that each stage subsumes the preceding one. He suggests that improved interaction between the senses accompanies the development. The process of subsumption requires that deficits in earlier stages effect the development of later stages.[56]

Two major studies by Birch and Belmont have emphasized the importance of auditory-visual integration and its effect on reading achievement.

Birch and Belmont studied 220 elementary school children using the Auditory-Visual Integration Test, which they developed, and a reading achievement test (Metropolitan Readiness Test for the First grade, Stanford Achievement Test for the upper grades). The Auditory-Visual Integration Test calls for the examiner to strike a series of taps on a desk with a ruler, according to a planned sequence, such as (. .. .). The child has to listen to the taps and then pick the appropriate sequence from a series of three presented visually. The investigators found that growth in auditory-visual integration...was most rapid in the age interval encompassed between kindergarten and second grade. In succeeding years, the importance in auditory-visual performance was slow and steady, with an average annual increase of five percent until fifth grade at which the asymtote was reached. With the exception of the kindergarten children, for which the test was too complex and thus involved a high level of guessing, there was a significant correlation at the .01 level between auditory-visual integration

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[56]Ibid., p.5.

and I.Q. and reading.[57] One criticism lodged against this study, however, is that the average I.Q. for these children was 120.

Several years later, Birch and Belmont studied the relationship of auditory-visual integration to reading retardation using 150 retarded readers and 50 normal readers, nine and ten years of age. The retarded readers were significantly less able to make judgements of auditory-visual equivalence than the normal readers. Within the two groups, those children with lower auditory-visual performance tended to have the lower reading scores. When children with low normal I.Q.'s were eliminated from consideration, the significant difference in auditory-visual test performance between the retarded and normal readers was sustained. The findings were interpreted to indicate that the development of auditory-visual integration has specific relevance to reading although it is not the sole factor underlying reading competence.[58]

The Auditory-Visual Integration Test devised by Birch and Belmont included ten items. In order to test the validity of the conclusion that auditory-visual integration skills reach an asymtote at fifth grade, the test instrument was extended to twenty items. Three hundred and fifty students in grades two through six were tested. They found that the mean auditory-visual integration scores increased with age, and that no asymtote was reached by sixth grade. Thus, when

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[57]H. G. Birch and I. Belmont, "Auditory-Visual Integration, Intelligence, and Reading Ability in School Children," Perceptual and Motor Skills, 20, 1965, pp. 295-305.

[58]H.G. Birch and I. Belmont,"Auditory-Visual Integration in Normal and Retarded Readers," American Journal of Orthopsychiatry, 34, 1964, pp. 852-61.

adequate provision was made for continued differentiation in auditory-visual integrative competence in older children, accuracy in judgement at each level continued to be significantly related to reading achievement from levels .37 to .57, at least up to sixth grade children. When the influence of I.Q. was statistically controlled, the relationship between auditory-visual integration and reading was somewhat reduced, however the auditory-visual integration skills and word knowledge remained high and significant at all grade levels at the .001 level; reading comprehension at the .05 level.[59]

There have been several replications of Birch and Belmont's study. Bryden examined the relationship between auditory-visual integration and reading achievement using a same-different judgement task rather than the matching to sample instrument employed in Birch and Belmont's research.[60] Poor readers were found to be somewhat inferior in matching an auditory sequence to a visual dot pattern much as Birch and Belmont reported. However, the poor readers also showed equivalent deficits on all other tasks involving matching one pattern with another, whether an auditory-visual transformation was required or not. Bryden suggests that this could be due to the fact that poor readers have not developed an affective verbal coding strategy for dealing with patterns

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[59] Dale Kahn and Herbert G. Birch, "Development of Auditory-Visual Integration and Reading Achievement," Perceptual and Motor Skills, 1968, 27, pp. 459-468.

[60] M.P. Bryden, "Auditory-Visual and Sequential-Spatial Matching in Relation to Reading Ability," (paper presented at the American Educational Research Association, 1971).

while good readers have. Thus, a dot pattern consisting of two dots, a space, and three dots may be encoded by a good reader, but either coded improperly (e.g. five dots) or left uncoded by the poor reader.[61]

Reilly employed the Birch and Belmont test instrument, using 225 students from grades one through four in order to investigate the relationship between auditory-visual integration, sex, and reading achievement. He found that females develop auditory-visual integration abilities earlier than males but that they reached an asymtote earlier, probably by fourth grade. For males, the ability appeared to develop later, not reaching significance until the second grade, and still evidenced at the fourth grade. He also found that auditory-visual integration ability was more related to comprehension scores than vocabulary, accounting for approximately three times as much of the variance.[62] This conflicts with results found in Kahn and Birch's study, which stated that,

> the auditory-visual integration and word knowledge relationship can be viewed as reflecting a direct association between such skills, while the auditory-visual integration and reading comprehension relationship an indirect connection mediated by the integral role of reading vocabulary in the initial stages of the comprehension process. As word knowledge skills are only one of many variables influencing reading comprehension, the relationship of auditory-visual integration ability to this capacity is limited.[63]

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[61] Ibid., p. 4.

[62] David H. Reilly, "Auditory-Visual Integration, Sex, and Reading Achievement," Journal of Educational Psychology, 62, 6, December, 1971 pp. 482-486.

[63] Kahn and Birch, op. cit., p. 31.

New studies, focusing on this area, need to be devoted to this question.

Muehl and Kremenak investigated the ability of 119 first grade children to match information within and between auditory and visual sense modalities. Matching visual pairs was easy for most children. Matching auditory pairs was the most difficult task, and matching visual to auditory and auditory to visual was intermediate in difficulty. When the extreme reading groups were equated in I.Q., the analysis showed that beginning of the year ability to match visual to auditory and auditory to visual pairs made significant contributions to predicting reading.[64]

However, this study, as well as the others cited, are all based on one test instrument--the Birch and Belmont Auditory-Visual integration test, which has never been analyzed in terms of reliability and validity. An examination of this test reveals that it requires other levels of processing skills, such as attention and memory. Therefore, it remains unclear whether the inability of a child to integrate auditory and visual information is a major cause of reading disability.

Conclusions

There are several factors which limit the generalizability of the studies mentioned in this review of the literature.

The auditory modality research results are confounded by a lack

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[64]S. Muehl and S. Kremenak, "Ability to Match Information Within and Between Auditory and Visual Sense Modalities and Subsequent Reading Achievement," Journal of Educational Psychology, 57, 1966, pp. 230-238.

of instrument standardization. A widely used test by Birch and Belmont has never been subject to tests of validity or reliability. Other widely used measures, such as the Wepman Auditory Discrimination Test probably include processes such as auditory acuity and sensitivity as well.

Several considerations that lead to a lack of confidence in the findings presented, involve variations in research designs. The research has spanned a variety of socioeconomic, age and ability groups. Selection of samples have been random as well as selective. Often the number of subjects involved in the experimental groups are so few as to eliminate opportunity for interesting results. Studies have been descriptive, predictive, correlational and implemental in nature.

In view of these limitations, the following conclusions have been derived from the studies reviewed:

1. It appears that perceptual demands at the initial stages of reading acquisition are the greatest.

2. Auditory processing skills are not highly predictive of later reading achievement.

3. Auditory processing skills can be taught.

4. Teaching children according to their modality preference does not seem to enhance reading achievement.

5. Gradual auditory improvement appears to be a possible requisite for the early stages of reading development.

6. Auditory-visual integration skills are possible predictors of reading achievement for individuals ranging from seven to twelve years of age.

Chapter 3

PLAN AND PROCEDURE OF THE STUDY

The purpose of this study was to analyze auditory processing skills to determine if these skills can be taught and, in turn, if such instruction has positive effects on reading achievement for kindergarten and first grade children.

The development of a research design for testing this question is described in this chapter as follows: (a) the selection of a sample, (b) the test materials, (c) the administration of the pretest to the experimental and control groups, (d) the development and implementation of the instructional program, (e) the administration of the posttest, and (f) the data analysis.

Selection of a Sample

Students from seventeen kindergarten and first grade classrooms in the Branford Public School System were chosen to participate in this study. All schools within the system were given the opportunity to participate; only one school, Brushy Plains, preferred not to be included. The rationale for the consideration of these grade levels is based on the assumption that auditory processing training can be most effectively used at the beginning of reading and phonics instruction. The town of Branford, heterogeneous in character, includes families from a major academic institution (Yale University) as well as a variety of industrial concerns. There is however, no significant minority pop-

ulation; thus the generalizability of the analysis must be confined to a suburban population. The socioeconomic status of each student was collected using the city directory. This information was then coded using the Duncan index, which ranged from one, representing the lowest level which includes unskilled, blue collar occupations, through five, which involved professions, and highly skilled positions. The average score of the entire sample was 3.5.

Schools were randomly assigned to the experimental and control groups with the exception of one experimental classroom which was transferred to a control school (Damascus).

Each kindergarten contained two sessions which were treated as two separate classrooms. One small elementary school (Stony Creek) did not have a kindergarten classroom. Table 1 summarizes this information concerning the sample size, grade level, and location of the test groups. The study began with 418 students. The final n was 382, representing an attrition of 10.4 percent. The primary causes of the attrition were extended absenteeism, incomplete testing, and the movement of students out of the school system.

All children entering kindergarten in Branford were subject to a prescreening evaluation, given by members of the school system, four months prior to school entrance. Prescreening conducted by the reading and speech specialists included three basic areas: auditory, visual, and language skills. Students who did not pass the auditory screening test were thus, not included in this study.

Table 1

Location, Grade Level and Number of Students in Test Groups

School	Number of Students			
	Exp. K	Control K.	Exp. First	Control First
Damascus	0	28	24	23
Indian Neck	50	0	57	0
Pine Orchard	0	55	0	21
Branford Hills	0	0	0	36
Short Beach	42	0	26	0
Stony Creek	0	0	0	20
Total	92	83	107	100

The Test Materials

Three tests were given to assess growth in the student's auditory processing, visual perception and reading achievement skills: The Auditory Processing Test; the Motor-Free Visual Perception Test by Donald Hammill and Ronald Colarusso and the Metropolitan Achievement Test for the first grade children, the Metropolitan Readiness Test for the kindergarten level.

The Auditory Processing Test

There are several exceptable individually administered test materials which attempt to assess certain areas of auditory processing skills. However, due to the large sample, it was far more expedient

to use a group measure. Unfortunately, there is no one measure that tests these skills. Therefore it was necessary to construct and combine four auditory subtests in order to obtain an overall auditory processing measure (see Table 2).

Table 2

The Auditory Processing Test

Subtest	Skill
Auditory Sound Blending Test (ITPA)	Auditory Blending
Auditory Sequential Memory Test (ITPA)	Auditory Attention Auditory Memory
Auditory Discrimination Test (Gates-MacGinitie Reading Readiness Test)	Auditory Discrimination
Auditory-Visual Integration Test (Birch and Belmont)	Auditory-Visual Integration

The subtests included in the Auditory Processing Test are as follows:

1. The Auditory Sound Blending Subtest: This subtest, from the Illinois Test of Psycholinguistic Abilities, is designed to measure the ability to integrate isolated sounds into a whole word. In its original form, the test includes thirty-two items--twenty-four familiar words ranging from two to seven phonemes, and eight nonsense words. For the purposes of this study, only the first twenty-four words were used. The investigator developed the subtest into a group measure by using twenty-four rows with five pictures per row. The student's

task was to mark an X on the picture of the word given slowly by the test administrator. Based on the assumption that all items measured a single trait, the Kuder-Richardson Formula 21 was used to establish reliability. Fifty-two first grade students in a nearby parochial school were administered the newly constructed measure. The reliability coefficient was .86, the mean 19.8, the median 19, and the variance 26.

2. The Auditory Discrimination Subtest, Gates-MacGinitie Reading Readiness Test, Kindergarten and First Grade: This test measures the child's skill in distinguishing between two words of similiar sounds. It includes 21 pairs of words. Each pair differs in only one sound. After naming both pictures in a pair, the examiner pronounces the name of one of the pictures again. The child marks the corresponding picture. The reliability of this subtest is .73, established by examining 4500 kindergarten and first grade students.

3. The Auditory Sequential Memory Subtest, Illinois Test of Psycholinguistic Abilities: This test is an auditory measure of short-term memory, which involves the ability to remember and correctly repeat a sequence of symbols just heard. The test resembles the standard digit repetition test except that: 1) the digits are uttered at a rate of two per second, which is twice the usual rate, 2) the examiner's voice drops at the end of the digit sentence, and 3) some digit sequences contain the same digit twice.[1] The test in its original form contains 28 items. However, for the purposes of this investigation, every other

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[1]Wilma Jo Bush, and Marian Taylor Giles, Aids to Psycholinguistic Teaching, (Columbus: Charles E. Merrill Publishing Company, 1969)

item was used. Furthermore, instead of vocalizing their responses, students marked an X on one of three digit sequences per row. The Kuder-Richardson Formula 21 was used to determine the reliability coefficient based on data obtained from 36 first grade students tested in September, 1976. The mean was 10.3, the median, 11, and the variance 11, and the reliability coefficient, .80.

4. The Auditory-Visual Integration Test: This test developed by Birch and Belmont has been used successfully in several research designs. The child is required to identify a visual dot pattern from among three presented, which he judges to be the same as the pattern of auditory presentation. The test is designed to assess the student's ability to interrelate auditory and visual stimuli. The present study has followed a modification used by Reilly in his study of auditory-visual integration by increasing the number of items from ten to twenty. This test has not yet been subject to any test of reliability.

The Auditory Processing Test, administered in its entirety takes approximately thirty minutes.

The Motor-Free Visual Perception Test: Devised by Ronald P. Colarusso and Donald D. Hammill, 1972.

The Motor-Free Visual Perception Test is a test of visual perception in five areas: spatial relationships, visual discrimination, figure-ground, visual closure, and visual memory. This test avoids motor involvement. Construct validity was demonstrated by correlating the MVPT with the Frostig Developmental Test of Visual Perception, resulting in a .73 coefficient. To determine the consistency of the

measure, split half reliability procedures were employed. The coefficients ranged from .81 to .84 at various age levels.

All thirty six items were used in developing this test into a group measure. The stimulus items were shown at the left side of the page. The student's task was to find the picture on the right that matched the stimulus picture and mark an X. For items 14 through 21, the test retest procedure was utilized. Forty-two prekindergarten children, ages five and six were administered the test on two occasions--April 5-10, 1975, and May 1-7, 1975. The Pearson product moment correlation coefficient was .84.

The Metropolitan Achievement Test

The MAT, appropriate for each grade level was administered to determine overall reading achievement. Three different levels were used in this study:

1. Metropolitan Reading Readiness Test, Level II: This test was administered to the kindergarten classrooms as a posttest. Three subtests were employed for the purposes of this study: a) Beginning Consonants, b) Sound/Symbol Relationship, c) listening. Reliability estimates were .93, .93, and .72 respectively.

2. Metropolitan Achievement Test, Primer: Three subtests were administered to first grade students as a pretest: a) Listening for Sounds, b) Reading Words, and c) Reading Sentences. Reliability data determined by split half coefficients, corrected by the Spearman Brown formula are .92, .92, and .91 respectively.

3. Metropolitan Achievement Test, Primary: In order to determine growth and overcome a ceiling effect, the primary form was administered to first grade classrooms as a posttest. Three subtests were included in the battery: a) Word Knowledge, b) Word Analysis and c) Reading. Reliability coefficients for the three subtests are .94, .94, and .96. Standardized T scores were used to determine differences between the pretest and posttest results.

All tests described in this section may be found in Appendix A.

Administration of the Pretest

It was the intention of the investigator to administer the three test measures described in the previous section to all kindergarten and first grade students prior to their participation in the study. However, due to several unanticipated factors, pretesting at the kindergarten level had to be discontinued. Children at this level experienced the following difficulties:

1) Inability to understand test directions

2) Inability to work independently

3) Extreme anxiety in some cases due to test situations

4) Lack of basic concepts, specifically, top, bottom, left, right, first, last.

The prescreening data obtained by the Branford School System were not available. Thus, the socioeconomic status of each child was the only method of equating any initial difference between the experimental and control groups.

The administration of all three pretests to the ten first

grade classes was completed during the first two weeks in October in three half hour sessions per class. All testing was conducted by the investigator in order to insure for consistency in test administration. The results of the test program were not given to the teacher until the study had been concluded.

Development and Implementation of the Instructional Program

The Auditory Processing Training Program is a sequential instructional system using audio taped lessons designed to improve listening, language, and reading skills by teaching auditory perceptual processes. The program, designated for children at the kindergarten and first grade levels may be used in remedial instruction for children grades two through six.

The program materials developed and refined over a period of two years, have implemented several lesson formats originally used in the Auditory Perceptual Program designed by Drrs. Dona Hendricks, Charles Manning, Katherine Butler, under the directorship of Dr. Belle Ruth Witkin of Alameda County Schools.[2]

The Auditory Processing Training Program, hereafter referred to as APT, developed for this study, includes 76 taped lessons and worksheets divided into four instructional units: (see Tables 3-6).

1. Unit 1, Auditory Attention: Lessons in this unit involve the ability to direct and sustain attention to sounds; to select a

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[2]Belle Ruth Witkin,"The Auditory Perceptual Training Program," ESEA Title III Project 0471, June, 1973.

relevant stimulus from a background of irrelevant stimuli, and to discriminate between familiar environmental sounds. Students are guided to see that sounds differ in intensity, frequency, pattern, and duration.

2. Unit 2, Auditory Discrimination: Emphasis in this unit is directed to hearing similarities and differences in the beginning, middle, and end of words and listening for rhyming patterns.

3. Unit 3, Auditory Blending and Closure: This unit includes three separate components: a) Auditory Blending--the ability to reproduce a word by synthesizing its component parts, b) Auditory Closure--the ability to anticipate and supply missing word parts, and 3) Grammatical Closure--the ability to predict future linguistic events from past experience. More specifically the skills involved in the unit include hearing separate sounds in words, identifying syllables in multisyllabic words, synthesizing phonemes to reproduce a one to three syllable word, identifying words with missing parts in the beginning, middle, and end, and categorizing words that belong to one unit.

4. Unit 4, Auditory Memory and Comprehension: These lessons emphasize short-term memory, first in nonmeaningful contexts, then in directed reading exercises, requiring a longer attention span and understanding.

The lessons are approximately five to fifteen minutes in length.

An important feature is the provision in each lesson for feedback to the listener. When the task is new and somewhat difficult, feedback is given immediately after each row. Generally, the narrator gives the correct answer, repeats the stimulus for reinforcement and

Table 3

The Auditory Processing Training Program: Sequence, Unit 1 Auditory Attention

Lesson	Title	Process	Format
1.1	Identification of Noisemakers	Identification; Vigilance Discrimination Selective Listening	The student will identify the noisemaker by marking an X on the appropriate picture.. On page 2 of this lesson, the student will identify two noisemakers.
1.2	Identification of Sounds that Vary in Intensity (Loud and Soft)	Identification; Vigilance; Discrimination; Selective Listening	The student will identify whether the sound given is loud or soft by marking an X on the picture of the clock (soft sound) or the picture of the horn (loud sound). On page 2 of this lesson, the student will compare two different sounds to determine whether both sounds are loud or soft.
1.3	Identification of Sounds that Vary in Duration	Identification; Vigilance; Discrimination; Selective Listening	The student will identify whether the sound is long or short by marking an X on the tall man if the sound is long; an X on the short man if the sound is short. On page 2, the child will compare the duration of two sounds.
1.4	Identification of Rising, and Falling and Level Intonation Patterns of Simple Sentences	Identification; Vigilance; Discrimination Selective Listening	The child will identify the direction of intonation of a stimulus sentence by filling in the appropriate dotted line.
1.5	Identification of Rising, Falling, and Level Intonation Patterns in Simple and Complex Sentences	Identification Discrimination	The student will identify the direction of the intonation pattern by filling out the appropriate road.

Table 3 (continued)

The Auditory Processing Training Program: Sequence, Unit 1 Auditory Attention

Lesson	Title	Process	Format
1.6	Identification of Sounds that Differ in Pattern	Identification Discrimination Short-term Memory Temporal Sequencing	The student will identify the direction of the intonation pattern by filling in an X on the appropriate picture.
1.7	Identification of Geometric Figures that Differ in Pattern	Identification Discrimination Short-term Memory Temporal Sequencing	The student will identify the pattern of figures given by marking an X on the appropriate picture.
1.8	Environmental Sounds	Identification Discrimination Elective Listening	The student will identify familiar sounds by marking an X on the picture that represents the sounds heard.
1.9	What Happens Now?	Understanding Cause and Effect Relationships; Identification	The student will mark an X on the picture of an action that would likely to occur after the sound is given.
1.10	Who's Talking	Identification Vigilance Auditory Figure-Ground	The student will mark an X on the picture named by the given leader, and will ignor pictures named by the other two speakers.
1.11	Selective Listening	Identification Auditory Figure-Ground	The student will mark an X on the appropriate picture while being distracted with white noise S/D=0db. (The white noise is presented at the same loudness as the speaker).

Table 3 (continued)

The Auditory Processing Training Program: Sequence, Unit 1 Auditory Attention

Lesson	Title	Process	Format
1.12	Identification of Complex Intonation Patterns in Simple and Complex Sentences	Identification Discrimination	The child will identify the intonation pattern of a stimulus sentence by marking an X on the appropriate roller coaster.
1.13	Identification of Patterns with Distracting Noise	Selective Listening Temporal Sequencing Short-term Memory	The student will practice sequencing against a distracting blue noise by marking an X on the box representing the order of the sounds heard.
1.14	Happy or Sad?	Comprehension Short-term Memory	The student will identify whether the sentence given is happy or sad by marking an X on the happy or sad face.

Table 4

The Auditory Processing Training Program: Sequence, Unit 2 Auditory Discrimination

Lesson	Title	Process	Format
2.1	Rhyming Fun	Discrimination Rhyming	The student will identify one or two pictures that rhyme with the stimulus word given, by marking an X on the appropriate pictures.
2.2	Rhyming Fun	Discrimination Rhyming	The student will identify the picture that rhymes with the stimulus word by marking an X on the appropriate picture.
2.3	Fun with Mother Goose	Discrimination Rhyming	The student will complete the Mother Goose rhyme by marking an X on the appropriate picture.
2.4	Silly Sentences	Rhyming Short-term Memory	The student will remember words that rhyme with the stimulus word, and draw a line through a circle for each word given in a sentence.
2.5	Identification of Initial Sounds--M,T,D, F	Discrimination	The student will identify the picture which begins with the sound given, by marking an X on the correct response.
2.6	Initial Sounds--B,T, P,D	Discrimination	The student will discriminate the beginning sounds in pairs of words, by marking an X on the pictures given.
2.7	Initial Sounds--G, J, C, P	Discrimination	The student will identify words that begin with a particular sound in a stimulus sentence by drawing a line through a circle for each word.

Table 4 (continued)

The Auditory Processing Training Program: Sequence, Unit 2 Auditory Discrimination

Lesson	Title	Process	Format
2.8	Initial Sounds-- G, J, C, P	Discrimination	The student will identify pictures that begin the same as the stimulus word given, by marking an X on the correct response.
2.9	The Sound of S	Discrimination	The student will identify pictures with the sound of /s/ at the beginning and end of a word, by circling the correct response.
2.10	The Sound of S	Discrimination	The student will recognize the occurrence of /s/ anywhere in a stimulus word by making an X on the snake if the word begins with the /s/ sound; an X on the bus if the word ends with the /s/ sound.
2.11	The Sound of R	Discrimination	The student will identify words that begin and end with the /r/ sound, by marking an X on the appropriate response.
2.12	The Sound of S and R	Discrimination	The student will discriminate between /s/ and /r/ at the beginning and end of the word, by marking an X on the appropriate word.
2.13	The Sound of R	Discrimination	The student will discriminate words with the /r/ sound in the beginning, middle, and end of the word, by marking an X on the correct response.
2.14	Beginning Sounds	Discrimination	The student will identify words that begin and end with the same sound as the stimulus picture, by marking an X on the picture.

Table 5

The Auditory Processing Training Program: Sequence, Unit 3 Auditory Closure

Lesson	Title	Process	Format
3.1	How Many Sounds	Identification Short-term Memory	The student will recognize and remember the number of phonems in a word when they are uttered at one second intervals by making a line through as many circles as there are phonemes.
3.2	How Many Syllables?	Identification of Syllables Short-term Memory	The student will remember the number of syllables heard in a word by making a line through as many circles as there are syllables.
3.3	How Many Do You Hear?	Identification of Syllables Short-term Memory	The student will remember the number of syllables in multisyllabic words and nonsense words by circling the appropriate digit in the row.
3.4	What Comes When?	Temporal Sequencing Discrimination	The student will remember and identify the order in which two unrelated speech sounds are uttered by making a circle around the correct sequence of letters.
3.5	What Comes When?	Temporal Sequencing Discrimination	The student will remember and identify the order in which four unrelated speech sounds are uttered by making a circle around the correct sequence of letters.
3.6	Slow Motion Words	Auditory Synthesis and Closure	The student will synthesize one syllable words when the phonemes are uttered separately at one second intervals by marking an X on the correct picture.

Table 5 (continued)

The Auditory Processing Training Program: Sequence Unit 3 Auditory Closure

Lesson	Title	Process	Format
3.7	Slow Motion Words	Auditory Synthesis and Closure	The student will synthesize multi-syllabic words when the phonemes are uttered separately at one second intervals by marking an X on the correct picture..
3.8	Slow Motion Words	Auditory Synthesis and Closure	The student will synthesize a word in which the phonemes are uttered at one second intervals by making a circle an X, or a line on the correct picture as instructed.
3.9	Forgotten Sounds	Auditory Closure	The student will identify one syllable words with sounds missing at the beginning or end of the word, by marking an X on the correct picture.
3.10	Forgotten Sounds	Auditory Closure	The student will identify two or three syllable words spoken with sounds missing, by marking an X on the correct picture.
3.11	Forgotten Sounds	Auditory Closure	The student will identify two or three syllable words spoken with sounds missing by marking an X on the correct picture.
3.12	Goes Together	Recognition of Language Categories	The student will recognize two objects that belong in the same language category by marking an X.
3.13	Categories	Grammatical Closure	The student will recognize objects that belong in the same language category by marking an X on the picture that does not belong.

Table 5 (continued)

The Auditory Processing Training Program: Sequence Unit 3 Auditory Closure

Lesson	Title	Process	Format
3.14	Riddles	Grammatical Closure	The student will answer riddles by marking an X on the correct response.
3.15	Categories	Grammatical Closure	The student will determine which of two objects belongs in a language category by marking an X on the picture of the same category as the three other words given.
3.16	Thinking and Talking	Grammatical Closure	The student will discriminate between singular and plural subject-verb forms by marking an X on the picture which matches the construction of the stimulus sentence.
3.17	Thinking and Talking	Grammatical Closure	The student will discriminate standard from non-standard subject/verb forms by marking an X on the picture which matches the construct of the stimulus sentence or by marking an X on the ghost if the form is non-standard.
3.18	Thinking and Talking	Grammatical Closure	The student will identify whether an action takes place in the past, present or future by marking an X on the picture that matches the stimulus sentence.
3.19	Thinking and Talking	Grammatical Closure	The student will identify whether an action takes place in the past, present, or future by marking an X on the picture that matches the stimulus sentence.

Table 6

The Auditory Processing Training Program: Sequence, Unit 4 Auditory Memory and Comprehension

Lesson	Title	Process	Format
4.1	What's My Number	Short-term Memory	The student will remember the last digit of a telephone number given, by circling the appropriate number. On page 2, the task will become more difficult, where the student is required to remember two to four digits.
4.2	Number Sequencing	Short-term Memory Temporal Sequencing	The student will circle the numbers given in a particular order. The student will be required to remember up to five digits.
4.3	Alphabet Sequencing	Short-term Memory	The student will circle the letters given in a particular order, while distracting music is being heard at the same time. The student will be required to remember up to five digits.
4.4	Picture Sequencing	Short-term Memory Temporal Sequencing Figure-ground	The student will remember pictures given in a particular order, while distracting television noise is being heard at the same time.
4.5	How Many Do You Hear?	Short-term Memory	The student will remember the number of syllables in multisyllabic words by marking an X on the appropriate row.
4.6	How Many Do You Hear?	Short-term Memory	The student will identify the pattern of syllables in phrases and sentences by marking an X on the dots that match the pattern.

Table 6 (continued)

The Auditory Processing Training Program: Sequence Unit 4 Auditory Memory and Comprehension

Lesson	Title	Process	Format
4.7	Picture and Word Comprehension	Comprehension	The student will mark an X on the picture that represents the sentence given.
4.8	Sense or Nonsense	Comprehension	The student will determine if a sentence makes sense or not by marking an X on the happy or sad face.
4.9	Would You?	Comprehension	The student will identify the picture that answers the questions given by marking an X on the appropriate response.
4.10	Sense or Nonsense	Comprehension	The student will determine if the sentence given makes sense by circling the response; if the sentence is right,by marking an X on the response if the sentence is wrong.
4.11	Would You Do It?	Comprehension (synonyms)	The student will demonstrate his comprehension of individual words by marking an X on the picture that is synonymous with the word given
4.12	Opposites	Comprehension (antonyms)	The student will demonstrate his comprehension of individual words by marking an X on the picture that is the opposite of the word given.
4.13	What's Missing	Short-term Memory	The student will identify the word missing in a sentence given, by marking an X on the picture.

Table 6 (continued)

The Auditory Processing Training Program: Sequence Unit 4 Auditory Memory and Comprehension

Lesson	Title	Process	Format
4.14	Pick-a-Picture	Discrimination of Prepositional Phrases	The student will discriminate between several prepositional phrases which describe complex spatial relationships by marking an X on a picture that corresponds with the stimulus sentence.
4.15	Pick-a-Picture	Discrimination of Prepositional Phrases	The student will discriminate between several prepositional phrases which describe complex spatial relationships by marking an X on the picture that corresponds with the stimulus picture.
4.16	Short Stories	Short-term Memory Comprehension	Six short stories will be read to the children. After each story, three to four questions will be asked. The students will answer the questions by circling the correct picture.
4.17	Fairy Tales	Memory Comprehension	Two fairy tales--The Three Bears and the Little Engine that Could--will be read to the students. After each story, questions will be asked. The students will answer the questions by circling the correct picture.
4.18	Funny Stories	Memory Comprehension	Two less familiar stories will be read--Chicken Little and I Know an Old Lady. After each story, questions will be asked. The student will answer the questions by circling the correct picture.

briefly explains the reason for the correct choice. As the lessons in the unit progress, feedback is delayed until the exercise has been completed.

Picture vocabulary was taught in each lesson to reduce ambiguity. While the auditory processing tasks increase in complexity, the visual motor tasks remain the same throughout the program, thus minimizing the attention directed to motor behavior.

The Instructional Tapes

The APT lessons are on cassette tapes, recorded under high fidelity conditions, using a Panasonic tape recorder with a frequency band of 50-15,000 Hz $\pm$ 3 db and a signal to noise ratio better than 45 db.

Several voices are heard on the tapes, however, the narrator, Susan, conducted the majority of the lessons. The scripts were all written by the investigator.

Implementation of the Instructional Program

Both the experimental and the control groups utilized the Ginn 360 Reading Program as the basis of reading instruction. Students designated in the experimental group participated in the APT program three times weekly for a period of seven months. The control group did not receive any additional instruction other than the traditional basal program.

In order to equalize treatment among the experimental classrooms, several important considerations were necessary involving the

environment, the teacher's role, and the role of the student aide.

The Environment

The lessons were conducted in a quiet environment. In seven of the nine classrooms, a listening center was utilized, accomodating five to eight students at one time. In the other two classrooms, half of the students participated in the APT program while the other half were involved in a quiet activity outside in the hall. After the lesson was completed, the procedure would be repeated with the second group of students.

In most cases the program was implemented during the period of language instruction, in the morning.

The Teacher's Role

In order to control for the teacher variable, all information in regards to pupil progress was kept confidental. The teachers were encouraged to continue their normal classroom routine.

The Student Aides

Through an accredited career education program, high school students were assigned to each experimental classroom to aide in the implementation of the instructional program. Their responsibilities included: 1) organizing the students into listening groups, 2) providing the listening materials, and 3) being available when difficulties would arise with equipment. No individualized instruction was given to the students. When children became confused or frustrated with a task, the aide would encourage them, and point to the correct response.

Conversation was kept to a minimum. No attempt was made by the aide or the teacher to reschedule lessons for children who were absent.

Administration of the Posttest

The Auditory Processing Test, the Motor-Free Visual Perception Test and the Metropolitan Achievement Tests were administered to all eighteen kindergarten and first grade classes beginning the second week in May. All testing was conducted by the investigator.

Kindergarten children were tested in small groups in a quiet area away from the classroom. Two aides assisted the students, making sure they understood directions, and worked independently.

Data Analysis

All test scores for the experimental and control groups were collected and the data were transferred to the standardized IBM card format. The keypunching was verified to reduce the potential for error in this part of the data analysis. The data file was then entered into the Statistical Package for Social Sciences (SPSS) system for the IBM 370/27 computer. Each step in the computer programming was double checked. The analysis of covariance subprogram of the SPSS system was utilized. The major part of the analysis involved a one-way design--the one independent variable being the experimental program, with socio-economic status and sex used as covariates as a means of equalizing the two groups. Results of this analysis are presented first as total test scores, then in order to give additional information, subtest scores.

In addition, the independent variables were utilized as factors

in a two-way and three-way design in order to study the interaction effects among the independent and dependent variables. The Pearson product moment correlation coefficient was utilized to study the effects of the treatment program on the relationship of auditory and visual perception before and after the experimental period. The results of these analyses are presented in the following chapter.

Chapter 4

ANALYSIS OF DATA

The purpose of this study was to determine if auditory processing skills can be taught using an audio taped program developed by the investigator, and if these skills effect overall reading achievement, at the kindergarten and first grade levels. More specifically, the following questions were raised:

1. Can auditory processing skills be taught using the Auditory Processing Training Program?

2. To what extent do auditory processing skills effect reading achievement?

3. Is their a relationship between auditory processing training and reading achievement?

4. Is their an interaction between auditory processing training and socioeconomic status with respect to auditory processing skills and reading achievement?

5. Is the effectiveness of the auditory processing training program related to the achievement level of the pupil?

6. Is there a difference between kindergarten and first grade pupils in their ability to develop auditory perceptual skills?

Three tests were administered to assess growth in the student's visual, auditory and reading skills: the Motor-Free Visual Perception Test, the Auditory Processing Test, and the Metropolitan Achievement Test (the Metropolitan Readiness Test for students at the kindergarten level.)

Both the visual and auditory measures may be referred to as criterion or mastery tests. Mastery testing assumes a known, finite set of specific objectives which are to be learned. Thus, it is possible and, in fact, desirable for a student to achieve a perfect score on a subtest such as Auditory Sound Blending. On the other hand, the Metropolitan Achievement Test is designed to maximize differences in student achievement. Its objective is to place students somewhere along the range of possible achievement for the test from the very lowest to the very highest scores. Therefore, scores on the posttests for the Motor-Free Visual Perception Test (hereafter referred to as MVPT), and the Auditory Processing Test (APT), will be markedly skewed, while most likely, a normal distribution will be anticipated for the achievement test results.

Raw Scores

Before turning to a full explication of the research findings, it is appropriate to review the distribution of test scores at the beginning and end of the test period for both the treatment and control groups.

In each of the following graphs, the horizontal axis represents the raw test scores (in Figure 5, the scores range from 10 to 36). The vertical axis represents the number of subjects in a single category (in Figure 5, the maximum number of subjects in a single category is 15). The bold lines illustrate the control group distribution, while the dotted lines represent the treatment group.

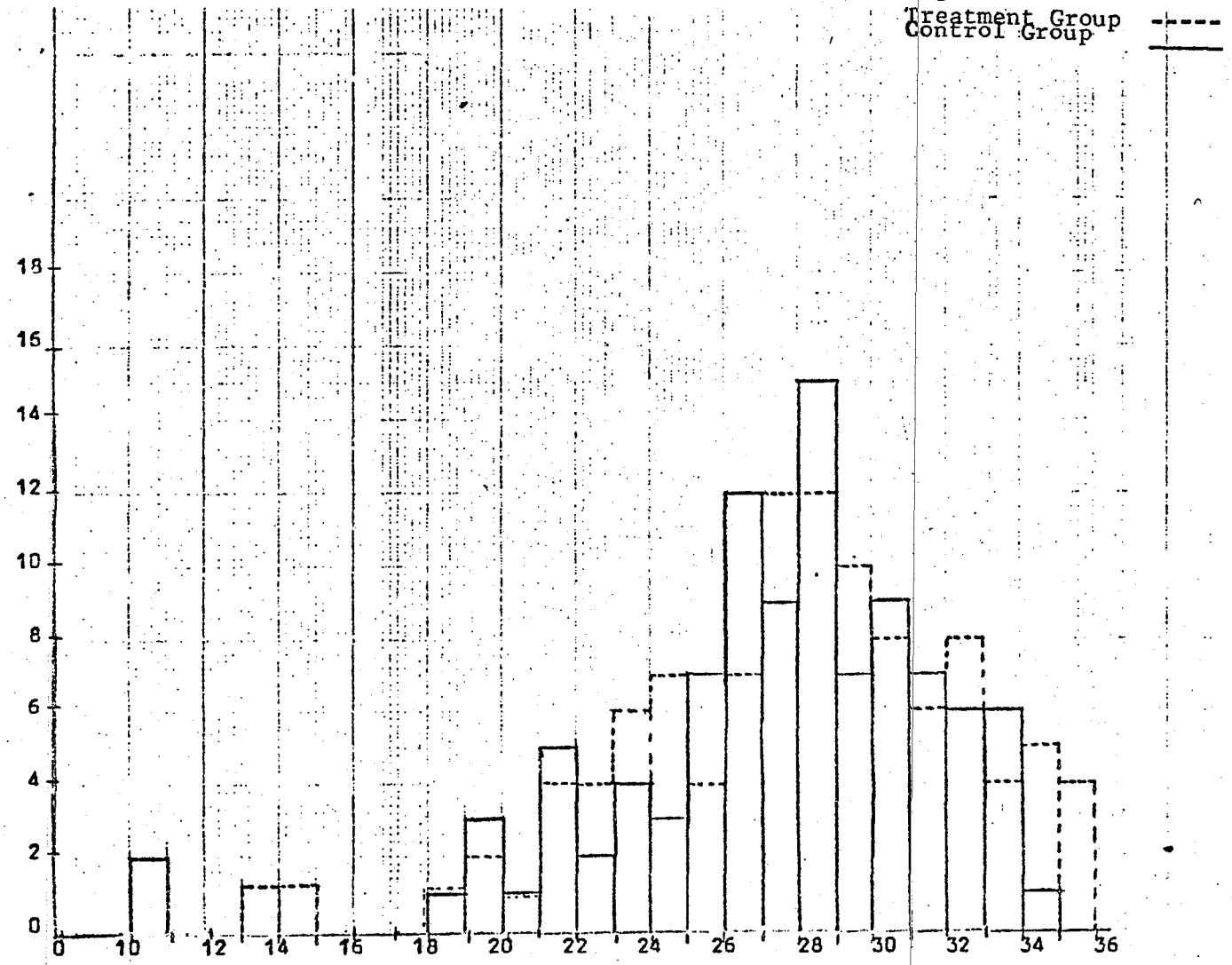


Figure 5

The Motor-Free Visual Perception Test--Pretest
For the First Grade Sample

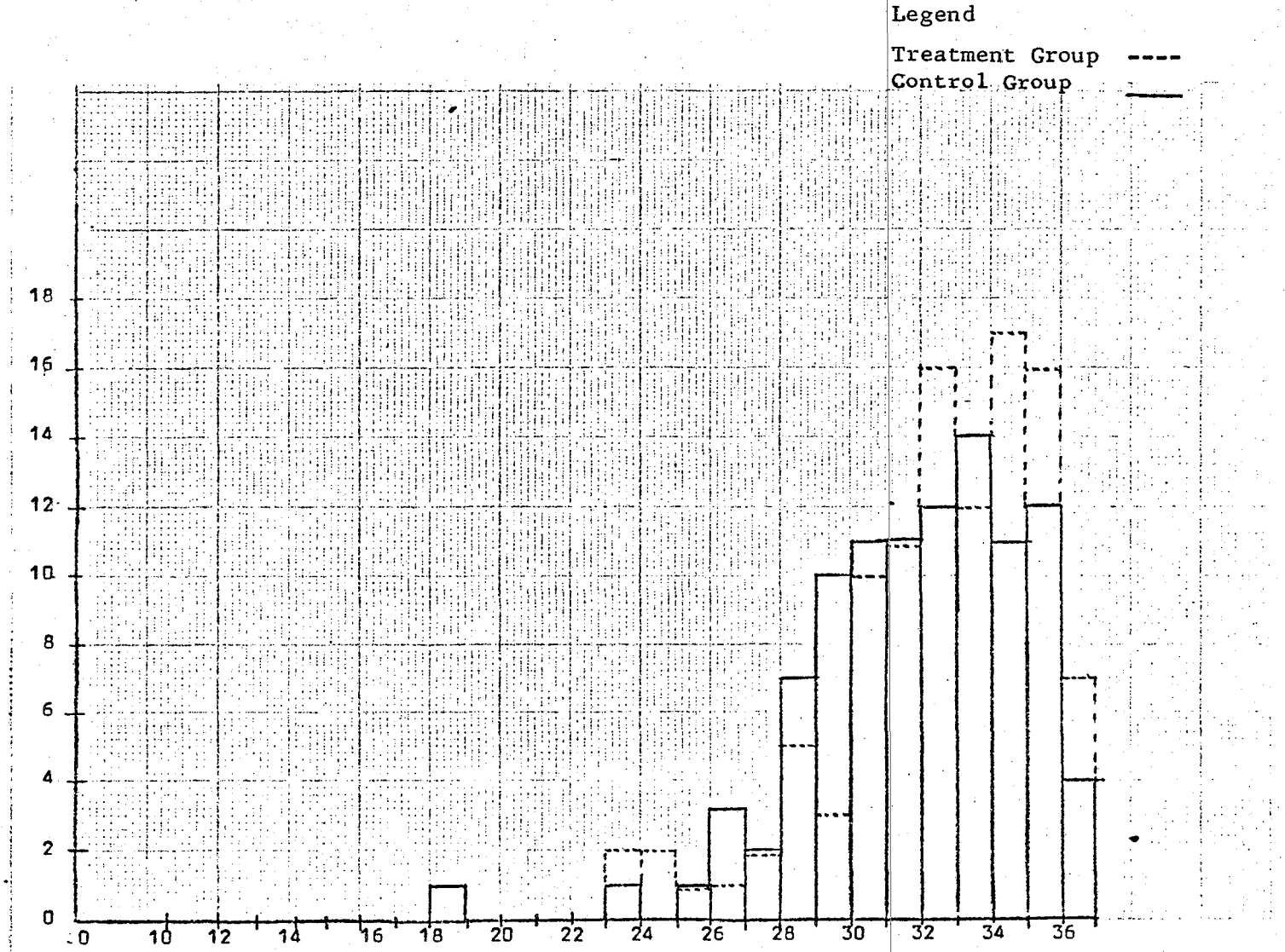


Figure 6

The Motor-Free Visual Perception Test--Posttest

For the First Grade Sample

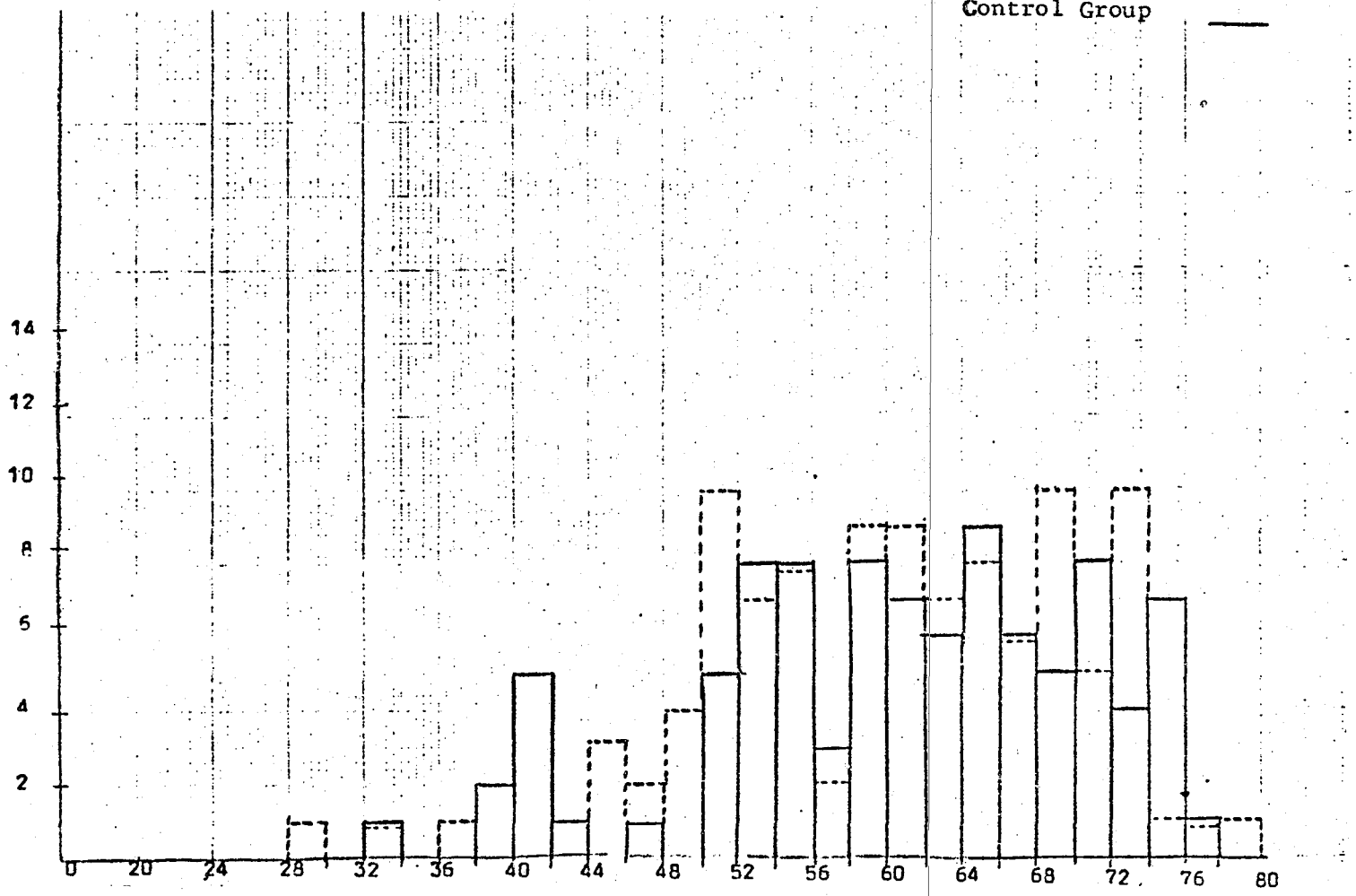


Figure 7

The Auditory Processing Test--Pretest

For the First Grade Sample

Figures 5 and 6 represent the distribution of the visual perceptual scores as measured by the MVPT for the pretest and posttest results at the first grade level. The same 36 item test was administered at the beginning and end of the experimental period. The test is described in Chapter 3, and the actual test materials are included in Appendix A. These figures describe two phenomena. First, before the initiation of the instructional program, the MVPT scores for both groups approximate a normal distribution. While slight differences may be seen with the treatment and control groups, the means are 27.4 and 26.9 respectively. Second, by the end of the experimental program, the distribution of subjects represents much more closely, a Poisson curve, rather than a normal distribution, with the greatest number of subjects attaining the highest possible score. The mean for the treatment group is 32.1; for the control, 31.4.

The same pattern is illustrated in Figures 7 and 8 which describe the distribution of APT scores for the treatment and control groups. Again, the curve at the beginning of the experimental period approaches normality, with the mean for the treatment group 60.8, for the control 61.4. However, by the end of the study, one can see more of a Poisson curve.

The pattern for the Metropolitan Achievement Test, however, is different on the whole, than the patterns seen in both the MVPT and the APT. The scores represented at the beginning of the experimental period are normally distributed with the means for the treatment and control groups 101.3, and 98.5 respectively. However, the phenomenon of an increasing number of students obtaining a perfect score in the posttest

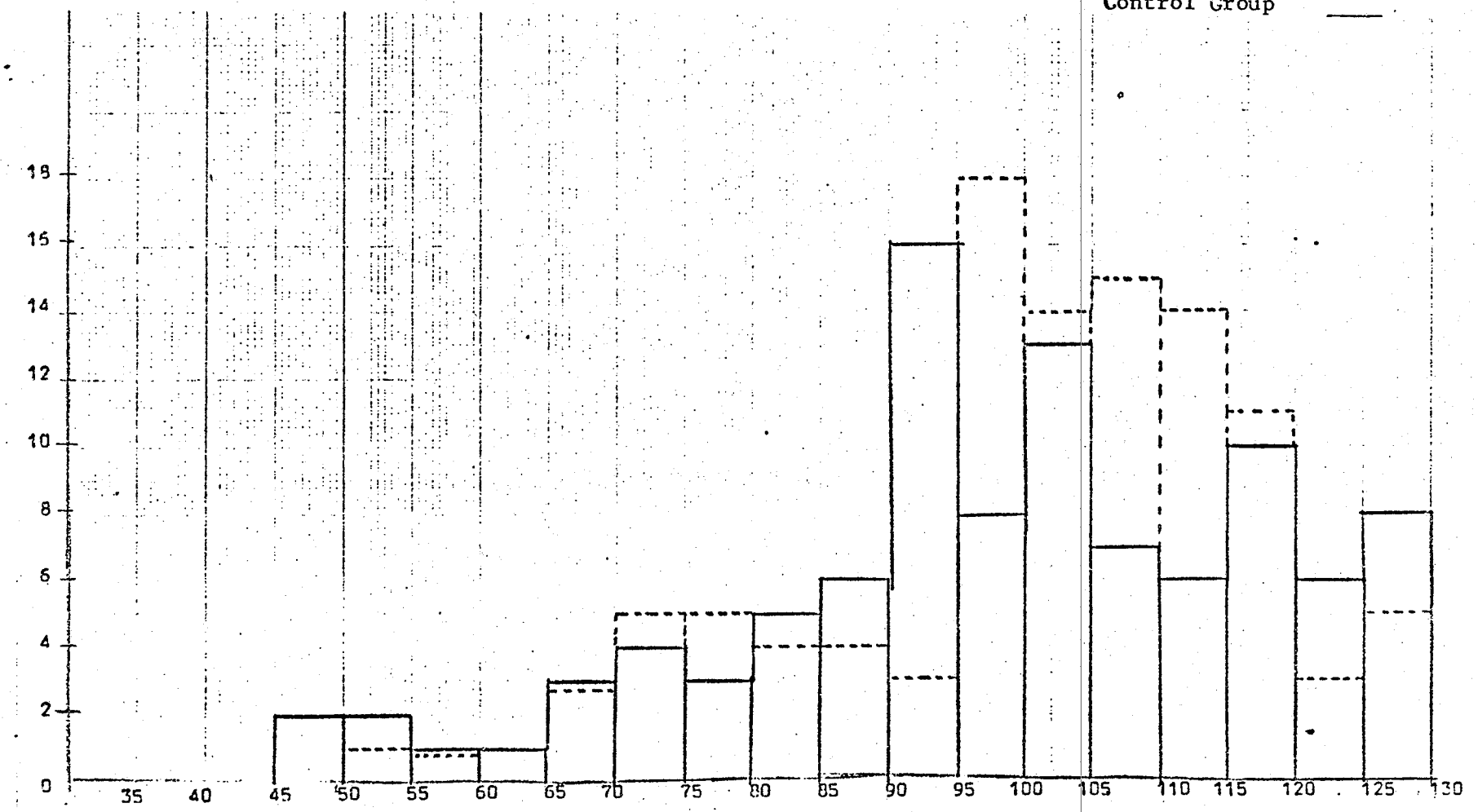


Figure 9

The Metropolitan Achievement Test--Pretest
For the First Grade Sample

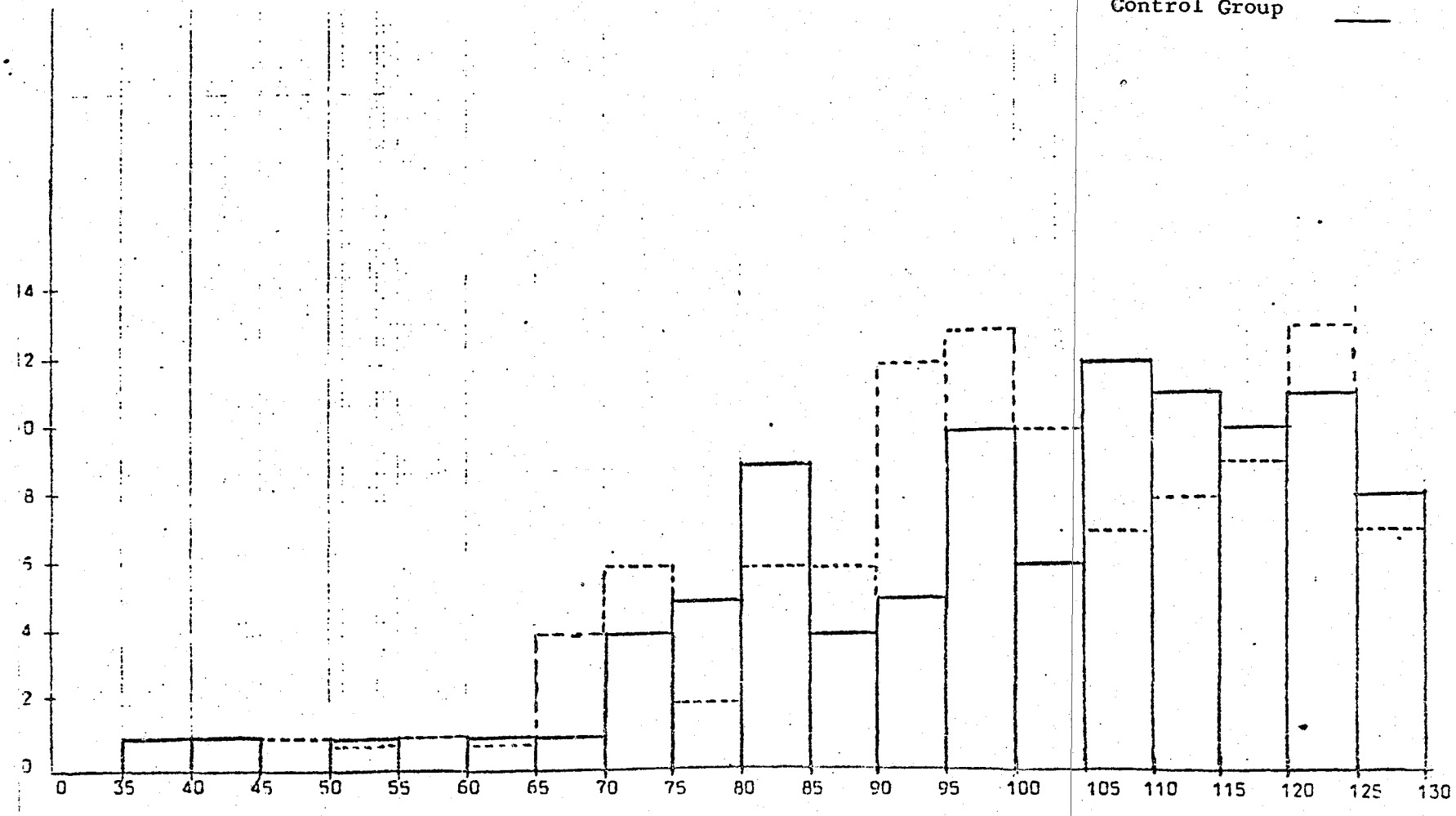


Figure 10

The Metropolitan Achievement Test--Posttest
For the First Grade Sample

is not present as in the previously described tests. In fact, the distribution of subjects at the end of the experimental period represents a flattened normal curve.

Table 7 presents a comparison of the distributions and standard deviations for both groups in the study at the first grade level.

Table 7

A Comparison of the Distribution of Test Scores For the First Grade Sample

Groups	MVPT		APT		MAT	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Treatment						
Pretest	27.45	4.44	60.89	9.83	101.40	17.85
Posttest	32.08	2.96	71.76	4.61	99.23	18.70
Control						
Pretest	26.93	9.41	61.04	10.22	98.56	18.81
Posttest	31.39	3.07	69.40	7.50	100.83	19.61

The following graphs reports the kindergarten sample--post-test scores only. In Figure 11, the MVPT scores, for both groups resembles closely, a normal curve, with the treatment mean of 24.09, and the control, 25.3.

Both the Auditory Sound Blending Subtests, and the Auditory Discrimination Subtest (those tests included in the APT battery at the kindergarten level) are described in Figures 12 and 13. Differences between the treatment and control groups in Figure 12 are small, with means of 19.3, and 18.2 respectively. The distribution for the Discrimination subtest is markedly skewed, showing that while slight differences have occurred between the two groups, almost 80 percent of all students fell within two points of a perfect score.

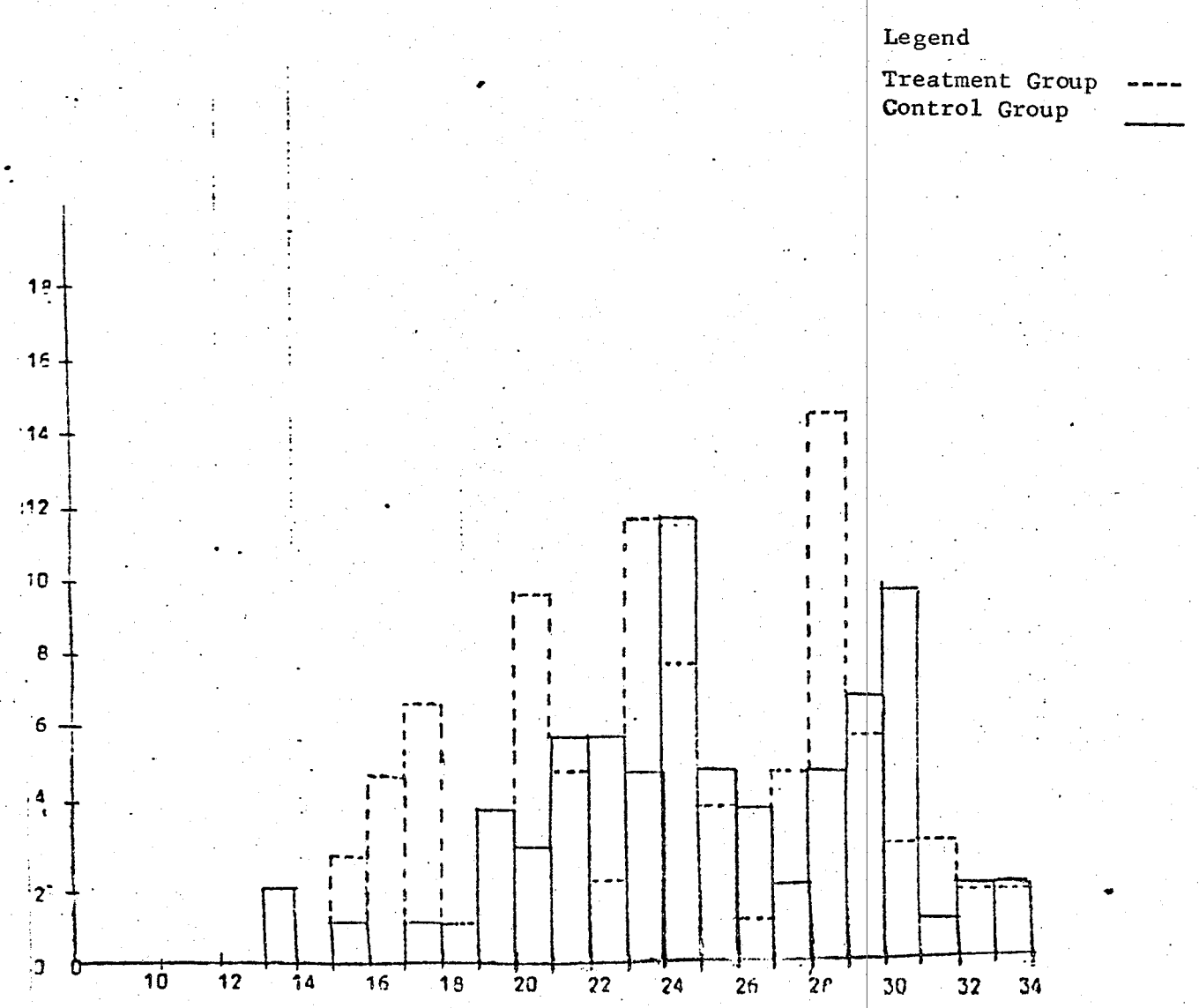


Figure 11

The Motor-Free Visual Perception Test--Kindergarten

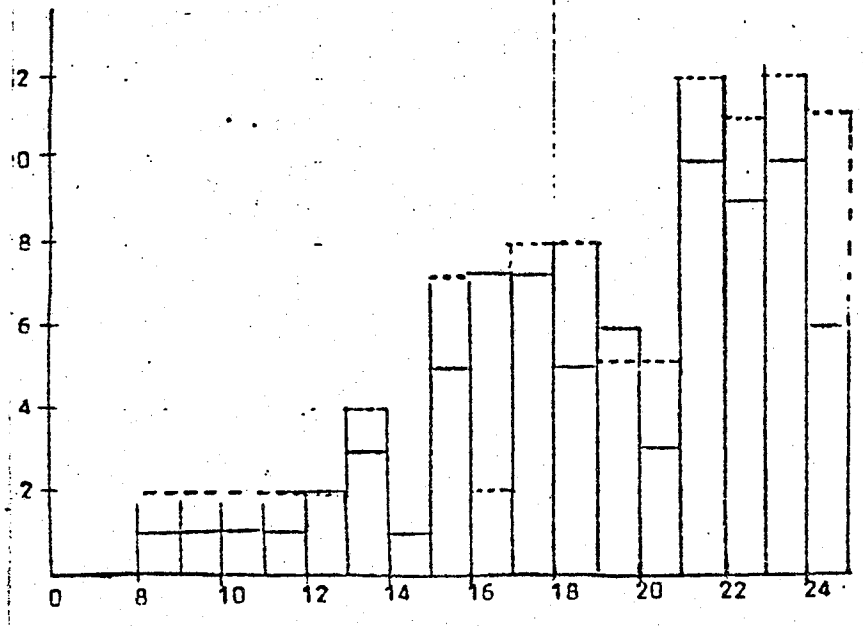


Figure 12

The Auditory Sound Blending Subtest--
Kindergarten

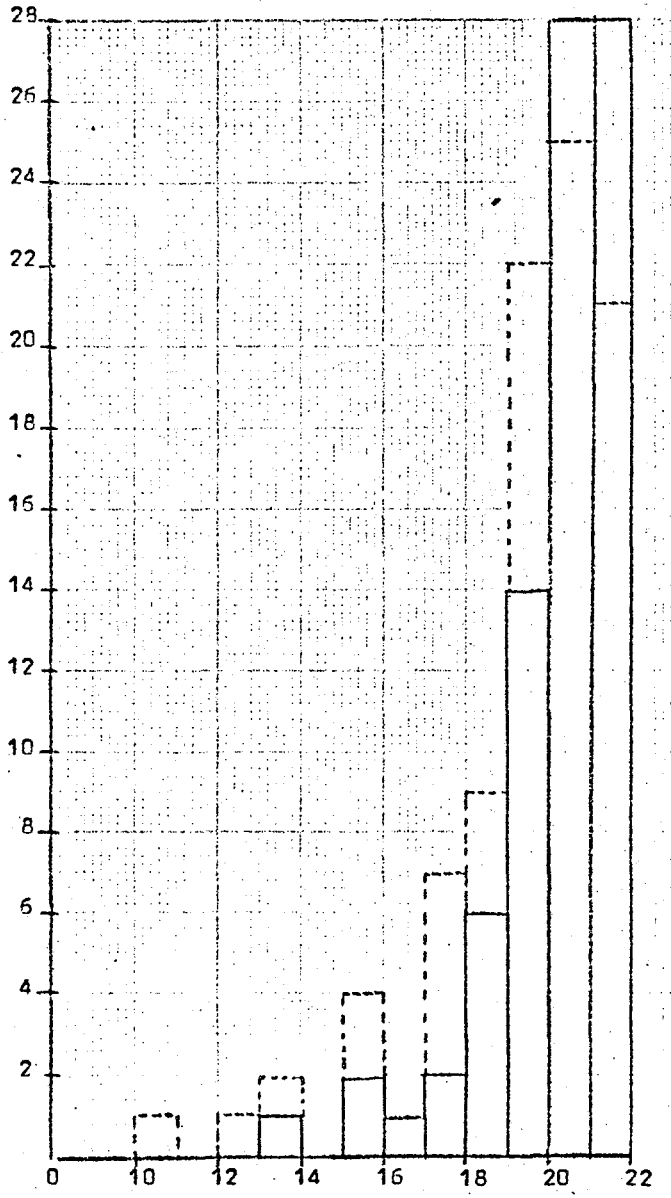
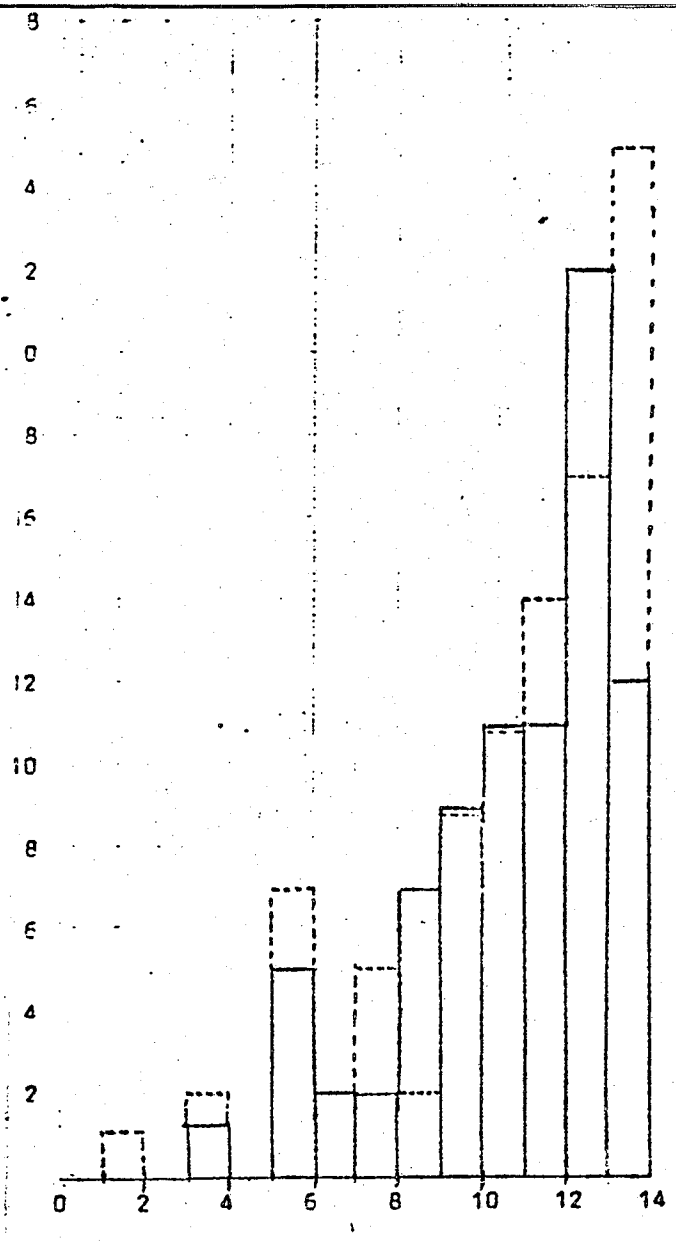


Figure 13

The Auditory Discrimination Subtest--Kindergarten



Legend

Treatment Group ----

Control Group ——

Figure 14

The Beginning Consonant Subtest--Kindergarten Level

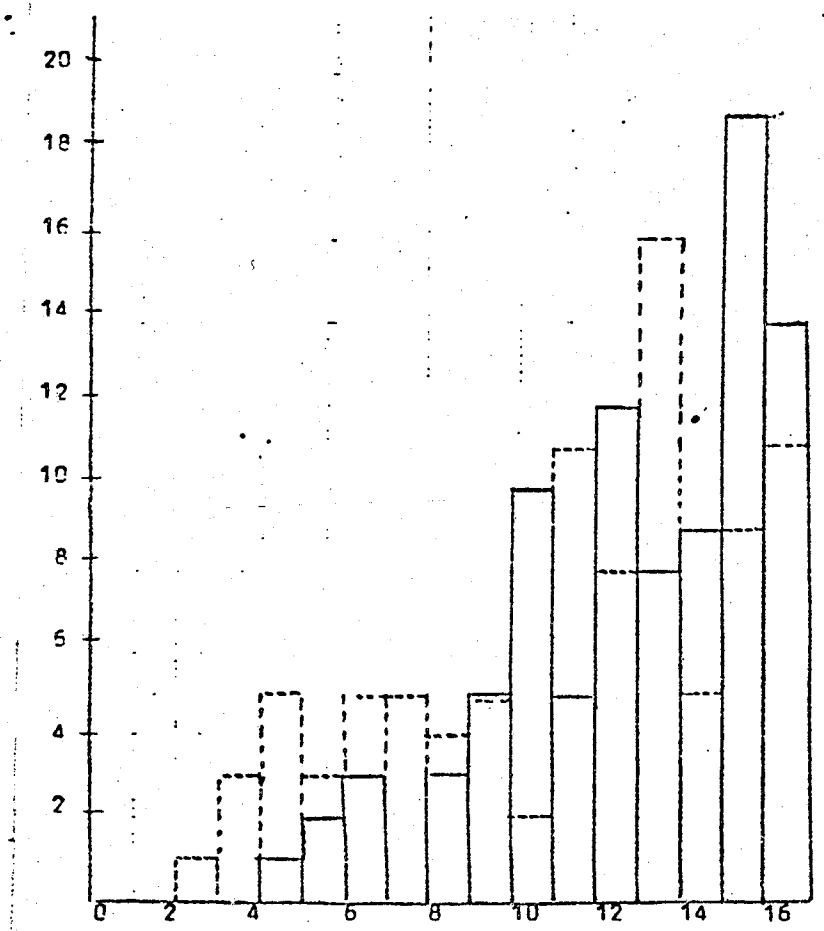


Figure 15

The Sound Symbol Relationship Subtest--Kindergarten

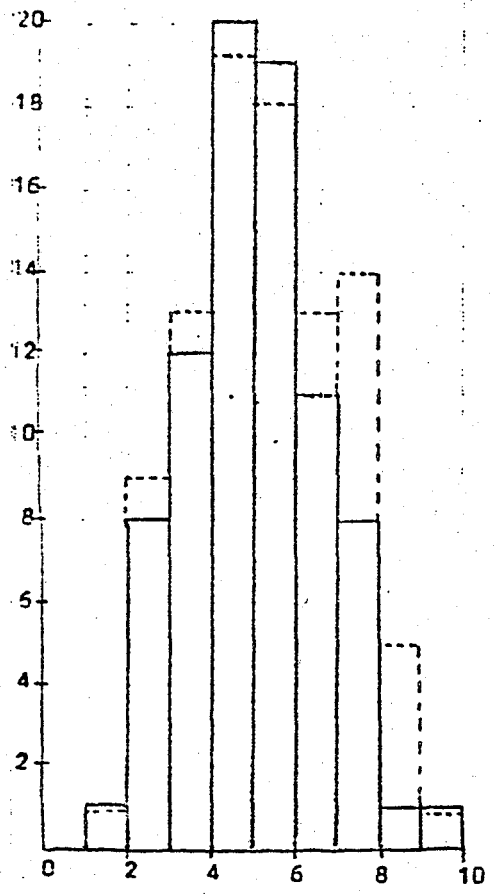


Figure 16
The Listening Subtest--Kindergarten

Figures 14, 15, and 16 illustrate posttest results on three subtests of the Metropolitan Reading Readiness Test: Beginning Consonants, Sound/Symbol Relationship, and Listening. Again, Figure 13 appears to be markedly skewed, with Figure 14 less so, and finally, Figure 15 resembles a normal curve.

These figures then, give the reader a sense of the overall learning context in which the study was conducted. It should be noted that the study involves students from a suburban population. Thus the variations likely to occur in a more diverse community are not in evidence.

Overall Difference Scores

The following paragraphs will describe the 'difference scores' or learning improvement for each subject in the first grade sample. These descriptive data are reported for hueristic purposes. Difference scores are easily interpreted and give the reader a sense of the parameters of change. The statistical analysis, it should be noted, is based on the analysis of covariance residual scores rather than simple difference scores. Difference scores are derived simply by subtracting the pretest score from the posttest score. In this case, the possible range includes minus scores, because in several cases, students achieved lower scores in the posttest than on the pretest. The means and standard deviations are, of course, smaller than those of the test scores themselves. It should also be noted that a small proportion of the subjects started with perfect or near perfect scores, and thus, are limited in the amount of learning growth that can be exhibited. Fortunately, this group was small enough not to be problematic.

Table 8

Learning Improvement Distribution of the
Motor-Free Visual Perception Test
For the First Grade Sample

Difference Score	Experimental	Control	Total
-3	3	0	3
-2	3	2	5
-1	3	2	5
0	2	6	8
1	8	8	16
2	12	11	23
3	13	17	30
4	13	7	20
5	9	14	23
6	9	9	18
7	7	8	15
8	6	6	12
9	9	4	13
10	6	1	7
11	1	3	4
12	0	0	0
13	2	1	3
14	0	0	0
15	0	0	0
16	1	0	1
Total	107	100	207

Table 9

Learning Improvement Distribution of the
Auditory Processing Test
For the First Grade Sample

Difference Score	Experimental	Control	Total
-14	0	1	1
-13	0	0	0
-12	0	0	0
-11	1	1	2
-6	0	0	0
-5	1	0	1
-4	0	0	0
-3	1	0	1
-2	2	0	2
-1	2	1	3
0	5	3	8
1	4	4	8
2	4	9	13
3	7	7	14
4	3	4	7
5	3	6	9
6	3	8	11
7	2	6	8
8	3	4	7
9	8	2	10
10	7	5	12
11	5	5	10
12	2	7	9
13	2	4	6
14	6	4	10
15	5	1	6
16	3	3	6
17	3	3	6
18	5	1	6
19	2	1	3
20	3	2	5
21	6	1	7
22	1	1	2
23	1	0	1
24	0	2	2
25	1	0	1
26	3	0	3
27	0	2	2
28	1	0	1
34	1	0	1
37	1	0	1
Total	107	100	207

Table 10

Learning Improvement Distribution for the Metropolitan Achievement Test--Reading For the First Grade Sample

Difference Score	Experimental	Control	Total
-45	0	1	1
-36	1	0	1
-34	1	1	2
-30	1	0	1
-29	0	1	1
-28	1	0	1
-27	0	1	1
-26	0	1	1
-23	1	1	2
-22	3	0	3
-21	0	1	1
-19	2	0	2
-18	1	2	3
-17	2	1	3
-16	2	0	2
-15	3	1	4
-13	1	3	4
-12	1	0	1
-11	3	0	3
-10	2	1	3
-9	5	0	5
-8	5	1	6
-7	3	4	7
-6	5	5	10
-5	3	4	7
-4	3	4	7
-3	4	2	6
-2	1	3	4
-1	3	2	5
0	6	3	9
1	3	3	6
2	6	3	9
3	0	4	4
4	3	3	6
5	4	1	5
6	3	3	6
7	2	3	5
8	3	3	6
9	1	1	2
10	0	3	3
11	1	2	3
12	2	3	5
13	3	1	4
14	2	1	3
15	0	3	3
16	0	2	2
17	0	1	1
18	0	3	3
19	0	2	2
20	0	1	1
21	0	1	1
22	3	1	4
23	0	1	1
24	2	0	2
25	1	1	2
26	0	1	1
33	0	1	1
35	0	1	1
46	0	1	1
Total	107	100	207

Tables 8 through 10 describe the learning improvement distributions for the Treatment and Control groups on the MVPT, APT, and the MAT.

Analysis of Covariance

The following series of tables represent the central findings of this study. The analysis of covariance has been utilized to control for variables which influence the variation of the criterion variable, and to reduce the error variance in the analysis. The function of the covariate is to determine a proportion of the variance prior to the experiment. For the purposes of this study, the pretest, sex, and socioeconomic status will be utilized as the covariates.

The socioeconomic status of each subject in the sample has been coded using the Duncan SES Index.[1] The code consists of a five point scale, the number one representing the lowest level which includes unskilled, blue collar occupations, through the number five, which involved professions, and highly skilled positions. The only variable with missing data was socioeconomic status. To prevent an unnecessary diminution of the sample size, subjects with missing data on that variable, were assigned mean scores so that analysis of covariance could be computed for the entire sample.

For the purposes of the analysis in this study, only the probability levels of .001, .01, and .05, will be examined in order to minimize the probability of type 1 errors.

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[1]Otis Dudley Duncan and Peter Blau, "The American Occupational Index," (New York: John Wiley, 1965).

Turning first to the analysis of the first grade sample, Table 11 represents the total APT results for the Treatment and Control groups.

Table 11

The Analysis of Covariance Summary Table of the Auditory Processing Test For the Treatment Versus the Control Group--First Grade

Source of Variation	df	SS	MS	F	Sig. Level
Between Methods	1	307.45	307.45	12.74	.001
Within	202	4876.34	24.14		
Total	203	5183.77	39.38		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment Group	107	60.89	71.76	71.80
Control Group	100	61.04	69.40	69.36

The analysis of covariance reveals a significant relationship between the treatment and control groups for the total APT score $F(1, 206)=12.74$, with the treatment group having an adjusted mean of 2.44 points higher than the control group. In past research studies, significant gains have often been reported using a specifically designed test authored by the investigator. However, in this case, the APT measure consisted of four well known subtests used successfully in the field of auditory processing research. Furthermore, it should

also be noted that the Auditory Processing Training Program does not include lessons using any of the test formats. Thus one can not attribute this increased learning to familiarity of test materials. Therefore, the statistical significant differences seen here may feasibly by interpreted as an effect of the Auditory Processing Training Program. The practical significance of a mean gain of 2.44 points however seems dubious.

The subtests within the APT give the reader additional information in regard to the pattern of learning seen in this first Table.

Table 12 compares the Treatment and Control groups on the Auditory Sound Blending Subtest.

Table 12

The Analysis of Covariance Summary Table of the Auditory Sound Blending Subtest For the Treatment Versus the Control Group--First Grade

Source of Variation	df	SS	MS	F	Sig. Level
Between Methods	1	7.63	7.63	3.74	.05
Within	202	411.88	2.04		
Total	203	419.88	2.64		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	107	20.6	23.36	23.36
Control	100	20.5	22.97	22.97

Again, the treatment group showed a greater average learning improvement at the .05 significance level.

However, this pattern is not continued in Table 13, which illustrates the comparison of the Treatment versus the Control in auditory discrimination as measured by the Gates--MacGinitie Auditory Discrimination Subtest.

Table 13

The Analysis of Covariance Summary Table of the Auditory Discrimination Subtest For the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sig. Level
Between Methods	1	4.65	4.65	4.78	.03
Within	202	196.39	.95		
Total	203	201.04	1.80		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	107	18.75	20.04	20.07
Control	100	19.14	20.41	20.38

In contrast to the other reported statistics thus far, the Control group scored significantly higher at the .05 level, than the treatment group. Because of the disparity, several interesting hypotheses can be reviewed in order to interpret this reversal:

1. Systematic Error: This hypothesis is unlikely due to the

traditional experimental design involving random assignment to the experimental and control groups.

2. Subtest Invalidity: While several subtests of the Gates MacGinite battery (such as the Auditory Memory Subtest) have been reviewed and criticized by Robert Dykstra, the reliability of this subtest is .73, established by examining 4500 kindergarten and first grade students.

3. Test Fatigue: The Auditory Discrimination Subtest was administered after approximately ten minutes of testing. Therefore the possibility of test fatigue is quite unlikely at that point.

4. Random Error: This is unlikely given the sample size. Random error, of course, can never by ruled out as a source of this pattern in the data.

5. Testing Incompatibility with program materials: The Auditory Processing Training Program, Unit 2: Auditory Discrimination was designed to aide students in developing a conceptual understanding of the similarities and differences in sounds and words. Specific sounds were not emphasized. It could be in attempting to teach students this overall concept, it led to confusion and frustration. Thus, the data has given the investigator a valuable insight which may influence future revision of program materials.

Table 14 compares the Treatment and Control groups on the Auditory Sequential Memory Subtest.

Table 14

The Analysis of Covariance Summary Table of the Auditory Sequential Memory Subtest For the Treatment Versus the Control Group--First Grade

Source of Variation	df	SS	MS	F	Sign. Level.
Between Methods	1	10.27	10.27	3.69	.05
Within	202	562.45	2.78		
Total	203	572.71	3.34		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	107	11.14	16.22	16.14
Control	100	10.58	14.21	14.30

The Treatment group scored significantly higher than the Control $F(1,206)=3.69$, at the .05 level.

Table 15 represents the comparison of the Treatment and Control groups on the Auditory-Visual Integration Subtest. In this subtest, the Treatment group scored an average of 1.84 points higher than the Control group--a difference significant at the .001 level.

Table 15

The Analysis of Covariance Summary Table of the Auditory-Visual Integration Subtest For the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	173.48	173.48		
				13.07	.001
Within	202	2680.56	13.27		
Total	203	2854.04	16.83		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	107	11.14	16.22	16.14
Control	100	10.58	14.21	14.30

It may be recalled that the test called for the examiner to strike a series of taps according to a planned sequence. The child's task was to choose the appropriate sequence from a series of three presented visually. Based on the structure of the Auditory Processing Training Program which involved audio-tapes, used with visually oriented materials, these differences seen here may be due to the specific pattern of the instructional program.

Summary of Tables 11 through 15

An overall analysis of the data revealed in Tables 11 through 15, illustrates a significant but slight relationship between growth

in auditory skills and the instructional program. On one case, the Auditory Discrimination Subtest, the Control made significantly greater gains than the Treatment. This could be due to the fact that the lesson format used in Unit 2 of the program was somewhat confusing and obscure for the children. Clearly, more research is needed in order to clarify this apparent discrepancy in the findings.

The Analysis of Covariance--The Motor-Free Visual Perception Test

The MVPT was administered to all students in the sample in an attempt to view the continuing relationship between visual and auditory perception through the experiment. Because both skills are initially stressed in beginning reading instruction, it was hypothesized that perhaps if one sensory channel, auditory, were trained, the other, visual, would also be effected.

Table 16 compares the visual perception change scores for the Treatment and Control groups.

Table 16

The Analysis of Covariance Summary Table of the Motor-Free Visual Perception Test For the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	12.27	12.27	2.02	n.s.
Within	202	1225.98	6.07		
Total	203	1884.92	9.15		

It appears that visual perceptual skills were not largely effected as a result of the Auditory Processing Training Program.

Analysis of Covariance--The Metropolitan Achievement Test

An important question concerning research in recent years is how readily auditory processing skills, as defined in this study, transfer to an overall level of word knowledge and word analysis abilities. In an attempt to bring data to bear on this problem, the MAT was administered to the first grade students as a pretest and a posttest. In order to avoid a ceiling effect, two different levels of the test were given: Primer level as a pretest; Primary level as a posttest. Both scores were then converted into T scores to permit standardization of test scores and analyze growth. The results of these tests are reported in the following tables.

Table 17 represents the total MAT scores for the Treatment and Control groups. It is apparent that the differences are small and not statistically significant.

Table 17

The Analysis of Covariance Summary Table of the Metropolitan Achievement Test For the Treatment and Control Groups

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	153.28	153.28	3.24	n.s.
Within	202	34756.68	10126.39		
Total	203	34909.96	365.35		

Tables 18 and 19 illustrate the two major subtests within the MAT: Word Knowledge and Word Analysis. In Table 18, the students in the Control group scored slightly higher than the Treatment group, although the differences were statistically insignificant.

Table 18

The Analysis of Covariance Summary Table of the Word Knowledge Subtest For the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	92.78	92.78	1.50	n.s.
Within	202	12509.14	61.93		
Total	203	12601.92	100.12		

These results are not to be unexpected. This test format is one in which the student must make a quick judgement, within a specified time period, of the word that goes with the picture. In actuality it is a sight vocabulary test. Therefore, the fact that students receiving an auditory training program did not show significant gains over the control is not to be unexpected.

However, the results of Table 19 are puzzling, in light of the fact that auditory processing abilities are thought to precede and, in fact, influence word analysis skills.

Table 19

The Analysis of Covariance Summary Table of the Word Analysis Subtest For the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	126.87	126.87	2.35	n.s.
Within	202	10918.84	54.05		
Total	203	11045.71	100.02		

Summary of Tables 17 through 19

Tables 17 through 19 reveal no significant differences in reading achievement in comparing the Treatment group with the Control; thus, the null hypothesis that training in auditory processing will not transfer to overall reading improvement is sustained. This conclusion tended to substantiate an increasing number of research reports which focus on the relationship of perceptual training and reading achievement. Authorities, such as Donald Hammill, Bruininks, and others[2] suggest that perceptual training has little to do with reading and thus should be abandoned in favor of language instruction. However, those in favor of teaching auditory and visual perceptual skills argue that perceptual training must be intensified and begun earlier in order to

[2]John Paul Jones, "Learning Modalities--Should They Be Considered?" in Althea Beery et. al. Elementary Reading Instruction: Selected Materials, (Boston: Allyn and Bacon, Inc., 1974) p. 191.

be effective.[3] The results of the analysis of the kindergarten classrooms will shed light on this continuing question.

Analysis of Covariance--The Auditory Processing Test at the Kindergarten Level

One of the major hypotheses in this study concerns the comparison of the Treatment versus the Control groups in auditory processing skills and reading readiness skills at the kindergarten level. The Auditory Processing Test at this level includes two subtests: The Auditory Sound Blending Subtest, and the Gates-MacGinitie Auditory Discrimination Subtest. The other two measures used in testing the first grade children were eliminated for the following reasons: 1) Lack of knowledge of numbers 1-19, 2) Lack of visual ability to discriminate numbers such as 2 and 3, 6 and 9, 3) the research literature in the case of the Auditory-Visual Integration Subtest suggests that this complex concept of linking visual and auditory channels does not develop until approximately age six.

Because of several methodological difficulties, a true test of the effectiveness of auditory training here will be limited. Rather than omit this part of the analysis altogether, it was thought that this partial analysis will at least provide groundwork for further investigations in this direction.

As reported in Chapter 3, no pretest measure was administered to the kindergarten classrooms. Therefore, only sex and socioeconomic

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[3]Donald D. Durrell, "Success in First Grade Reading," Boston University Journal of Education, 3 (1958) pp. 2-47.

status are used as covariates in the following analysis.

Looking first at the total test scores for the Treatment and Control groups on the APT, the results indicate that the instructional program was not effective for children at this level. .

Table 20

The Analysis of Covariance Summary Table of the Auditory Processing Test For the Treatment and Control Groups--Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	10.77	10.77	.396	n.s.
Within	171	4438.77	25.96		
Total	172	4449.54	18.56		

Perhaps the level of instruction in the Auditory Processing Training Program was too complex for these children. It could be that children need time in school to, at least, grasp the concept of letters and sounds before auditory training is begun. Again, because of the lack of a true experimental design, only tentative conclusions can be reached at this point.

Table 8 describes the Auditory Blending Subtest results for the treatment and control groups. While the treatment group exhibited a slightly higher ability to blend separate sounds into words, the differences are insignificant.

Table 21

The Analysis of Covariance Summary Table of the Auditory Sound Blending Subtest For the Treatment and Control Groups Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	52.15	52.15	3.15	n.s.
Within	171	2831.50	16.56		
Total	172	2883.65	16.98		

Table 22 compares discrimination skills for the Treatment and Control groups at the kindergarten level.

Table 22

The Analysis of Covariance Summary Table of the Auditory Discrimination Subtest For the Treatment and Control Groups Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	16.14	16.14	4.37	.036
Within	171	631.67	3.68		
Total	172	647.81	3.88		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	93	18.30	18.92	18.98
Control	82	18.41	19.68	19.62

It might be recalled that in the first grade analysis, the control group scored higher than the treatment at the .05 level of significance. Here, in the kindergarten classrooms, the same phenomena has occurred. The Control group scored an average of almost a point higher than the treatment group--a difference signiticant at the .05 level.

Summary of Tables 20 through 22

It appears from the findings seen here, that the Auditory Processing Training Program was not effective in teaching the limited skills measured. In fact, in terms of the Gates-MacGinitie Auditory Discrimination Subtest, it might have had an adverse effect, perhaps confusing students at this age. Unfortunately, the lack of pretest data inhibits the ability to make conclusive generalizations regarding the test results. Nevertheless, the data does not encourage future emphasis in auditory perceptual training.

Analysis of Covariance--The Motor-Free Visual Perception Test at the Kindergarten Level

Visual perceptual change scores were again analyzed for the

Treatment and Control groups at the kindergarten level. As seen before in the first grade sample, no significant differences are recorded. However, unlike the first grade where the Treatment group scored an average of .70 points higher than the Control, the Control group here surpassed the Treatment with an average difference of 1.21 points.

Table 23

The Analysis of Covariance Summary Table of the Motor-Free Visual Perception Test For the Treatment and Control Groups--Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	21.65	21.65	1.00	n.s.
Within	171	3673,76	21.48		
Total	172	3695.41	22.18		

It appears then, that auditory training does not significantly effect visual perceptual skills.

Analysis of Covariance--The Metropolitan Reading Readiness Test at the Kindergarten Level

For the purposes of this analysis, three subtests of the Metropolitan Reading Readiness Test were administered to the Treatment and the Control groups: Beginning Consonants, Sound/Symbol Relationship, and Listening. The Listening subtest, included within this battery, was administered because reading research has often found that auditory

processing training is often reflected in an improvement of this skill. These data should perhaps be interpreted as the rate of transference of learning, since this test measures more general skills.

Table 24 represents a summation of the total Metropolitan Reading Readiness Test for both Treatment and Control groups at the kindergarten level.

Table 24

The Analysis of Covariance Summary Table of the Metropolitan Reading Readiness Test For the Treatment and Control Groups--Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	60.85	60.85	1.58	n.s.
Within	171	6606.81	38.64		
Total	172	6667.65	38.88		

While the control group scored higher on the overall test, the differences are insignificant.

Table 25 examines the Treatment--Control comparison for the Beginning Consonant subtest.

Table 25

The Analysis of Covariance Summary Table of the Beginning Consonants Subtest For the Treatment and Control Groups--Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	2.16	2.16	.31	n.s.
Within	171	1160.56	6.79		
Total	172	1162.73	6.73		

The Treatment and Control groups are practically equal with a mean of 10.4 and 10.2 respectively.

Table 26 represents a comparison of the two groups on the Sound/Symbol Relationship Subtest.

Table 26

The Analysis of Covariance Summary Table of the Sound/Symbol Relationship Subtest For the Treatment and Control Groups--Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	10.68	10.68	11.04	.001
Within	171	2179.55	12.75		
Total	172	2190.23	13.55		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	93	10.68	10.9	10.84
Control	82	10.71	12.65	12.71

The average difference of 1.97 points favoring the control group, is significant at the .001 level. Again, because of the limitations of the experimental design, it is unclear whether this difference is due to the inequality of the experimental groups at the very outset of the study, or a phenomena which occurred during the experimental period.

Table 27 describes the differences found on the listening subtest for the Treatment and Control groups. While the Treatment achieved a very slight margin over the control, the differences were not significant.

Table 27

The Analysis of Covariance Summary Table of the Listening Subtest For the Treatment and Control Groups--Kindergarten

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	6.71	6.71	2.25	n.s.
Within	171	509.99	2.98		
Total	172	516.70	2.98		

Summary of Tables 24 through 27

This study focused not only on the question of the ability to learning auditory processing skills, but also on the ability to transfer this knowledge to prereading skills. It appears from the preceding analysis that the training program at the kindergarten level was not effective. Several hypotheses might account for these results: 1) taped programs, utilizing both the auditory and visual modalities are too complex for children at this age, 2) the specific tasks required in the program were too obscure, 3) general language experience must precede specific auditory training. Therefore, due to the inability of the program to teach auditory processing skills to kindergarten children, a true test of the transference theory--the ability to transfer knowledge of auditory processing skills to reading--remains unconfirmed.

Interaction Analysis

In previous sections of the analysis reported thus far, the variables of sex and socioeconomic status have been used as covariates as a means of equalizing the two groups, providing a true test of the experimental program. However, in the following tables, these independent variables will be utilized as factors in order to study the interaction effects among the independent and dependent variables.

Three significant interactions which will be presented in Tables 28 through 37, were identified in the analysis: the experiment and sex on the Auditory Sound Blending Subtest of the APT, the experiment and socioeconomic status on the Auditory Sequential Memory Subtest of the APT, and the experiment and sex on the Word Knowledge Subtest of

Metropolitan Achievement Test.

Table 28 illustrates that the independent variable of sex interacted with the Treatment program at the .05 level of significance.

Table 28

The Analysis of Covariance--Interaction of the Experiment and Sex For the Auditory Sound Blending Subtest--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Covariates	1	115.19	115.19	57.66	.001
Blend	1	115.19	115.19	57.66	.001
Main Effects	6	22.13	3.69	1.85	n.s.
Exper.	1	7.66	7.66	.83	n.s.
SES	4	5.99	1.50	.75	n.s.
Sex	1	8.09	8.09	4.05	.016
2 Way Interactions	9	28.43	3.16	1.57	n.s.
Exper SES	4	11.34	2.83	1.43	n.s.
Exper Sex	1	11.60	11.60	5.81	.016
SES Sex	4	1.56	.39	.20	n.s.
3 Way Interactions	4	6.41	1.60	.80	n.s.
Exper SES Sex	4	6.41	1.60	.80	n.s.
Explained	20	172.15	8.61	4.31	
Residual	186	371.58	2.00		
Total	206	543.73	2.64		

Looking first at the analysis of covariance of girls in the Treatment versus the Control groups, it is apparent that there are very little differences between the two groups.

Table 29

The Analysis of Covariance Summary Table of the Auditory Sound Blending Subtest For Girls in the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	.53	.53	.36	n.s.
Within	100	147.51	1.48		
Total	101	174.23	1.71		

However this pattern is dramatically changed with the boys in the sample population.

Table 30

The Analysis of Covariance Summary Table of the Auditory Sound Blending Subtest For Boys in the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	19.55	19.55	8.15	.005
Within	101	242.17	2.40		
Total	102	261.72	3.50		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	57	20.76	23.42	23.36
Control	47	20.94	22.42	22.49

Table 30 represents the average improvement in test results for boys within the Treatment and Control groups. On this test, the boys in the Treatment group exhibited an average learning improvement of one point higher than boys in the Control. These results tend to confirm research findings reported by Durrell and others which state that supplemental auditory training enables boys to maintain the same level of progress as girls. While the results here are tenative, it does tend to substantiate that finding.

An interaction between the independent variable of socioeconomic status and the experiment is observed in Table 31, on the Auditory Sequencing Subtest.

Table 31

The Analysis of Covariance Summary Table of the Auditory Sequential Memory Subtest--Interaction of the Experiment and Socioeconomic Status at the First Grade Level

Source of Variation	df	SS	MS	F	Sign. Level
Covariate	1	100.65	100.65	39.10	.001
Memory	1	100.65	100.65	39.10	.001
Main Effect	6	26.19	4.67	1.70	n.s.
Exper	1	10.18	10.19	3.96	n.s.
SES	4	16.61	4.15	1.61	n.s.
Sex	1	.03	.03	.01	n.s.
2 Way Interactions	9	58.01	6.45	2.50	.01
Exper SES	4	34.76	8.69	3.38	.01
Exper Sex	1	7.61	7.61	2.95	n.s
SES Sex	4	12.90	3.23	1.25	n.s.
3 Way Interactions	4	24.14	4.14	2.34	n.s.
Exper SES Sex	4	24.14	4.14	2.34	n.s.
Explained	20	208.99	10.45	4.06	
Residual	186	478.82	2.57		
Total	206	687.81	3.34		

It might be recalled that in the previous analysis, the variable socioeconomic status was divided into five subsections. However, for the purposes of this analysis, the people with missing data were not included, and the five cells were collapsed into three in order to increase the sample size in each cluster.

Table 32 describes the relationship between the Treatment and Control groups in the low socioeconomic group.

Table 32

The Analysis of Covariance Summary Table of the Auditory Sequential Memory Subtest For Students in the Low Socioeconomic Group--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	31.07	31.07		
				11.32	.002
Within	33	98.79	2.74		
Total	34	129.86	1.68		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	23	8.76	12.00	11.98
Control	17	9.21	10.17	10.19

It appears that the lower socioeconomic group was positively effected by the training program at the .01 level of significance. Considering the small N, the differences between the two groups is substantial. However, it should be noted that this is the only significant interaction seen between these two variables; thus the relationship could be due to chance alone. While the treatment program might, in fact, be influential among students of low socioeconomic status, the true test of these materials must await further replications.

Looking next at the analysis of covariance for the middle socioeconomic group, it is apparent that the pattern reflecting the

the relationship between socioeconomic status and the experiment has changed.

Table 33

The Analysis of Covariance Summary Table of the Auditory Sequential Memory Subtest For Students in the Middle Socioeconomic Group--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	3.38	3.38	1.43	n.s.
Within	31	73.14	2.36		
Total	32	76.52	2.34		

The grand mean for the middle socioeconomic status group is 12.2, compared with the lower socioeconomic status group which had a grand mean of 11.2.

The relationship between the high socioeconomic status group and the experimental program may be seen in Table 34.

Table 34

The Analysis of Covariance Summary Table of the Auditory Sequential Memory Subtest For Students in the High Socioeconomic Group--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	.04	.04	.02	n.s.
Within	49	116.42	2.38		
Total	50	116.46	1.75		

The statistics reveal almost no differences between the Treatment and Control groups. This, of course, could be due to a ceiling effect. However, regarding the other data here, it appears that students at this level were uneffected by the treatment program.

The third significant interaction involves the experiment and sex as seen on the Word Knowledge Subtest of the Metropolitan Achievement Test.

Table 35

The Analysis of Covariance Summary Table of the Word Knowledge Subtest--Interaction Between The Experiment and Sex--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Covariates	1	7006.84	7006.84	112.47	.001
Word Knowledge	1	7006.84	7006.84	112.47	.001
Main Effect	6	1221.24	203.54	3.27	.005
Exper	1	116.37	116.37	1.87	n.s.
SES	4	1039.72	259.93	4.17	.003
Sex	1	23.36	23.36	.38	n.s.
2 Way Interactions	9	737.27	81.92	1.32	n.s.
Exper SES	4	468.75	117.19	1.88	n.s.
Exper Sex	1	275.48	275.48	4.42	.035
SES Sex	4	36.48	9.12	.15	n.s.
3 Way Interactions	4	70.74	17.69	.28	n.s.
Exper SES Sex	4	70.74	17.69	.28	n.s.
Explained	20	9036.09	451.80	7.25	.001
Residual	186	11587.56	62.30		
Total	206	20623.65	100.12		

The experiment interacted with sex at the .05 level. As a method of interpreting this interaction, the analysis of covariance was computed separated with both girls and boys.

Table 36

The Analysis of Covariance Summary Table of the Word Knowledge Subtest For Girls in the Treatment and Control Groups--First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	352.87	352.87	5.81	.017
Within	101	6078.38	60.78		
Total	102	6431.25	82.53		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	50	47.65	48.39	48.56
Control	53	45.74	52.44	52.27

It might be recalled, as noted in the previous section, that the Word Knowledge Subtest of the Metropolitan Achievement Test, is basically a sight vocabulary test. Therefore, it is interesting to notice the striking differences between the two groups as seen in Table 36. This lead the researcher to an interesting hypothesis: Could the girls in the treatment group demonstrate deficiencies in visual perceptual skills as a result of the auditory program? In other words, in training

one modality, does one inhibit the other? Obviously this question cannot be answered at this time and must await further study.

In the analysis of boys scores on the Word Knowledge Subtest for the Treatment and Control groups, there appears to be almost no differences at all.

Table 37

The Analysis of Covariance Summary Table of the Word Knowledge Subtest For Boys in the Treatment and Control Groups-- First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	.81	.81	.01	n.s.
Within	101	6999.79	69.31		
Total	102	7000.60	68.22		

Summary of Tables 28 through 37

Only three out of twenty-four possible interactions were found to be significant in the analysis: the experiment and sex on the Auditory Sound Blending Subtest of the APT; the experiment and socio-economic status on the Auditory Sequential Memory Subtest of the APT; and the experiment and sex on the Word Knowledge Subtest of the MAT. The interaction between the experiment and sex tends to substantiate the findings in the literature which state that boys benefit more from

ear training in earlier years than girls. This leads one to speculate as to the relationship between boys reading skills and auditory techniques. If supplementary training were given to boys over an extended period, would they be able to attain the same level of proficiency in reading as girls? Can auditory differences be pointed to as the main difficulty in beginning reading for boys? New methodological studies must bring data to bear on this issue.

The second significant interaction involved the relationship between the experiment and socioeconomic status, on the Auditory Sequential Memory Subtest. Only the differences found at the low socioeconomic status group were significant at the .01 level.

In the final interaction between the experiment and sex, girls in the Control group scored significantly higher than the girls in the Treatment group on the Word Knowledge Subtest. Speculation was raised as to the relationship between auditory and visual perception. If one modality is trained, does the other modality stay the same? Can specific auditory training negatively effect the other modalities? Obviously, this question is a subject for further research.

High and Low Achievers

As noted in Chapter 1, the question of whether an experimental approach might be especially effective with high or low achievers is an intriquing and important problem. The issue is important because of its innate plausibility. This is recognized in the literature. Several researchers report major gains in reading achievement for children in the lower achievement groups. Rosner, in particular, be-

lieves that specific auditory training at the pre-kindergarten level leads to greater gains in the ability to learn phonics in later school years. The high achievers, on the other hand, are able to induce generalizations from their own environment, and thus do not need specific training in auditory perception or phonics.

Measuring learning improvement for higher achievers in auditory perceptual abilities presents difficulties. The ability to structure, analyze, and store auditory data is a fairly straight forward skill--in other words, students can learn to do it or not. Unlike the matter of reading achievement which always allows for improvement, the question of "improving auditory abilities" among students who already possess such knowledge, is, of course, a moot point. The complex causal factors influencing disadvantaged readers also makes analysis of the extreme lower achievement group difficult. The following analysis, then, will examine the more broadly defined groups above and below the mean of reading skills, which are based on reading achievement tertiles on the MAT as measured in the first week of the experimental period.

The examination of differential learning patterns proved to be most informative, and may offer interesting implications in the revisal of the Auditory Processing Training Program.

Table 38 represents a comparison of the Treatment and Control groups for the low achievers on the overall APT.

Table 38

The Analysis of Covariance Summary Table of the Auditory Processing Test For Low Achievers in the Treatment and Control Groups First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	230.77	230.77	7.21	.009
Within	61	1952.61	32.01		
Total	62	2183.37	52.15		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	26	65.47	69.08	70.12
Control	40	64.97	66.80	66.13

The difference of more than two points for the low achievers, favoring the Treatment group, is significant at the .01 level. These results are particularly interesting when noting the small sample size. The results also suggest that these materials may be an efficient source of remedial instruction for students who have auditory difficulties.

Reviewing Table 39, for the middle achievers, it is apparent that the pattern of learning improvement favoring the Treatment group is continued.

Table 39
The Analysis of Covariance Summary Table of the Auditory Processing Test For Middle Achievers in the Treatment and Control Groups First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	250.24	250.24	10.18	.002
Within	66	1622.55	24.58		
Total	67	1872.79	36.01		

Subgroup Descriptive Statistics

	N	Pretest Mean	Posttest Mean	Adjusted Mean
Treatment	43	65.47	71.66	71.83
Control	28	64.98	68.22	67.96

The Treatment group scored an average of 3.87 points over the Control--a difference significant at the .01 level.

However, this pattern is not sustained with the high achievers.

Table 40

The Analysis of Covariance Summary Table of the Auditory Processing Test For the High Achievers in the Treatment and Control Groups First Grade

Source of Variation	df	SS	MS	F	Sign. Level
Between Methods	1	.01	.01	.001	n.s.
Within	65	776.92	11.95		
Total	66	776.93	14.01		

It is apparent that the socres for both the experimental and control groups are almost equal. In viewing the results, it appears, the, that training in auditory processing skills for high achievers is not required.

Summary of Tables 38 through 40

In developing the methodological design for this study, the decision was made to include the total classrooms in either the Treatment and Control groups in order to obtain information as to the learning impact of auditory processing abilities for all students; their ability to be learned and their effect on reading achievement.

However, the expectation of the investigator was that the low and middle achievers would be most effected, by the training program, with the slight improvement in the high achievement group. This turned out to be the case. In fact, learning improvement represented a bell

shaped curve, with the middle levels learning the most, the lower achievers (less attentive and perhaps, confused) learning less, and the high achievers, who already know a great deal of material and therefore do not exhibit marked learning improvement, exhibiting less growth.

The results of this analysis confirms the opinions of authorities who state that most children, upon entering school, have sufficient underlying auditory skills. If schools can identify potential low achievers at the very outset of the school year, these materials may prove helpful in teaching pre-phonics skills, and thus effect future achievement in reading.

The Relationship Between Auditory and Visual Perception

A question yet to be explored within the research literature is the relationship of auditory and visual perception before and after one of the modalities has been trained. Authorities have documented reports stating that children seem to prefer one modality over another, perhaps as early as the pre-kindergarten years. However, does this relationship change if one of the modalities is trained?

The Pearson product-moment correlation coefficient was computed between auditory perception, as measured by the APT, and visual perception, as measured by the MVPT, for the Treatment and Control groups at the beginning of the experimental period for the first grade. The correlation between the two factors is .56, significant at the .00001 level, with a slope of .25. Several outliers, (in this case, indicating a low auditory and middle visual score), tended to lower the regression slope.

The correlation between auditory and visual perception at the end of the experimental program was .28, significant at the .001 level, and the slope is .18. The effect of the lower correlation in the posttest results, is perhaps an artifact of the mastery effect--more than twenty three subjects have perfect scores, representing over twenty percent of the subjects within the Treatment group. The lower correlation is due to lower variance, and thereby is not a significant indication that any dramatic change has occurred. Therefore it appears most likely that the relationship between the two modalities has remained the same throughout the experiment.

Conclusions:

This study focused on an analysis of the effectiveness of the Auditory Processing Training Program in teaching auditory perceptual skills to children at the kindergarten and first grade levels.

Classes participating in the study were randomly assigned to either the Treatment and Control groups for both levels. Besides receiving regular basal instruction (Ginn 360) the Treatment group participated in an auditory program developed by the investigator which involved seventy-six taped lessons, five to fifteen minutes in length, three times weekly, for a period of seven months. The MVPT, the APT, and the MAT, were administered to all first grade students as a pretest and posttest. The kindergarten analysis is based on posttest scores alone, using sex and socioeconomic status to equate for initial differences.

Comparisons of learning achievement reveal the following find-

ings for the first grade level:

1. Students, participating in the Auditory Processing Training Program showed greater improvement at the .001 level of significance in auditory skills as measured by the APT than those using regular basal instruction.

2. There was no difference in the ability to transfer auditory perceptual skills to reading achievement for the Treatment or Control groups.

3. There were no differences in visual perceptual scores as measured by the MVPT, for either the Treatment or Control groups.

4. Three significant interactions were reported in the analysis:

   a. Boys in the Treatment group scored significantly higher at the .001 level, than the Control group on the Auditory Sound Blending Subtest of the APT.

   b. Students in the Treatment program who were in the low socioeconomic status group, scored significantly higher, at the .01 level, than those in the Control on the Auditory Sequential Memory Subtest of the APT.

   c. Girls in the Control group scored significantly higher, at the .05 level, than girls in the Treatment program on the Word Knowledge Subtest of the MAT.

5. Students in the low and middle tertiles of reading achievement as measured by the MAT pretest, were most effected by the training program. The groups appeared to be equally effective among the high achievers.

6. The relationship between auditory perception and visual

perception were not significantly effected during the experimental period.

The results of the kindergarten analysis led to the following conclusions:

1. Students participating in the Auditory Processing Training Program did not show greater improvement in auditory skills as measured by the APT, than those using regular reading readiness materials.

2. There were no differences in the ability to transfer auditory processing skills to reading readiness skills for the Treatment and Control groups at the kindergarten level.

Chapter 5 will give a more detailed account of these findings.

Chapter 5

SUMMARY AND CONCLUSIONS

The primary goal of this study was to investigate whether auditory processing skills can be taught utilizing the Auditory Processing Training Program developed by the investigator. A secondary goal was to determine if these auditory skills, as defined in the training program, facilitated growth in overall reading achievement.

With these objectives in mind, the following hypotheses were generated:

1. Students participating in the Auditory Processing Training Program will show greater improvement in auditory skills in the kindergarten and first grades as measured by the Auditory Processing Test, than those using regular basal instruction.

2. Students participating in the Auditory Processing Training Program will show greater improvement in reading achievement, as measured by the Metropolitan Achievement Test for the first grade classrooms, the Metropolitan Reading Readiness Test for the kindergarten classrooms, than those using regular basal instruction.

3. There will be a greater interaction between visual and auditory perception for students participating in the Auditory Processing Training program than students using basal instruction alone.

4. There will be a greater interaction between sex and auditory skills for students participating in the Auditory Processing

Training Program than students using basal instruction alone.

5. There will be a greater interaction between sex and reading achievement for students participating in the Auditory Processing Training Program than students using basal instruction alone.

6. There will be a greater interaction between socioeconomic status and auditory skills for students participating in the Auditory Processing Training Program than students using basal instruction alone.

7. There will be a greater interaction between socioeconomic status and reading achievement for students participating in the Auditory Processing Training Program than students using basal instruction alone.

8. There will be a greater interaction between achievement levels, as measured by the Metropolitan Achievement Test, and auditory skills for students participating in the Auditory Processing Training program than students using basal instruction alone.

Summary of the Procedure Followed

This study consisted of seventeen kindergarten and first grade classrooms in the Branford Public School System, Connecticut. The town of Branford is heterogeneous in character, and includes families from a major academic institution (Yale University) as well as a variety of industrial concerns. Schools were randomly assigned to the experimental and Control groups. All classrooms, participating in the study, followed the Ginn 360 Basal Reading Program.

Students from ten first grade classrooms were administered the

the Motor-Free Visual Perception Test, the Auditory Processing Test, and the Metropolitan Achievement Test as a pretest and a posttest. Due to factors such as test anxiety, inability to understand test directions, and the lack of basic concepts, pretesting at the kindergarten level had to be discontinued. Therefore, the analysis of kindergarten classrooms was based on posttest scores alone, using sex and socioeconomic status as covariates. The posttest battery for children at the kindergarten level included: The Motor-Free Visual Perception Test, the Auditory Processing Test (Auditory Sound Blending and Auditory Discrimination Subtests only) and the Metropolitan Reading Readiness Test. All testing was conducted by the investigator to ensure for consistency in test administration.

The Treatment group participated in the Auditory Processing Training Program as a supplemental listening activity in addition to the traditional language arts instruction. The program materials included seventy six taped lessons and worksheets divided into four instructional units:

1. Unit 1: Auditory Attention: Lessons in this unit involve the ability to direct and sustain attention to sounds; to select a relevant stimulus from a background of irrelevant stimuli, and to discriminate between familiar environmental sounds.

2. Unit 2: Auditory Discrimination: Emphasis in this unit is directed to hearing similarities and differences in the beginning, middle, and end of words, and listening for rhyming patterns.

3. Unit 3 Auditory Blending and Closure: Skills in this unit involve hearing separate sounds in words, identifying syllables in words.

4. Unit 4, Auditory Memory and Comprehension: These lessons emphasize short-term memory, first in nonmeaningful contexts, then in directed reading exercises, requiring a longer attention span and understanding.

Each lesson contained provisions for feedback to the listener. Picture vocabulary was also taught to reduce ambiguity. The lessons, approximately five to seven minutes in length, were given three times weekly for a period of seven months. A student aide was assigned to each experimental classroom to assist in the implementation of the program. They were instructed not to give any individual attention or assistance to particular students. No attempt was made by the aide or teacher to reschedule lessons for children who were absent.

Only students who completed all tests and ninety percent of the lessons were included in the final tabulation. The data was collected and transferred to IBM cards. Analyses of covariance were utilized to examine differences between the two groups. Interactions of the independent and dependent variables were analyzed. The Pearson product moment correlation coefficient was computed to analyze the relationship between auditory and visual perception for the experimental group. In addition, the treatment group was divided into three levels, high, middle and low, based on initial reading achievement scores, to determine which group was most effected by the instructional program. The results of the data analysis led to the following conclusions for the first grade level:

1. Students, participating in the Auditory Processing Training Program scored higher at the .001 level of significance, in auditory

skills as measured by the Auditory Processing Test, than those using regular basal instruction. This appears to substantiate one of the major findings of Bond, in his documentation of the first grade studies, reported in 1967, which concluded that a supplementary auditory program in addition, to the basal program, proved most effective in terms of test scores.

2. The supplemental instruction did not transfer to greater overall reading achievement skills as measured by the Metropolitan Achievement Test. This could be due to several factores. One, a sleeper effect might have occurred. After a period of time, scores in reading achievement could possibly be effected, reflecting the benefits from the instructional program. Two, the change in auditory processing skills was not great enough to transfer to other reading tasks. Perhaps, auditory processing abilities are not a primary factor in beginning reading instruction.

3. Three significant interactions were reported in the analysis:

a. Boys in the Treatment group scored significantly higher than the Control on the Auditory Sound Blending Subtest of the Auditory Processing Test. Other studies have also found that boys benefit from auditory activities.

b. Students in the Treatment program who were in the low socioeconomic status group scored significantly higher than those in the Control on the Auditory Sequential Memory Subtest of the Auditory Processing Test.

c. Girls in the Control group scored significantly higher than girls in the Treatment Program on the Word Knowledge Subtest of the Metropolitan Achievement Test.

While these interactions are interesting and suggest directions for further research, it is possible that they have occurred by chance alone.

4. No evidence could be found to warrant the conclusion that training in the auditory modality influences the growth or change in the visual modality.

5. The results of the data on high and low achievers were mixed. In summary, the low and middle achievers using the Auditory Processing Training Program scored significantly higher than the Control group. The high achievers were not effected by the supplemental instruction.

The results of the kindergarten analysis led to the following conclusions:

1. Students, participating in the Auditory Processing Training Program did not show greater improvement in auditory skills, as measured on the Auditory Processing Test, than those using the traditional reading readiness instructional program. However, this conclusion is based on the results of two auditory subtests alone. Due to the lack of group measures in auditory perception at the kindergarten level, skills such as attention and memory were not tested. Furthermore, perhaps children at this level with auditory difficulties need personal attention on a one to one basis, and have difficulty relating to a

taped instructional program.

2. There were no differences in the ability to transfer auditory processing skills to reading readiness achievement for the treatment and Control groups. This hypothesis remains unconfirmed due to the fact that the children in the experimental program did not gain auditory processing abilities.

Conclusions

The results of this experiment indicate that auditory skills can indeed be taught at the first grade level. Improvements in Auditory Sound Blending, Auditory Sequential Memory, and Auditory-Visual Integration were significantly higher for the Treatment group than the Control. This was especially true for students at the low and middle levels of reading achievement. The improvement in auditory skills did not translate into increased reading achievement within the experimental period. It could be that significant effects will be inevidence later on but further research will be necessary to explore this possibility.

Difficulties in testing these skills among kindergarten children severly limit the ability to measure treatment effects at this level. A different experimental design will be necessary if further research is to proceed successfully.

Most often in educational research, materials are designed and tested for a short period in classrooms, and conclusions are drawn based on the differences evidenced along with the potential differences if the experiment had occurred over time. However, this is not true in this case. A carefully designed instructional program was implemented in seventeen classrooms for over a period of seven months,

virtually the entire school year. The results presented in Chapter 4 indicate that over this period of time, there are indeed measurable positive effects of the instructional program. There are, however, three distinct and important qualifications of these positive results:

1. The improvement for the experimental group in the Auditory Sound Blending, the Auditory Sequential Memory and the Auditory-Visual Integration Subtests, though statistically significant, was small.

2. Improvement on the most important dimension, actual reading achievement, was not found.

3. As a result, the cost effectiveness of the program is doubtful. Indeed on some dimensions, the Treatment group showed less improvement than the Control, indicating that in addition to monetary expense, a program such as this involves costs of student time which might otherwise be spent on more profitable educational activities. Additionally, some students may have become confused by the program--obviously, the lessons here stressed sounds using a different approach than the basal text.

At this point it is necessary to re-evaluate the strength of the relationship between auditory processing skills and reading achievement. Hammill and others have suggested that educational research needs to be redirected from perceptual training in favor of language instruction. Further research will be required in this area.

Suggestions for Future Research

The following are recommendations for further thought and research:

1. The present study could be replicated, using the Auditory Processing Training Program, with a minority population.

2. The kindergarten and first grade sample used in this study could be tested again, in order to measure a "sleeper" effect.

3. A program, specifically developed for children at the kindergarten level, could be constructed and tested.

4. A group test which includes: Auditory Attention, Auditory Memory, Auditory Discrimination, and Auditory Blending and Closure, is needed in order to screen potential students with auditory processing difficulties.

5. New methodological studies are needed to examine whether those students who are low achievers actually benefit from auditory training or, in fact, are responding to supplemental instruction alone.

6. A study, using factor analysis, could be conducted in order to find the specific deficiencies found with students in the low socio-economic groups.

7. New studies are needed which focus on programs and skills which would enable boys to maintain progress in early reading instruction.

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APPENDIXES

MVPT

MOTOR-FREE VISUAL PERCEPTION TEST

NAME_____ BOY_____ GIRL_____ DATE OF TESTING_____

TEACHER_____ SCHOOL_____ DATE OF BIRTH_____

GRADE_____ BASAL TEXT_____ PUPIL'S AGE Yrs_____ Mos_____

TOTAL TEST SCORE_____ PERCEPTUAL QUOTIENT_____ PERCEPTUAL AGE_____

Devised By
Ronald P. Colarusso, EdD
Donald D. Hammill, EdD
1972

Adapted as a Group Measure by Susan Neuman

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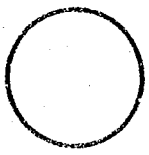

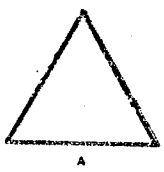

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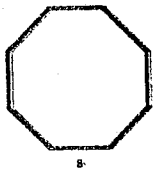

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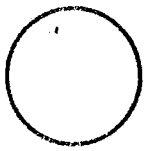

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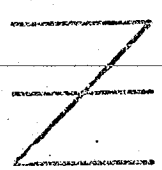

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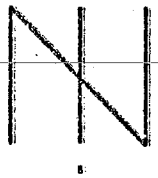

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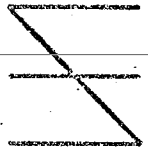

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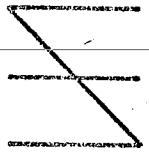

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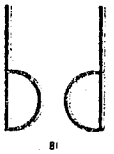

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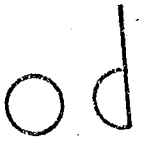

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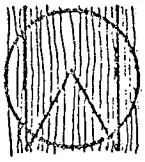

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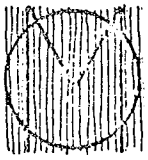

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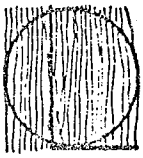

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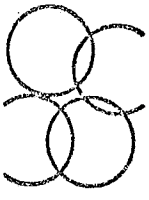

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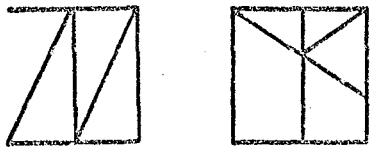

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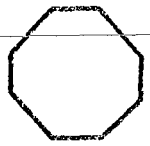

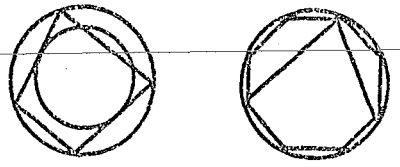

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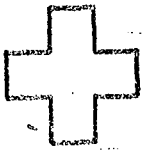

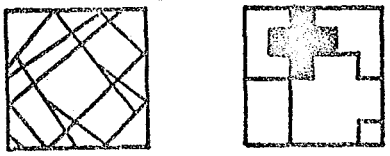

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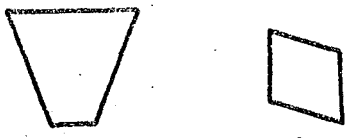

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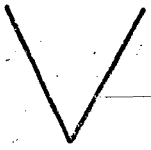

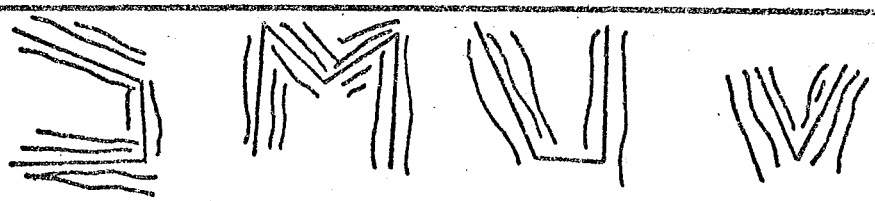

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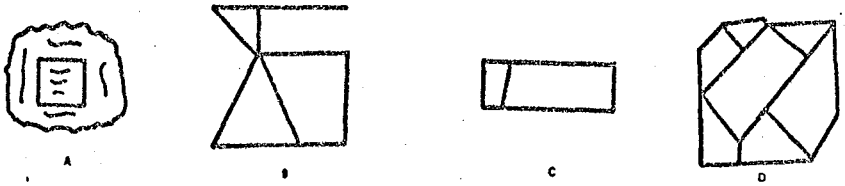

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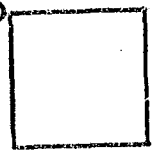

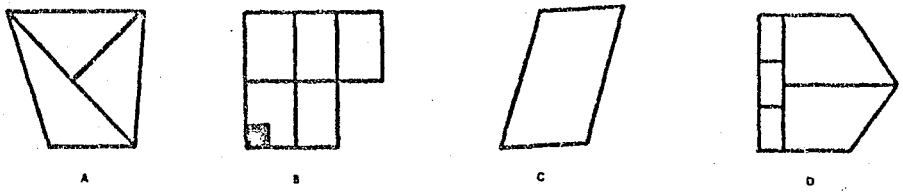

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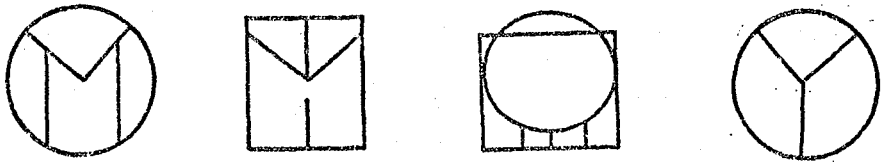

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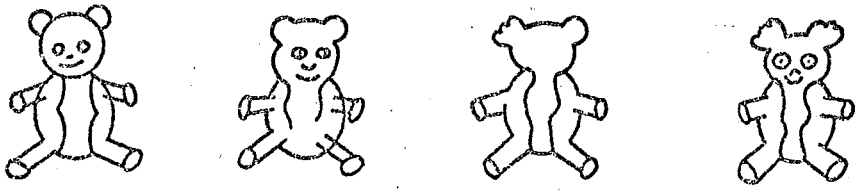

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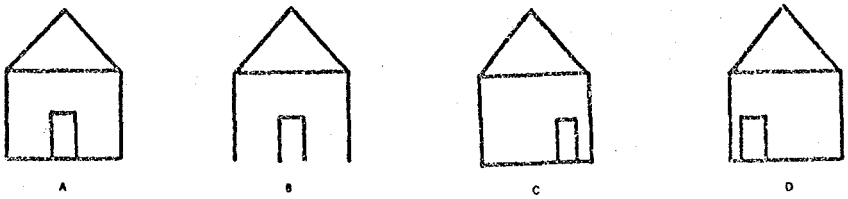

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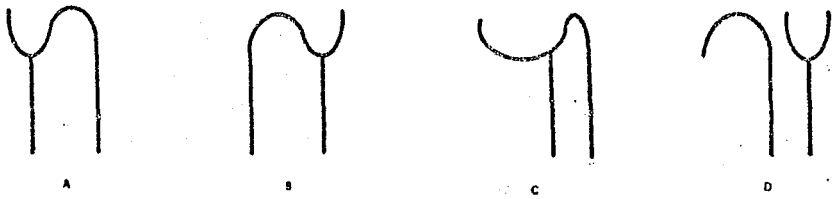

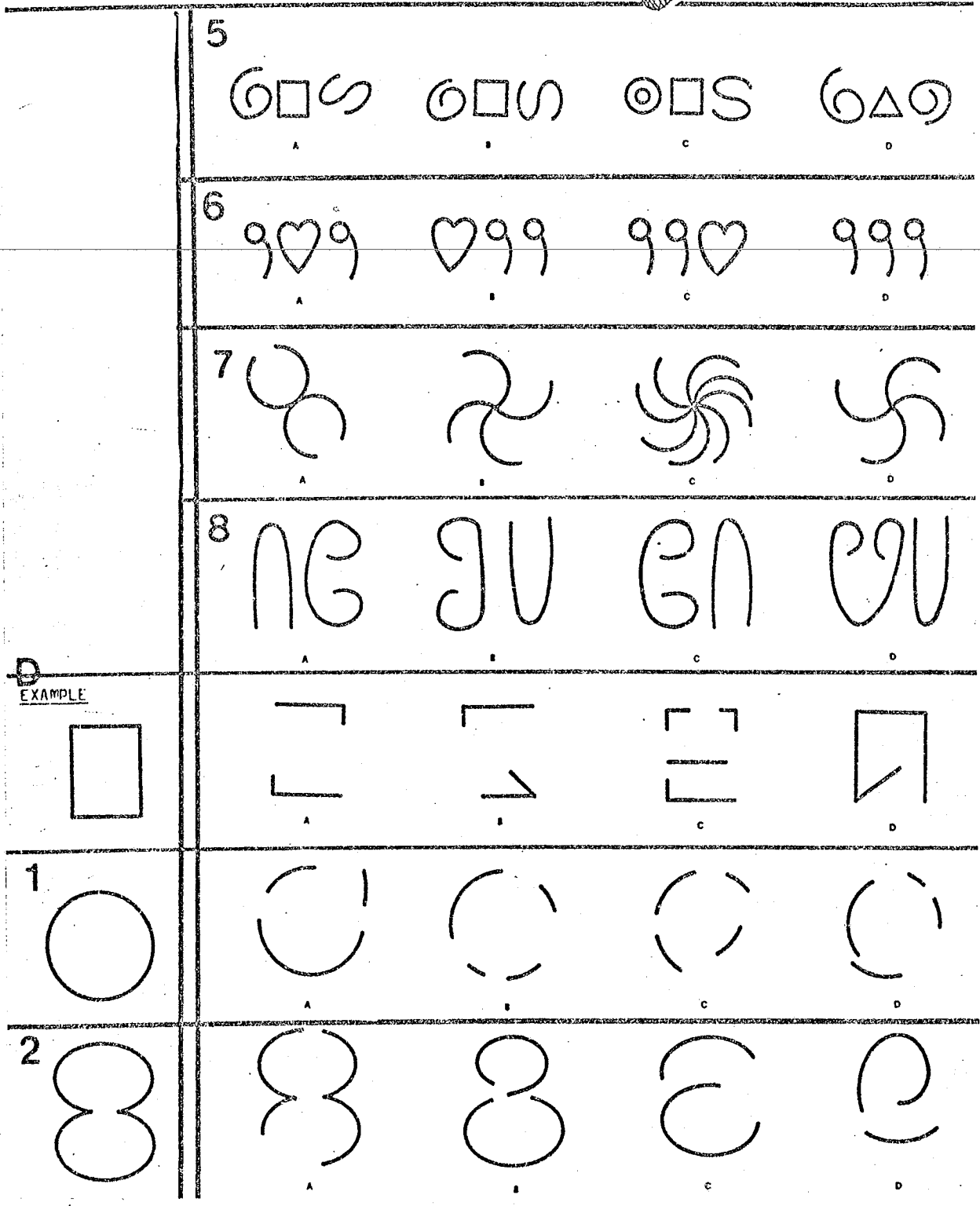
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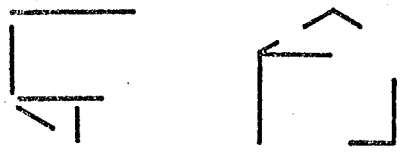
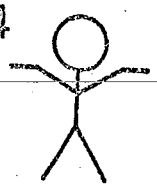
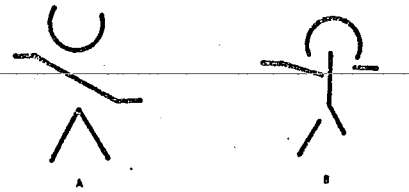
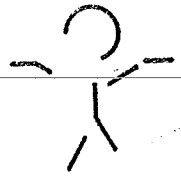
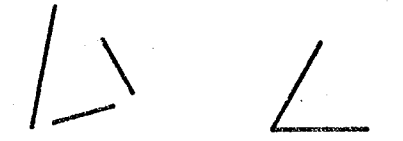
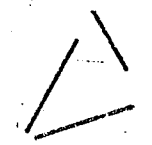
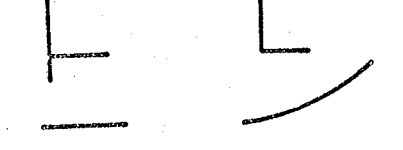
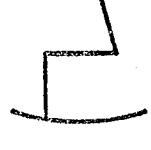
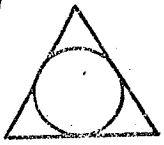
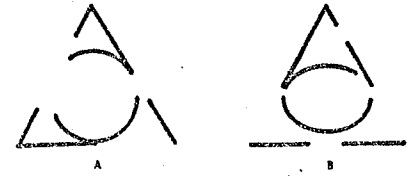
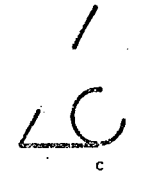
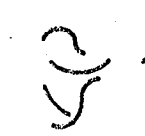
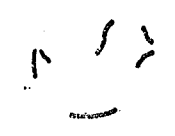
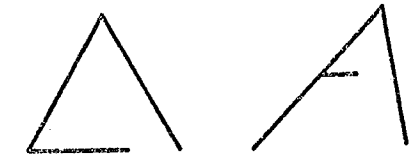
3		 A	B	 C	 D
4		 A	B	 C	 D
5		 A	B	 C	 D
6		 A	B	 C	 D
7		 A	B	 C	 D
8		 A	B	 C	 D
9		 A	B	 C	 D

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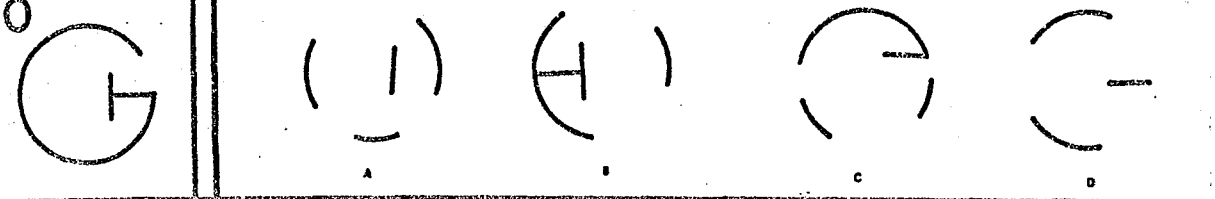

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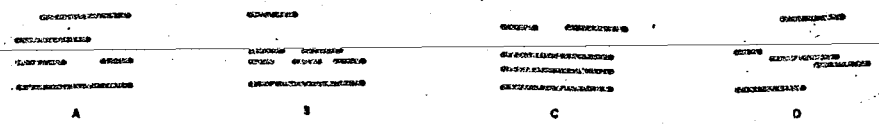

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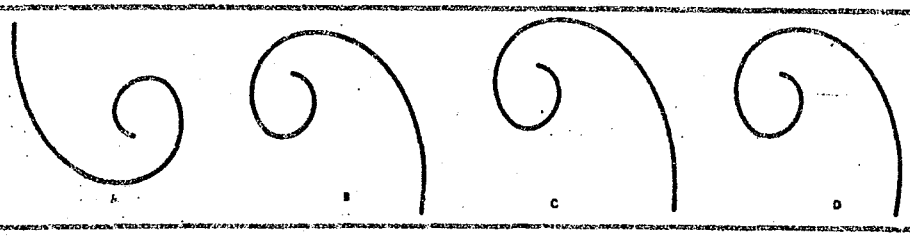

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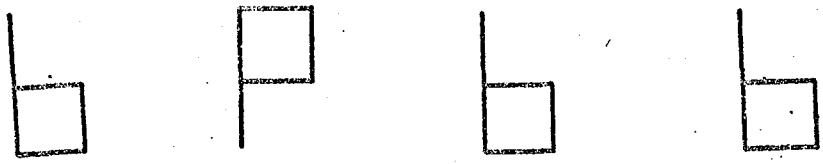

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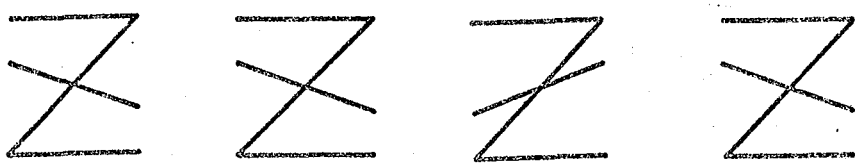

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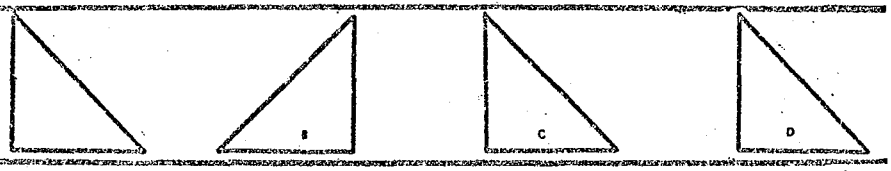

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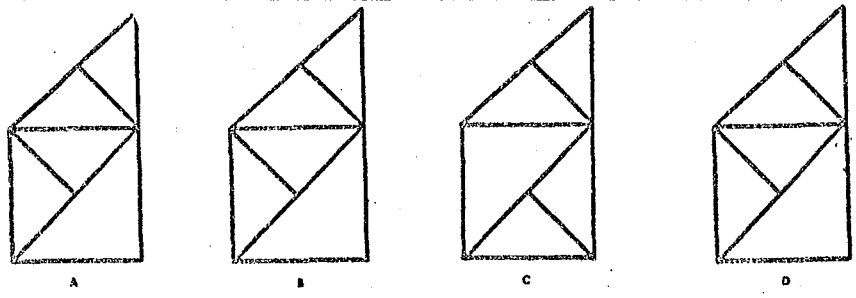


MVPT

MOTOR-FREE VISUAL PERCEPTION TEST

NAME_____ BOY_____ GIRL_____ DATE OF TESTING_____

TEACHER_____ SCHOOL_____ DATE OF BIRTH_____

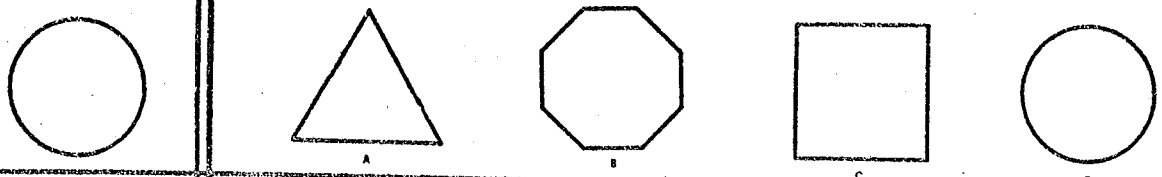
GRADE_____ BASAL TEXT_____ PUPIL'S AGE Yrs_____ Mos_____

TOTAL TEST SCORE_____ PERCEPTUAL QUOTIENT_____ PERCEPTUAL AGE_____

Devised By
Ronald P. Colarusso, EdD
Donald D. Hammill, EdD
1972

Adapted as a Group Measure by Susan Neuman

EXAMPLE



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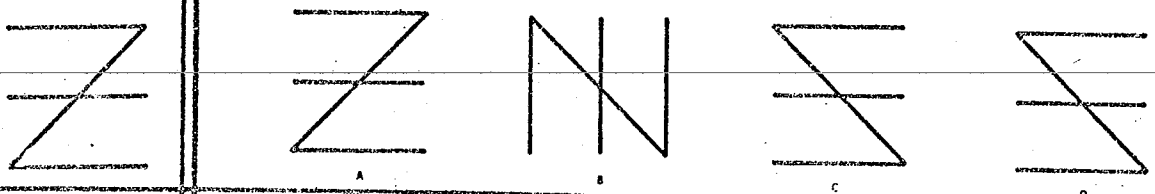

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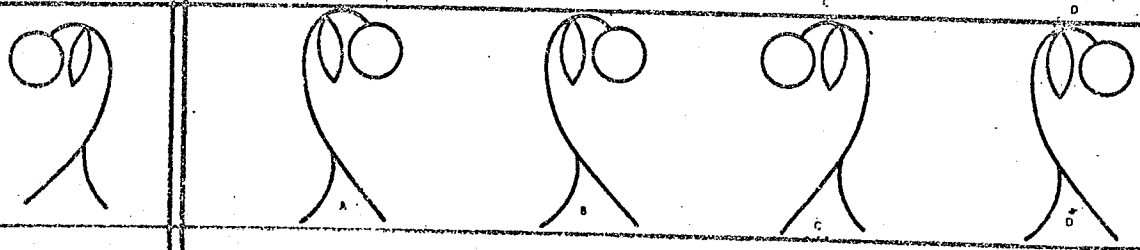

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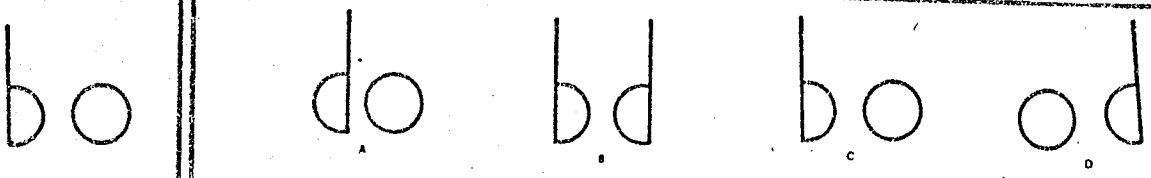

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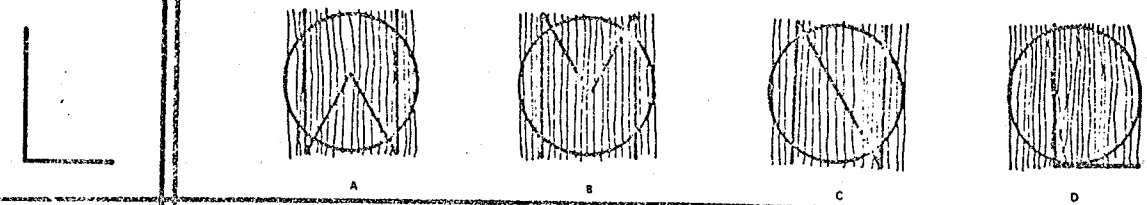

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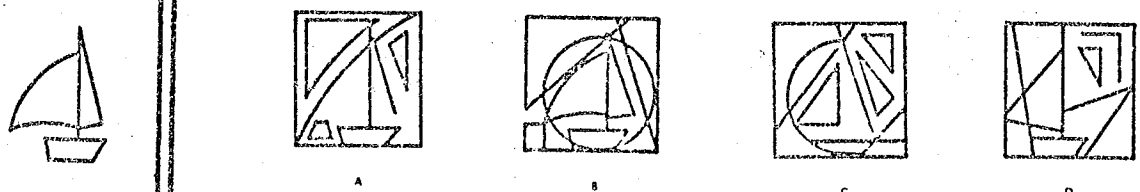

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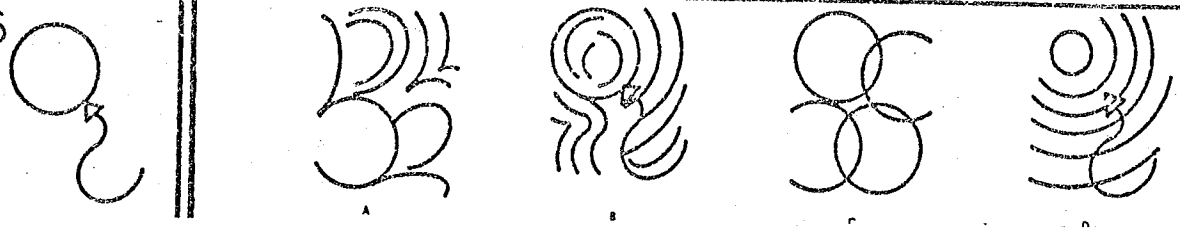

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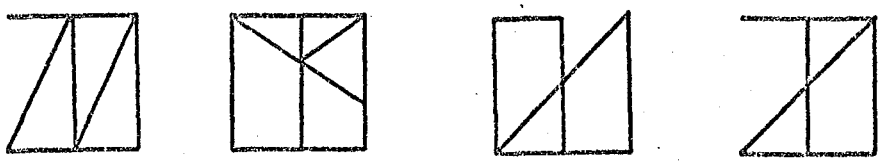

A B C D

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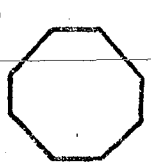
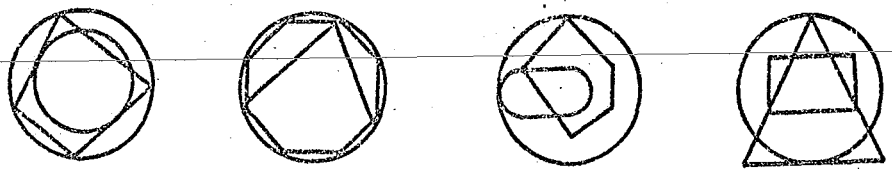
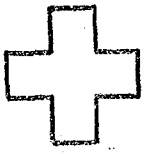
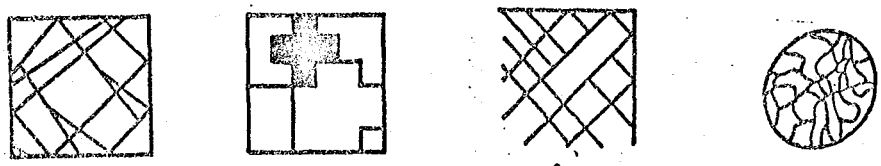




A B C D

B EXAMPLE





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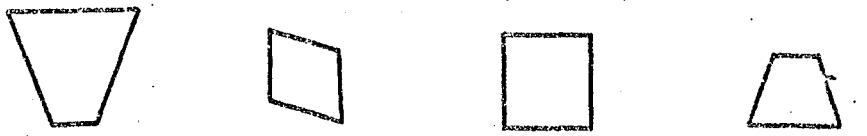

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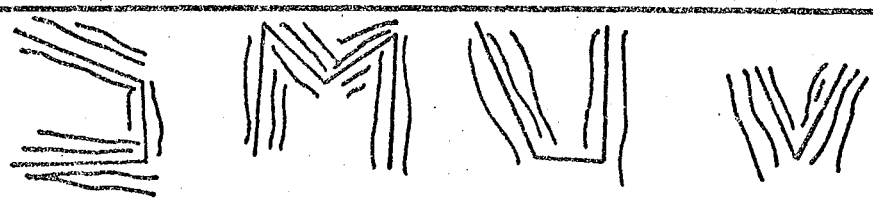

A B C D

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A B C D

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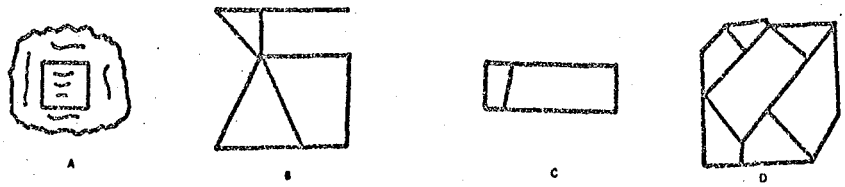

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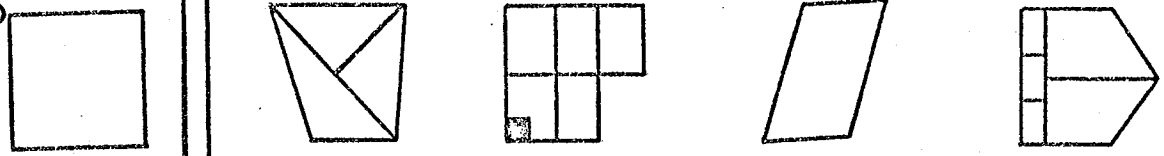
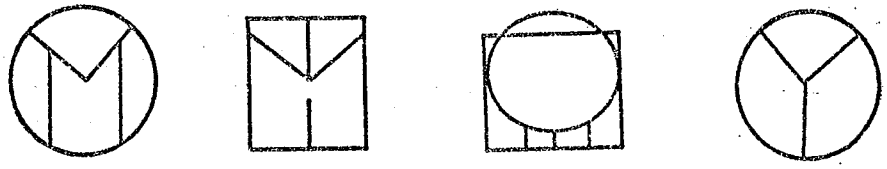


C

EXAMPLE



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axn (A) bxg (B) yag (C) tlb (D)

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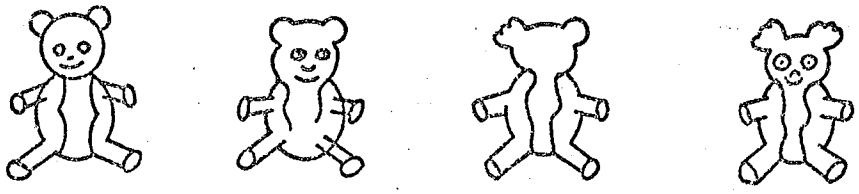

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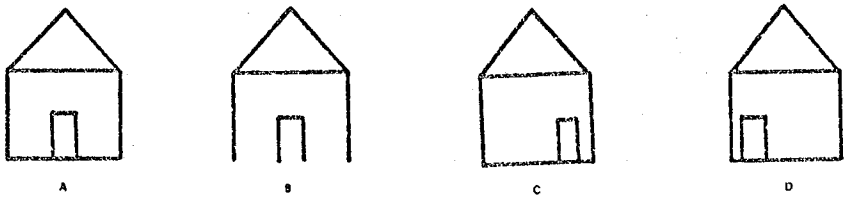

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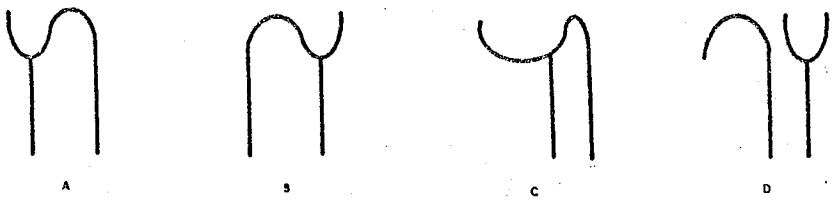

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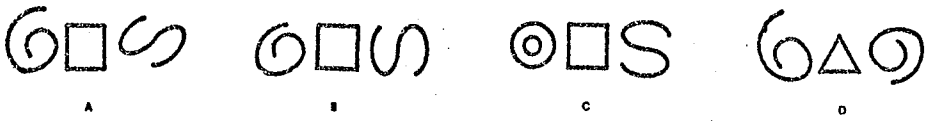

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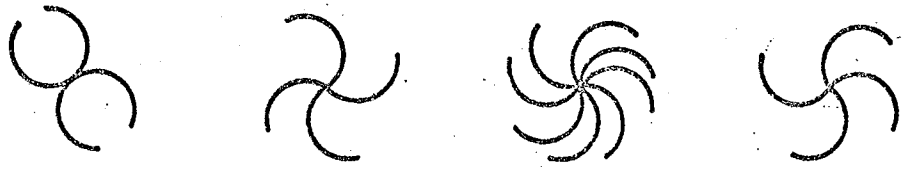

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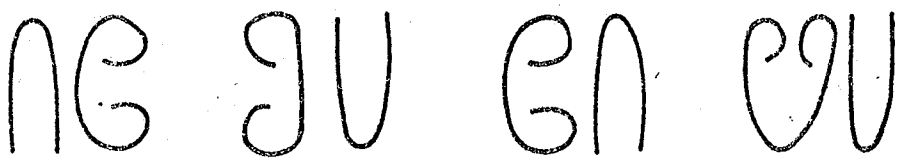

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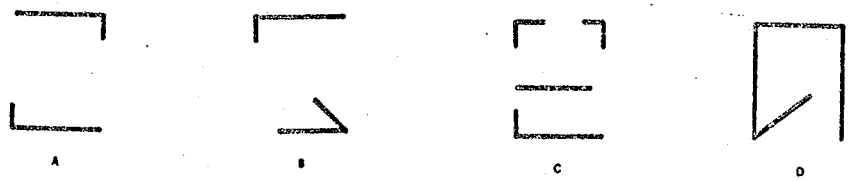

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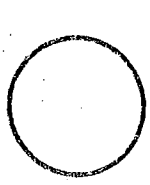

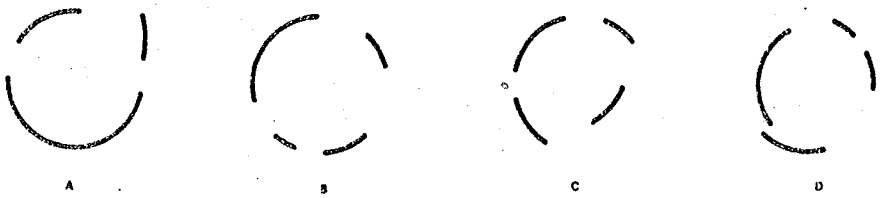

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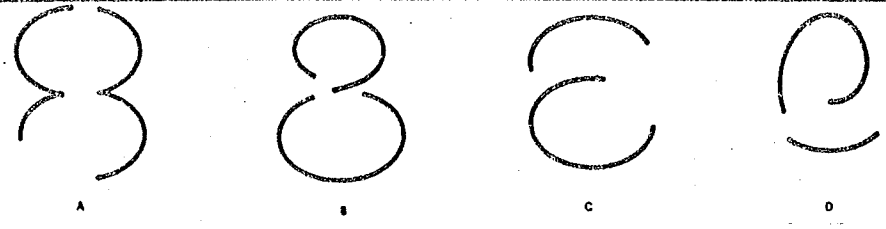

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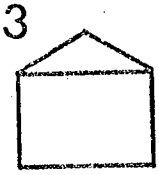

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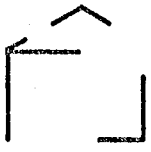

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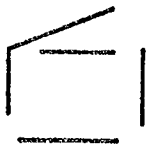

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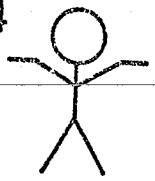

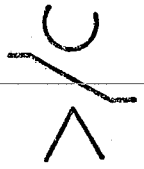

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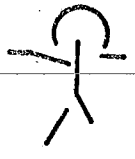

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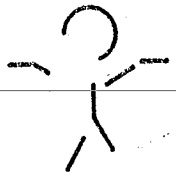


D

5

A

B

C

D

6

A

B

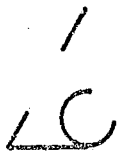
C

D

7

A

B



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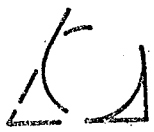

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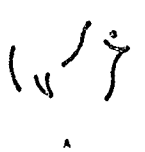

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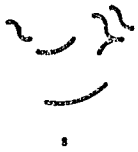

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D

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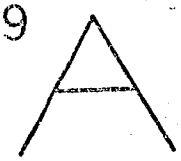

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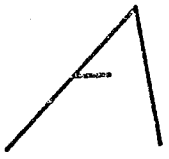
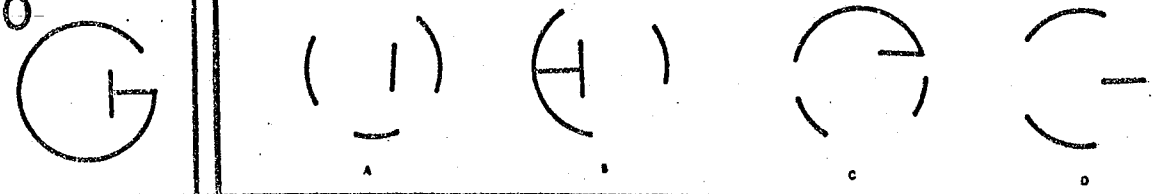


B

C

D

10



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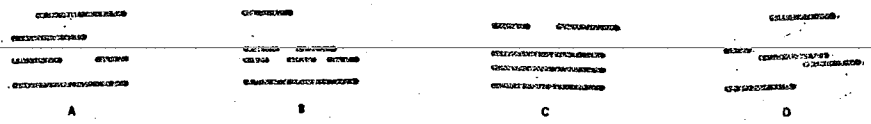
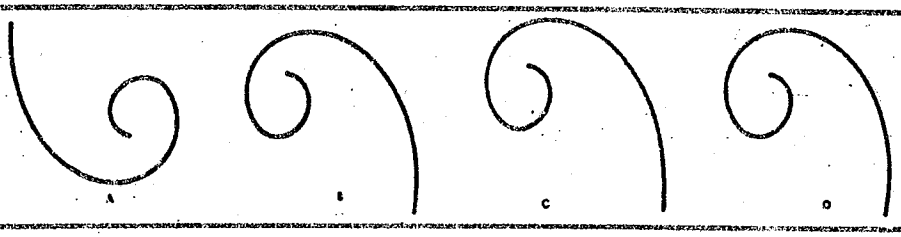


E EXAMPLE



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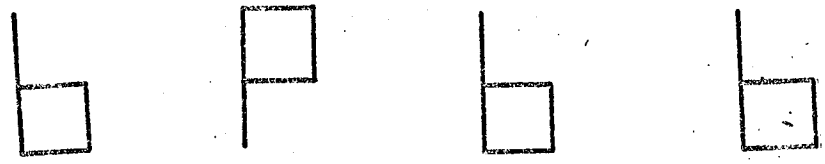

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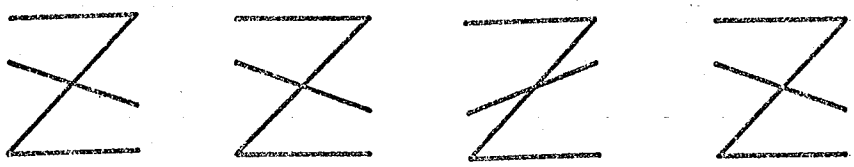
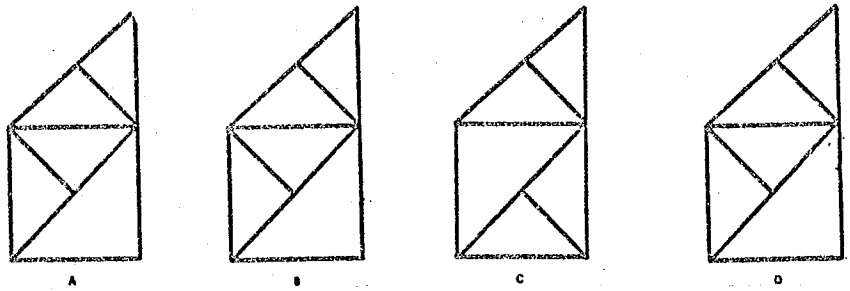


3

4



THE AUDITORY PROCESSING TEST

NAME_____ BOY____GIRL_____ DATE OF TESTING_____

TEACHER_____ SCHOOL_____ DATE OF BIRTH_____

GRADE_____ BASAL TEXT_____ PUPIL'S AGE_____

THE AUDITORY PROCESSING TEST

TEST 1 _____

TEST 2_____

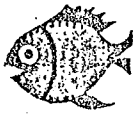
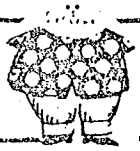
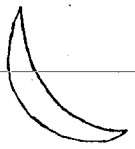
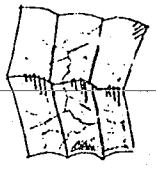
TEST 3 _____

TEST 4 _____

TEST 5 _____

TOTAL TEST SCORE_____

AUDITORY BLENDING SUBTEST

A.					
1					
2.					
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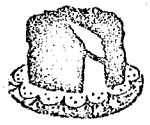
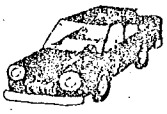
4					
5					
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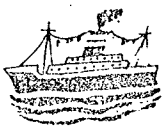
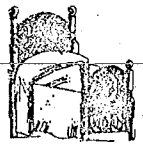
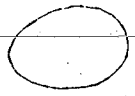
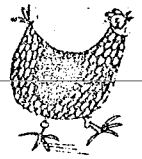
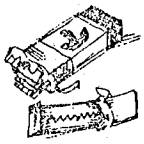
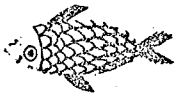
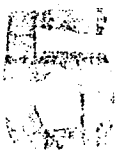
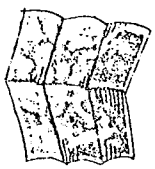
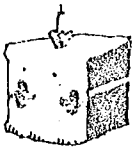
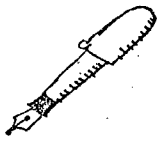
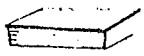
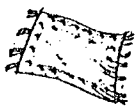
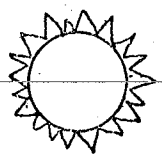
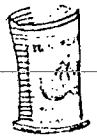
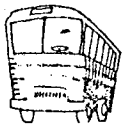
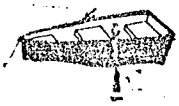
7					

AUDITORY BLENDING SUBTEST

8					
9					
10					
11					
12					
13					
14					

AUDITORY BLENDING SUBTEST

15					
16					
17					
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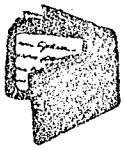
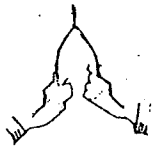
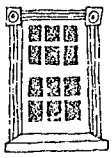
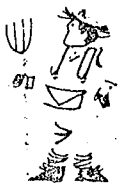
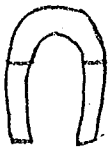
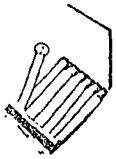
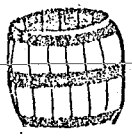
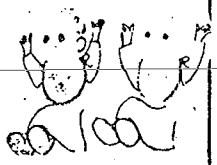
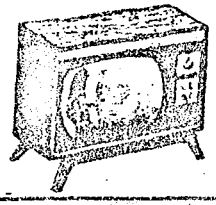
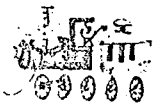
19					
20					
21.					

AUDITORY BLENDING SUBTEST

22.					
23.					
24.					

STOP

AUDITORY ATTENTION SUBTEST

1 

2 

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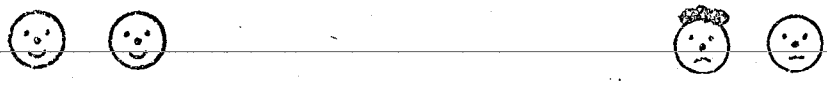
AUDITORY ATTENTION SUBTEST

11 

12 

13 

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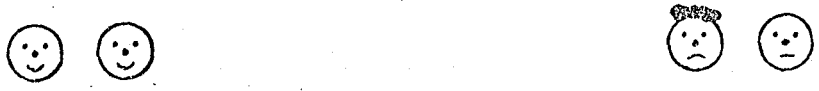
AUDITORY ATTENTION SUBTEST

21 

22 

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AUDITORY ATTENTION SUBTEST

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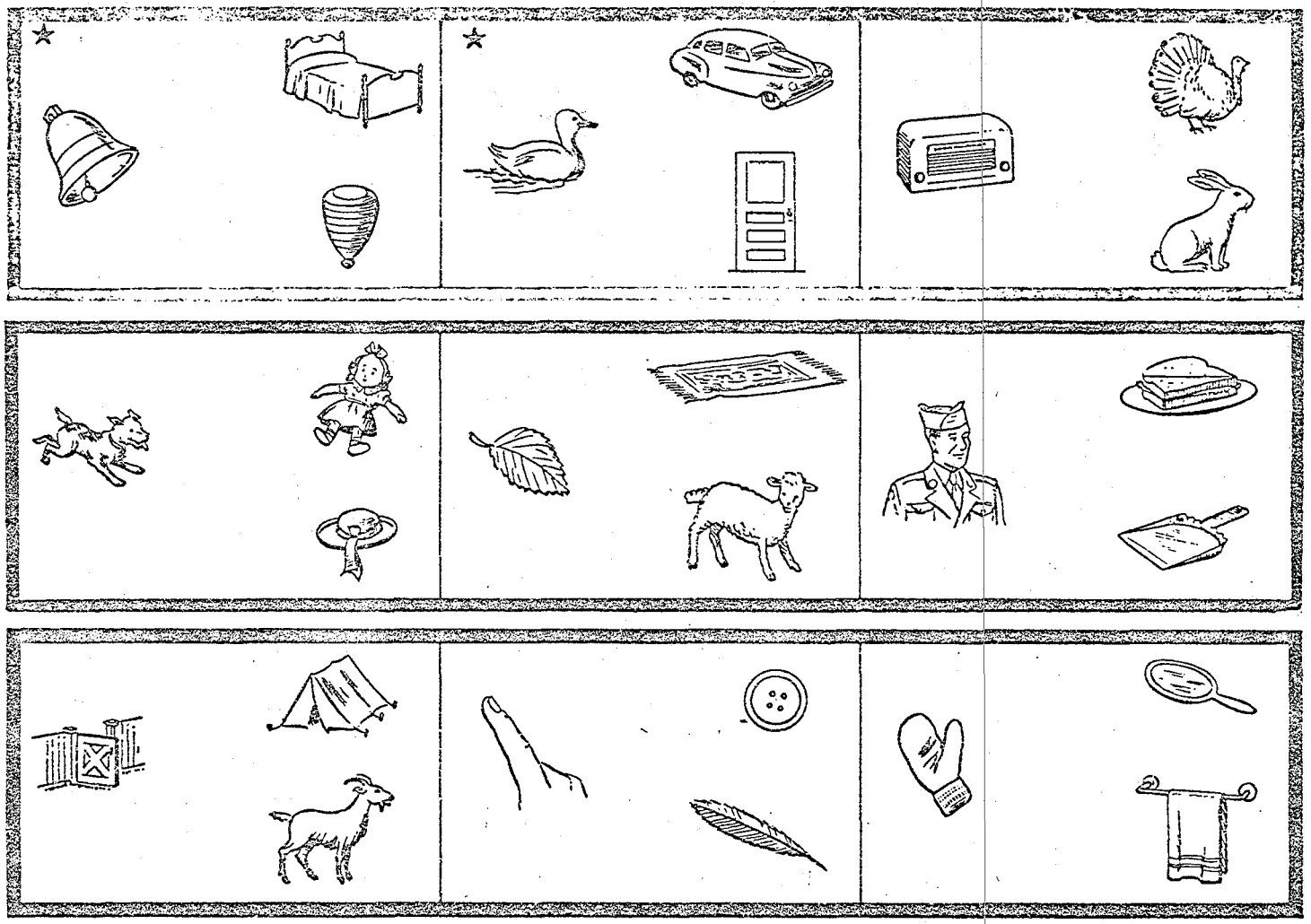
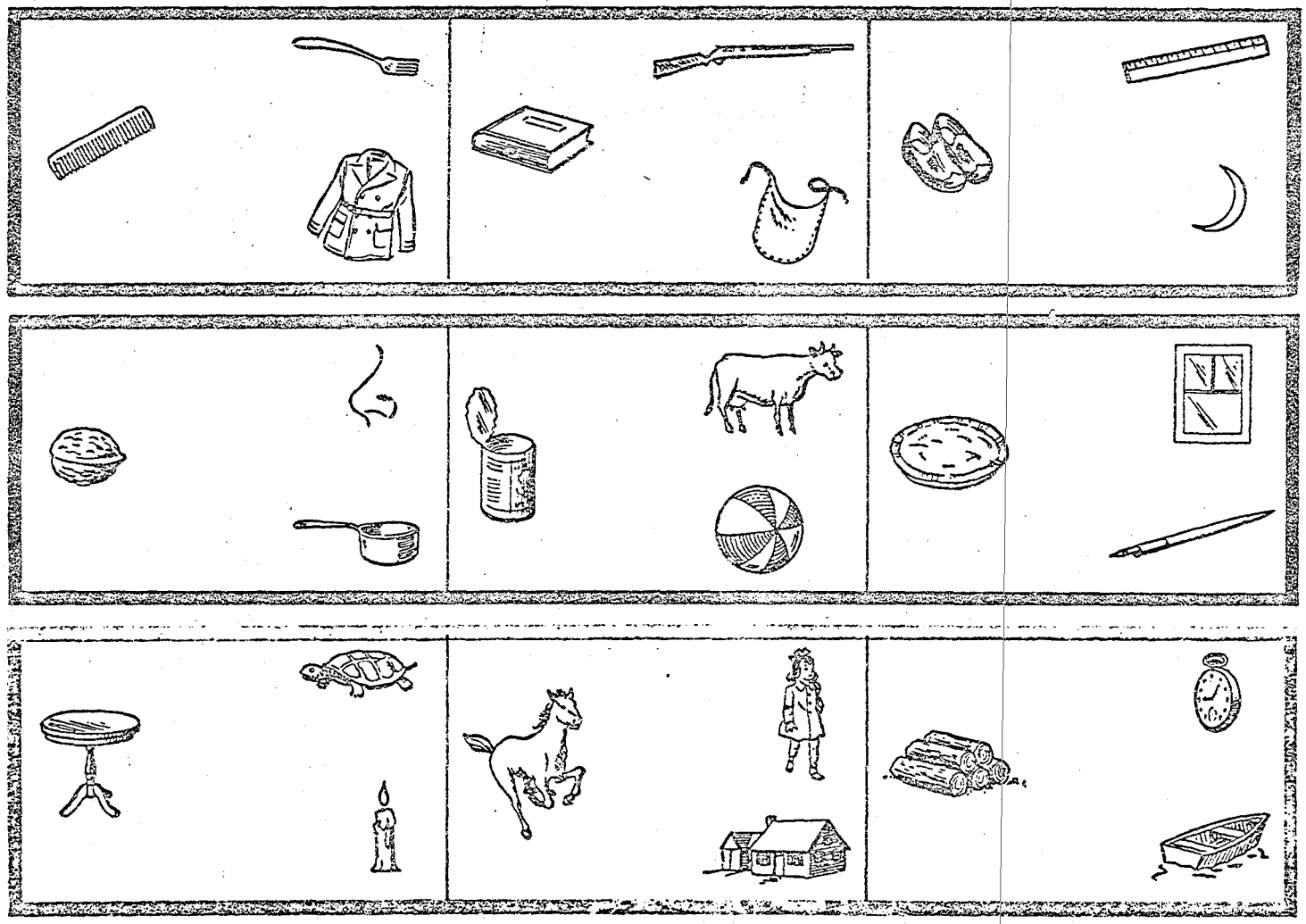


NAME_____ DATE_____



SCORE FOR TEST 4, pages 9 and 10 (16 possible) _____
(Do not count the 2 starred Practice Exercises on page 9)

TEST 4 AUDITORY SEQUENTIAL MEMORY

A.	2 2	3 4	2 1
B.	2 3	4 2	1
1.	9 5	1 9	9 1
2.	7 9	9 7	7 7
3.	8 1 1	1 8 8	8 8 1
4.	6 9 4	4 9 6	6 4 9
5.	2 8 5	8 5 2	5 2 8
6.	2 7 3 3	3 2 7 3	2 7 7 3

TEST 4 AUDITORY SEQUENTIAL MEMORY

7.	6 5 1 3	3 6 5 1	6 3 5 1
8.	2 8 9 3	8 2 9 3	8 9 2 3
9.	1 6 8 5	1 8 5 6	5 1 8 6
10.	7 3 9 9 4	4 7 9 3 9	4 7 3 9 9
11.	6 1 4 2 8	6 4 2 1 8	6 8 4 1 2
12.	1 9 5 2 6	5 1 2 9 6	1 5 2 9 6
13.	7 3 6 8 4 1	7 3 1 8 4	7 4 1 8 3
14.	5 9 6 2 7	5 2 7 9 6	5 9 7 2 6

TEST 4 AUDITORY SEQUENTIAL MEMORY

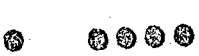
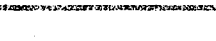
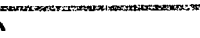
15.	748355	735548	783455
16.	231896	261983	296183
17.	529436	524936	529634
18.	473815	481735	487315
19.	695728	682957	675928
20.	3779461	3691377	3619277
21.	5843697	5369782	5973684
22.	8611539	8145936	8162593

TEST 4 AUDITORY SEQUENTIAL MEMORY

23	2836174	2741836	2871436
24	4357196	4963571	4956137
25	37441889	31488937	31927488
26	96853173	96385173	96385731
27	47316395	46395731	49563743
28	84359634	85944363	83593641

STOP

Test 5 AUDITORY-VISUAL INTEGRATION TEST

	A	B	C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

	A	B	C
11	●●● ● ●●	●●● ●●	●●●● ●
12	●●● ●● ●●●	●●●● ●●●	●● ●●● ●●●
13	● ●● ●● ●	●● ●● ●● ●●	●● ● ● ●●
14	● ●● ●●● ●	● ●●● ●● ●	●● ●●● ●● ●
15	●●● ●● ●●●	●● ● ●●●	● ●●● ●●●
16	●●● ●● ●●●●	●● ●●●● ●●●	●●●● ●● ●●●
17	●● ●●●● ●●	●●● ●● ●●	●● ●● ●●●
18	● ●●● ●● ●●	● ●● ●●● ●●	●● ●●● ●● ●
19	●●●●●● ●●	●●●●● ●● ●	●● ●●● ●● ●
20	●●● ●●● ●●●	●● ●●● ●●●	●●● ●● ●●●

STOP