This dissertation has been microfilmed exactly as received 67-2531

SABATINO, David Albert, 1938-
EXPERIMENTAL TESTS DESIGNED TO ASSESS THE AUDITORY PERCEPTUAL FUNCTION OF NEUROLOGICALLY IMPAIRED AND NORMAL CHILDREN UNDER CONTROLLED CONDITIONS.

The Ohio State University, Ph.D., 1966
Psychology, clinical

University Microfilms, Inc., Ann Arbor, Michigan
EXPERIMENTAL TESTS DESIGNED TO ASSESS
THE AUDITORY PERCEPTUAL FUNCTION OF NEUROLOGICALLY
IMPAIRED AND NORMAL CHILDREN UNDER CONTROLLED CONDITIONS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

David Albert Sabatino, B.S., M.A.

* * * * * * *

The Ohio State University
1966

Approved by

[Signature]

Adviser
School of Education
ACKNOWLEDGMENTS

This research effort has been well marked by the efforts of many people. It would be impossible in the space provided to mention the thought or effort of all those who did contribute.

A special note of sincere appreciation is herein expressed for the untiring assistance given so freely by Dr. Viola M. Cassidy, my major adviser. Her conscientious support was the means by which this task developed, grew, and was completed.

My sincere gratitude for the invaluable assistance provided by Dr. Donald C. Smith, who served on both the doctoral reading and examination committees.

To my adviser and friend, Dr. William M. Gibson, a very special note of thanks. The contributions of all those at the Children's Hospital and especially, the staff of the Handicapped Children's Program has been keenly felt by this writer.

Special mention should go to Donald Elliot, audiologist, and my wife. Through their efforts the test tape was recorded, administered, and the laborious task of preparing many dissertation drafts was completed.
VITA

August 14, 1938 . . . Born - Bellaire, Ohio

1960 . . . . . . . B.Sc., The Ohio State University, Columbus, Ohio

1959-1960 . . . . Speech and Hearing Therapist, Columbus State School

1961 . . . . . . . M.A., The Ohio State University, Columbus, Ohio

1960-1961 . . . . Audiologist, The Hearing and Speech Center, Columbus, Ohio

1961-1962 . . . . Intern Psychologist, Delaware City Schools, Delaware, Ohio

1962-1964 . . . . Psychologist and Director of Pupil Personnel, Lancaster City Schools, Lancaster, Ohio

1964-1965 . . . . H.E.W. Doctoral Fellow, The Ohio State University, Columbus, Ohio

1966 - . . . . Clinical Instructor of Psychology, Department of Pediatrics, College of Medicine, The Ohio State University Columbus, Ohio

Publications:

Sabatino, David A., A Panel Discussion of the Internship in School Psychology in Ohio. Published by the Lancaster City Schools and Division of Special Education, 1963.

# CONTENTS

## ACKNOWLEDGMENTS

Page 11

## VITA

Page iii

## TABLES

Page vi

## CHAPTER

### I INTRODUCTION

- Background of the problem .......................... 1
- Purpose of the study .................................. 7
- Definition of terms .................................... 12
- Setting of the study .................................. 14
- Assumptions ........................................... 15
- Questions ............................................. 16
- Hypotheses to be tested ............................. 17
- Limitations of the study ............................ 18
- Organization of the study ........................... 20

### II REVIEW OF THE LITERATURE

- A historical review ................................... 21
- Visual perception: the Bender Visual Motor Gestalt Test ........................................... 23
- Auditory perception ................................... 30
- A neurological review of language reception 41
- A theoretical review of auditory perceptual functioning ........................................... 47

### III METHODOLOGY

- General design ........................................ 53
- Description of the subjects ......................... 56
  - Selection criteria .................................. 56
  - Matching criteria .................................. 57
- Instrumentation used in the study ................ 61
- Standardized instrumentation: the Bender Visual Motor Gestalt Test ......................... 64
- Construction of the experimental test ............ 65

iv
CONTENTS (contd.)

Experimental testing procedures:
administration of the Test of Auditory Perception ............................... 67
Instructions for the Test of Auditory Perception ..................................................... 70
Administration of the Bender Visual Motor Gestalt Test ............................. 71
Collection of the data ..... 71

IV TREATMENT OF DATA, DISCUSSION, AND CONCLUSIONS ............................. 74
Analysis of the data ........................................ 74
Summary of the data ........................................ 97

V SUMMARY, CONCLUSIONS, AND IMPLICATIONS ........................................ 98
Summary ......................................................... 98
Conclusions ....................................................... 101
Implications for this research ........................................ 104
Implications for further research ........................................ 105

APPENDIX A Instructions for each auditory perceptual subtest ............................. 111

APPENDIX B Record scoring form for the Test of Auditory Perception ............................. 114

APPENDIX C Standardization data for the BVMGT and TAP ........................................ 122

BIBLIOGRAPHY ....................................................... 125
# TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Matching Criteria for the Experimental and Control Subjects Showing Mean Values, Range of Values, and Statistical Differences</td>
<td>58</td>
</tr>
<tr>
<td>2</td>
<td>Summary Table Showing Mean, Standard Deviations and Sum of Squares for the Subtests of Auditory Perception and the BVMGT for the Experimental and Control Subjects</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>The t Test of Each Auditory Perceptual Subtest Between the Means of the Experimental and Control Subjects</td>
<td>77</td>
</tr>
<tr>
<td>4</td>
<td>The t Value of Difference Between the Means of the Experimental and Control Subjects for Each TAP Subtest Administered Under Conditions of Background Noise</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>The Significant Differences Between the Means of the Subtest Scores Administered in Background Noise and Under Normal Testing Conditions</td>
<td>82</td>
</tr>
<tr>
<td>6</td>
<td>The Correlational Values and Significant Differences Between the TAP Subtests for the Experimental Subjects, Control Subjects, and Total Population</td>
<td>86</td>
</tr>
<tr>
<td>7</td>
<td>The Correlational Values Between the BVMGT and Each of the TAP Subtests for the Experimental and Control Populations</td>
<td>89</td>
</tr>
<tr>
<td>8</td>
<td>The t Values and Significant Differences for the Correlations Obtained Between the BVMGT and the TAP Subtests for the Experimental and Control Subjects</td>
<td>89</td>
</tr>
</tbody>
</table>
TABLES (contd.)

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>The Number of Subjects Identified by the BVMGT and the TAP at the Clinical Criterion Under Normal Testing Conditions and Under Conditions of Control Test Background Noise</td>
<td>94</td>
</tr>
<tr>
<td>10</td>
<td>The Number of Subjects Identified by Each TAP Subtest Under Normal Testing Conditions and Conditions of Background Noise at the Clinical Criterion</td>
<td>94</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Background of the problem

There has been a recent upsurge in interest among psychologists and educators in identifying children with neurological impairment. Many state departments of education have underwritten special classroom units and individual tutoring programs for these children, after a final diagnosis of neurological impairment has been established.

The initial responsibility for identifying such children remains with school personnel. The school psychologist is generally responsible for screening children with possible neurological problems. The Ohio Department of Education (1966) has records to indicate that school systems without psychological services have generally failed to develop programs for these children.

The problems of diagnosing children with neurological impairment are many. The specific problems that psychologists have in identifying children with so-called "minimal" neurological impairment and obtaining a final diagnosis are:

1. The lack of medical agreement as to the
acceptability of the term "minimal" neurological impairment.

2. The findings of the physicians upon physical examination are not always significant.

3. The developmental histories of the children depend upon the reliability of the informant.

4. The psychologists depend primarily upon tests of perception in identifying the neurologically impaired child. Visual motor perceptual tests are the most frequently used perceptual tests.

5. The reliance of psychologists on visual perceptual tests may mean that children with impairments in this function are being identified. However, children with learning problems associated with auditory perceptual problems may go unidentified because of the lack of auditory perceptual tests available to the psychologist.

Auditory perception, although important for learning, has not been assessed as a primary function in the process of identifying neurologically impaired children. The research in auditory perception has not advanced auditory perceptual test development. Psychologists need the best available means of assessing children suspected of neurological impairment. Early identification of children with neurological impairment is decidedly important.

Special classes or tutoring may make the difference between school success or failure of these children. Minimal
neurologically impaired children have been shown to have normal intelligence for academic achievement (Grover and Allen, 1962).

The problem of academic underachievement in neurologically impaired children seems to be associated with their perceptual difficulties. The process of sensation is the sensory neural coding which takes place at the peripheral sense organs. Sensory coding is the means by which environmental stimuli are arranged for neural transmission to the perceptual centers. Perception is the ability of the central nervous system to interpret the sensory coded information. In other words, neurologically impaired children would probably develop academically if it were not for their perceptual difficulties. It is the perceptual difficulties that necessitate specialized instruction if academic success is to be achieved.

Learning begins when sensory stimuli, coded for neural transmission, are received in the central nervous system as recognizable units of information. Strauss and Kephart (1955) consider perception to be "an activity of the mind intermediate between sensation and thought... psychological events which are materialized through central nervous processes for functions of the brain." The perceptual functions in the central nervous system are not clearly understood. Theorization has attempted to explain the specific functions of perception leading to conceptualization. But,
the complexities of neural activity tend to make empirical research in perception most difficult.

Broadbent has recently summarized the various approaches used to investigate the central nervous system. He writes:

The study of the nervous system can be carried out in at least three major ways. First, one may examine the physiological mechanisms by detecting the electrical and chemical events that go on in the system while it is operating. Second, one may examine the behavior of a man or animal from outside either by observing what occurs spontaneously or by devising experimental situations which will throw certain functions into relief. Third, one can devise mechanical or mathematical analogies and models for processes similar to those performed by nervous systems: this type of study can be carried out as an end in itself, in order to produce effective machines, or it may be deliberately pursued as having put light on the processes in nervous systems which are found in nature. All these three approaches are of value and no one of them should be neglected.

(Broadbent, 1965)

Broadbent has established the importance of clinical assessment in understanding the functions of the central nervous system. There is a timely reason for theorization on perceptual function. Psychologists must recognize the different developmental stages or levels in each area of perceptual functioning. It is one thing to diagnose a child on the basis of a generalized perceptual problem, but in planning for children's education, very little specific information can be obtained unless all the stages or levels of each perceptual function are assessed.

The significant problems associated with educating
neurologically impaired children begin immediately following their diagnosis or identification. Academic teaching materials and techniques used in the regular classroom often do not obtain satisfactory results with perceptually disturbed children. Research by Gallagher (1960) and Cruickshank (1961) tends to indicate that children with learning or behavior problems due to neurological impairment profit from prescriptive teaching.

If neurologically impaired children are placed into a special class or given tutoring, this experience should consist of specialized academic programs and techniques that were not provided in regular classes. One author writes:

The opinion is expressed here that the development of special education classes for minimally brain damaged children has sped ahead of the psychological research upon which it is founded. The basic objective of the special education program is the remediation of academic deficits and if possible to correct the underlying intellectual and psychomotor disabilities. (Strong, 1964)

Neurologically impaired children placed into special academic programs should be provided special techniques, techniques to train and retrain their sensory and perceptual functions. A teacher must know the specific kinds of perceptual deficiencies that a child has if specialized techniques of a prescriptive clinical nature are to be applied. Prescriptive clinical teaching begins with the recognition that specific stages or levels of perception are interfering with the meaningful reception of information. A child
learns to the extent that he has full use of each level or stage of perceptual function available leading to the uninterrupted comprehension of information. Therefore, the diagnosis of learning disability in children should include the comprehensive assessment of each stage or level of perceptual functioning.

Research (Bender, 1938) in visual perception has shown that background fields have a decided effect upon the visual stimuli being perceived. A review of the research tends to be inconclusive in denoting the effect various kinds of background noise have upon auditory perception.

The effect of congenital brain impairment or mal-development upon auditory figure-ground perception, on the other hand, has received little experimental attention, and the few studies which are reported have yielded contradictory findings. (Grey, D'Asaro, and Sklar, 1965, p.50).

Schlanger (1958), Lerea (1961), Werner and Bowers (1941), and Hunt (1960) fail to agree on the ability of brain-injured mental retardates to discriminate various kinds of sound stimuli in noise backgrounds. Jacquot (1959) found no significant difference between speech and pure tone thresholds in background noise for cerebral palsied children. Siegenthaler (1959) found that cerebral palsied children had significantly more acute speech-in-noise thresholds than did normal children. Grey, D'Asaro, and Sklar (1965) report no significant differences between the thresholds for pure tones and for words (spondees) in quiet and noise, for brain damaged and non-brain damaged children.
Purpose of this study

The purpose of this study was to develop an experimental Test of Auditory Perception (TAP). The test was used to: (1) Differentiate normal subjects from neurologically impaired subjects, and (2) assess each of the sequential stages or levels of function that comprise the hierarchy of skills known as auditory perception. The TAP was based on a theoretical explanation of auditory (receptive language) perception. The neurological model shall be discussed at length in the next chapter. The four specific auditory perceptual functions and the six subtests assembled to assess each function are:

1. Auditory recognition
   1a. Sound discrimination test
   1b. Word discrimination test

2. Auditory retention
   2a. Memory for digits
   2b. Memory for sentences

3. Auditory integration
   3a. Rhythmic structures

4. Auditory comprehension
   4a. Aural comprehension of stories

The rationale for the development of an experimental Test of Auditory Perception are:

1. The limited number of such tests available for use with children. The majority of auditory perceptual
tests (Eisenson, 1954), (Halstead and Wepman, 1947), and (Minnesota, 1955) have been developed for use with adults.

2. The restricted number of perceptual functions assessed by the auditory perceptual tests already developed. Most of the tests assess only one aspect of auditory perception (Wepman, 1958) (Templin, 1957) in children. There are no tests known to the researcher that assess more than one theoretical function of auditory perception.

3. There is limited theorization related to test development in auditory perceptual functioning in children. The only test known to this author to be particularly concerned with auditory perception theorizes about the total development of language behavior in children (McCarthy and Kirk, 1961). This test seemingly assesses such numerous sensory, perceptual and motor complexities that auditory perception is not a significant factor.

4. The dependence of psychologists upon visual motor tests of perception as diagnostic screening instruments to distinguish neurologically impaired children from non-neurologically (normal) impaired children. Auditory perceptual tests have not been developed for use with neurologically impaired children.

Benton (1962) summarizes this problem:

In summary, the bulk of clinical investigative work on the capacities of the non-defective, brain-damaged child has centered
on his visuoperceptive and visuomotor performances; the approach has been a rewarding one. However, other possibilities exist and they should be thoroughly explored. So far as one can see, there is no apriori reason why linguistic behavior, reasoning, or some more or less general characteristic as behavioral flexibility (in terms of the capacity to respond appropriately to disparate stimuli) should not be as sensitive indicators of behavioral impairment consequent to brain damage as visuo motor tasks. Actually, some of them would seem to be particularly well suited to pick up subtle changes in higher level behavioral function. But this remains to be determined. The answer will come from broad and comprehensive evaluations which are free from preconceptions and are based on a careful and rational selection of cases.

Gallagher (1960) writes, "In contrast to the visual motor area, other areas of sensory perception have been almost neglected in comparing brain-injured versus non-brain injured children." The problem as Gallagher states it is that "neither the auditory or kinesthetic perceptual areas have been investigated sufficiently to comment on any differences." Harris (1950) adds, "Little is known about alterations in auditory function following brain injury."

Myklebust (1954) has developed a differential diagnostic summary which accounts for language delay in children. He reveals five problem areas associated with language delay:

1. Peripheral deafness or lack of hearing acuity.

2. Emotional factors due to rejection or inconsistent response to environment.
3. Mental retardation or a lack of cognitive ability to learn language.

4. Language deprivation where environmental conditions have limited the child's need to speak.

5. Neurological impairment which inhibits
   5a. Expressive speech or motor paraphasia.
   5b. Central language or a lack of language concepts due to the impairments of central nervous system areas that mediate the symbolic processes language.
   5c. Receptive speech or the ability to comprehend auditory information meaningfully.

Myklebust (1954) has discussed the need for psychological instruments that will differentially diagnosis language impairment denoting the specific problem. Differential diagnosis should include the assessment of each specific sensory and perceptual area of development. Clinicians are merely sorting symptoms until psychological instruments are developed to measure specific sensory and perceptual functions.

McWilliams (1965) distinguishes differential diagnosis from symptom sorting. She writes:

   ...Language impairment suggests that the failure to develop expressive and receptive language is usually the result of deafness, mental retardation, brain damage, emotional disturbance, or some variation or combination of these disorders. ...the process of making this decision is called differential diagnosis. By definition, diagnosis is the art of recognizing disease from its symptoms. As has been pointed out, in problems of delayed language the symptoms
are often complex, poorly differentiated from one etiological group to another, and peculiarly in reality, the process is more nearly akin to "ruling out" which is both practically and philosophically different from diagnosing.

Symptoms are not accurate means of diagnosing a problem because

1. Many important ones go unnoticed.

2. Often one symptom may arise from more than one etiology. The multiple handicapped child is an example.

The effectiveness of educational planning for children with multiple handicaps depends upon the complete evaluation of all the skills that comprise educational potential (learning). The importance of assessing such a child has only recently become of concern. Haeussermann (1958) indicates the importance:

Not infrequently his symptoms are mistaken for mental retardation or for mental deficiency, for deafness, for emotional problems, for prepsychotic states. The symptoms and problems attending this child are not observed in the infant or in the small child; consequently many problems arise before patients suspect that further examination is necessary. Often the diagnosis is confused with the symptoms of disease involvement as in the case of the multiple handicapped, the blind aphasic, the cerebral palsied or the epileptic aphasic child.

The background and problems associated with auditory perception have been discussed. The terms used in the study are defined before discussing the setting for this study.
**Definition of terms**

**Hearing**  Hearing may be defined as the reception of sound by the ear (sensation) and the meaningful recognition of this sensation by the higher brain structures.

**Sensation**  Sensation refers to the selection and reception of environmental stimuli (physical) by the peripheral sensory receiving organs. Coding permits selective transmission of the environmental stimuli to the central nervous system.

**Visual acuity**  Visual acuity is the chemo-neural reaction of the rods and cones in the retina to luminosity. Visual acuity is measured by the units, diopters, of light refracted.

**Auditory acuity**  Auditory acuity begins with the conversion of sound waves to hydrostatic waves in the cochlea. This established sensory coding of the physical properties of sound for neural transmission. Auditory acuity is measured by the intensity needed to differentiate the presence of sound (decibels).

**Perception**  Perception is the function of the central nervous system. Perception is interpreting coded sensory data so that it is meaningful for learning.

**Visual perception**  Visual perception involves an immediate response to or delayed recall of visual sensory stimuli. Visual perceptual function is measured by the Bender Visual Gestalt Test.
Auditory perception  Auditory perception is the interpretation, integration, and mediation of sound as a meaningful unit of information. Auditory perception involves the reception of speech or sounds in such a way that it conveys meaning to be further associated in the central nervous system. Auditory perception is the: (1) meaningful recognition of speech sounds; and (2) retention of language concepts which are associated and comprehended within the central nervous system.

Neurological impairment  For the experimental population neurological impairment refers to children whose neurological, psychological, and pediatric examinations demonstrate insult or injury to the central nervous system. Excluded from this study are children with gross handicaps involving motor, speech, language, or bodily co-ordination.

Non-impairment  Non-impairment indicates that the control population did not reveal neurological impairment upon examination.

Perceptually disturbed children  Perceptually disturbed children are defined as having difficulty in one or more of the areas listed: haptic, kinesthetic, fine or gross motor, visual, or auditory. Their response to perceptual tests should be below their general level of development. Perceptual difficulty may be due to neurological impairment when the central nervous system perceptual centers are damaged.
Setting of the study

The Test of Auditory Perception was administered at the Children's Hospital and the Columbus Public Schools, Columbus, Ohio. The test was assembled under controlled audiometric conditions and recorded on magnetic tape to ensure inter subject test consistency.

The experimental and control subjects were selected by a team at the Children's Hospital. This team was comprised of: a pediatrician, a psychologist and an audiologist. Thirty (30) normal subjects with no known neurological impairment (control subjects) were matched with thirty (30) neurologically impaired subjects (experimental subjects). The subjects were matched on: sex, chronological age, years in school, and verbal intelligence.

The auditory perceptual test was administered once under normal psychological assessment procedures; the second administration was in a background of classroom noise recorded on the test tape recording. It was felt that noise as a background condition would approximate the distractions that children must attend to in the classroom. For this reason, pre-recorded classroom noise was used. A comparison of the ability of the tests to discriminate the subjects under normal conditions and in a noise background was made.
Assumptions

The assumptions basic to the purpose(s) of this study:

1. The cognitive development of children is closely related to the sensory-motor development that precedes it. Difficulties in the auditory perceptual functions may cause learning and behavioral problems of serious consequence.

2. The problems associated with auditory perception could be identified and learning and behavioral difficulties might be altered, assisting the child to gain more from his school experience.

3. The research in auditory perception has not been as complete as research in visual perception. Therefore, test development in auditory perception has lagged far behind the development of tests in visual perception.

4. The present tests of visual-motor perception do not attempt to assess auditory perceptual difficulties. Children with auditory perceptual problems may go undetected until comprehensive tests of auditory perception are developed.

5. The children without gross signs of neurological impairment may be distinctly screened from normal children, on the basis of their auditory perceptual test results.

6. Children with neurological impairment may
have more difficulty in distinguishing signal stimulus from noise backgrounds than children with no neurological impairment.

Questions

Several questions are pertinent to the assumptions:

1. Is the integrative function of the central nervous system so complex that experimental tests of auditory perception will not show significant differences when comparing a population of neurologically impaired children with a matched control population of normal children?

2. Can a test designed to measure auditory perception differentiate four separate auditory perceptual functions: (1) recognition, (2) retention, (3) integration, and (4) comprehension, utilizing both a normal and a neurologically impaired population? If so, is one subtest a more sensitive discriminator of children with auditory perceptual problems than another?

3. Is the commonly used Bender Visual Motor Gestalt Test (BVMGT) capable of finding children with auditory perceptual problems? Or is this test only successful in screening children with visual perceptual errors?

4. Can tests of auditory perception differentiate significantly a pre-selected experimental population of neurologically impaired children from a matched control group of normal children as well as the BVMGT?
5. Does an ambient noise in the background of the stimulus signal (the introduction of classroom noise) significantly reduce the auditory perceptual ability of children with known neurological impairment? What will be the effect of background noise on the auditory perceptual ability of normal children?

6. What is the relationship between the four perceptual functions: recognition, retention, integration, and comprehension? If the relationship is positive but low in value, can it be assumed that the theoretical design of the Test of Auditory Perception has represented the neurological model?

Hypotheses to be tested

Hypothesis (I): There is no significant difference between the scores on the Test of Auditory Perception for the experimental (neurologically impaired) and control (normal) subjects. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.

Hypothesis (II): There is no significant difference between the scores on the Test of Auditory Perception for the experimental (neurologically impaired) and control (normal) subjects when the tests are administered under conditions of background noise. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.
Hypothesis (III): There is no significant difference between the means of the auditory perceptual subtest, when the tests are administered under normal testing conditions of background noise. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.

Hypothesis (IV): There is no significant difference in the relationship between the various subtests of auditory perception for: (1) the experimental population, (2) the control population, and (3) both populations.

Hypothesis (V): There is no significant difference in the relationships between the scores obtained on the Bender Visual Gestalt Test and the Subtests of Auditory Perception for: (1) the experimental subjects and (2) the control subjects.

Hypothesis (VI): There will be a higher incidence of experimental subjects with auditory perceptual problems (assessed by the TAP) than those having visual motor perceptual problems (assessed by the BVMGT) when assessed under: (1) normal testing conditions and (2) conditions of background noise.

Limitations of the study

The following limitations were recognized as being inherent to this study.

1. It is difficult to acquire concise agreement on the definition of "minimal" neurological impairment. The subjects presumed to have minimal neurological impairment (experimental subjects) were carefully screened by a selection team using multidisciplinary criteria. The control
subjects were selected as not having any developmental history or physical findings suggestive of neurological impairment. The most prudent care in selection does not establish that a given subject is free of unknown or unwanted conditions.

2. Noise served as one possible type of distractor during an administration of the Test of Auditory Perception. There is no known research to indicate what the minimum or maximum level of signal-to-noise ratio should be for children. In fact, there is very little research as to the effect of noise on auditory perception of children with neurological impairment.

3. The auditory perception tests were tape recorded for the purposes of controlling the test administration among subjects. The test tapes were recorded under controlled procedures to insure that the signal output of the tapes would be constant. In using the rigor of electronic equipment to control the stimulus signal on the test tapes there was some signal distortion added in the final tape reproduction. Although it was barely distinguishable, it represents an unknown quantity.

4. Statistical procedures control to some extent inter-subject variability. However, the research in visual perception has indicated that there is a reliability problem in assessing visual motor perceptual function. No efforts will be undertaken in this study to assess the reliability of the auditory perceptual test.
5. It would seem almost impossible to generalize from any of the results of this initial effort and small sample. For this reason, the results should be regarded as tentative until further research can be undertaken.

Organization of the study

The present chapter introduces the problem and purposes of the investigation. A brief discussion of the experimental design was presented in the setting of the study. The assumptions, questions, and hypotheses pertinent to this study were also introduced.

The second chapter presents a review of the literature in visual and auditory perception. The neurological functions thought to represent the various levels or stages of auditory perception are presented following a discussion of the research of auditory perception.

The third chapter describes the procedures used in the study, the population, the experimental instrumentation and scoring procedures.

The fourth chapter contains an interpretation of the data, conclusions, and results. The final chapter presents the summary of the study and the implications for further research.
CHAPTER II

REVIEW OF THE LITERATURE

This chapter begins with a historical review of perceptual developmental, an overview of the research in visual and auditory perception, and discusses the Bender Visual Motor Gestalt Test. A theoretical explanation of auditory perception is presented, terminating in a neurological model. This neurological model of auditory perception provides the basis for assembling the experimental test of auditory perception.

A historical review

Psychology became differentiated from philosophy through the scientific study of behavior. In the first psychological laboratories the elements and functions that produced behavior were studied. Historically, in the 1900's Wundt in Leipzig, Galton in London, and William James at Harvard carried on investigations of the mental elements (structuralism) or functions of behavior (functionalism). It became evident from this initial research that behavioral responses were related to the perceptual interpretations of sensory stimuli.
Research in sensation delineated inter subject variability in sensory acuity. This led to introspective theorization about perceptual function. Perception is defined as the mediating act through which sensory data is interpreted, stored, and associated within the central nervous system.

The concept that mental process depends on sensory information has been present since Plato (427-347 B.C.). It cannot be established who was the first to write: "Nihil est in intellectu, quod non prue fuent in sensu," when translated means "there is nothing in the intellect that has not first been in the senses" (Peiper, 1963, p.16). Aristotle, Democritus, Epiculus, and Lucretius all wrote of the mind as a tabula rasa, or a blank tablet to be written on by sensory experiences. Aquinas later wrote, "It is natural for man to acquire knowledge through the senses" (Hegel, 1814, p.7).

In the nineteenth century, Locke (1894) refuted the concept of sensation as the sole source of learning. He believed sensations were the primary but not the only source of information for mental activity. He regarded reason as a specific, creative faculty related to intelligence. Locke recognized that there must be an intact receiving mechanism within which sensory stimuli could be mediated.
Preyer (1895), a physiologist during the last quarter of the nineteenth century, wrote:

The basic condition for every mental development is the functioning of the senses. Without these, no psychogenetic occurrence can be imagined. The only material available to the intellect is received by the senses. This material enters the mind only through sensations.

The philosophy and observations of many great men served as the key which unlocked a differentiating view of man. Concern for the way in which learning is obtained resulted in an equal concern for sensory and perceptual functioning. The recognition that perception was basic to the conception of man's ideas ended the reign of the naturalist or structuralist. No longer were men afraid to educate or train so-called handicapped persons. The change in view prompted Itard, Sequin, Howe, and DeCroly (Dunn, 1961, p. 15) to undertake work with the handicapped.

Visual perception: the Bender Visual Motor Gestalt Test

During the seventeenth century, the sensory mechanisms were viewed as important to learning. It was observed that differences in intellect may be explained by determining the acuity of the senses. On this premise Francis Galton (1883) established his famous anthropometric laboratory in London. He measured many sensory and motor performances because he believed that intellectual differences among people were based upon the perceptual responsiveness of the sensory modalities. Galton hoped to differentiate sensory
acuity in man, thus identifying those persons possessing higher intellectual development.

Galton in England and Cattell in Germany developed simple sensory-motor tests to assess cognitive function. These sensory-motor tests have been shown to assess sensation, not cognition. In 1889, as director of the first psychological laboratory in France, Binet abandoned sensory tests as an unfruitful means of differentiating changes in the intellectual ability of children. Those interested in developing cognitive tests followed the research insights of Binet (Peterson, 1925).

Wertheimer, Koffka, and Kohler (Peiper, 1963, p.16) working in Berlin during the first quarter of the present century studied visual perception. From their investigations and hypotheses grew the principles of Gestalt Psychology. Kohler (1947, p.5) defined gestalt function as the ability of the organism to respond to a given constellation of stimuli, as a whole, or a gestalt. These units of meaningful information, or gestalt patterns, are perceptually organized within the central nervous system. Thus, specific stimuli can be brought from the background of the sensory fields and organized into structural configurations. This greatly reduces the enormous quantities of sensory stimuli in the environment. Limiting sensory data, or closure, one of the basic principles of the Gestaltists, is the most prominent means of controlling the amount of sensory information received.
Several authors (Strauss and Kephart, 1955) (Werner, 1945, p.51-110) believe that one problem of the brain damaged child is his inability to focus perceptually on meaningful stimuli, separating it from the meaningless background stimuli that surround him. Bender (1938) writes:

There is an innate tendency to experience gestalten (Schilder) not only as wholes which are greater than their parts (Wertheimer, Koffka, Köhler) integrates the configuration not only in space, but in time. Furthermore, in the act of perceiving the gestalt the individual contributed to the configuration. The final gestalt is, therefore, composed of the original pattern in space (visual pattern), the temporal factor of becoming and the personal-sensory-motor factor. The resulting gestalt is also more than the sum of all these factors. There is a tendency not only to perceive gestalten but to complete gestalten and to reorganize them in accordance with principles biologically determined by the sensory motor patterns of action. This pattern of action may be expected to vary in different maturation or growth levels and in pathological states organically or functionally determined.

Wertheimer (1923, p.4) developed a set of nine visual perceptual stimulus designs. The manual copying response to these visual perceptual designs demonstrated the principles of Gestalt Psychology. Bender adapted these figures and used them in a visual-motor test. In developing this clinical test, she established that:

...Gestalt figures are determined by biological principles of sensory motor action and vary depending on (a) the growth pattern and maturation level of an individual and (b) his pathological state either functionally or organically induced. (Wertheimer, 1923, p.5)
Bender assumed that visual perception based on Gestalt principles can:

a. differentiate developmental levels
b. differentiate neurologically impaired from non-neurologically impaired subjects.

The Bender Visual Motor Gestalt Test (BVMGT) has been used extensively to identify children with perceptual problems. Bayley's (1935, p.9) correlational studies have demonstrated the high degree of relationship between general development and visual-motor perceptual function with children. As children become older this correlation decreases.

Thompson (1962, p.264) summarizes:

This trend toward differentiation between intellectual and motor function appears to continue throughout childhood. So-called tests of "intelligence" in the early months of life, of course depend very much on motor processes and this is much less true during later age periods. This may account, in part, for the higher correlations between motor and "intellectual" functions during the early months. Correlations between intellectual and motor variables in late childhood are typically positive but extremely low.

Knobloch and Pasamanick (1960, p.10-31) have shown repeatedly that Gesell Developmental Schedules and other tests of sensory-motor function are most effective for detecting possible signs of cerebral dysfunction in early childhood. By the pre-school and early school years tests of language and perception constitute sensitive indicators.
of the total development of the child. An explanation can be found in Piaget and Inhelder's (1958) contention that at about age seven, the child has the ability to communicate at a higher cognitive level than he had previously through sensory-motor processes. At age seven the child develops from the pre-conceptual and intuitive levels to the conceptual level, where he can reason without dependence upon perception. The child is able to compensate for perceptual problems through cognitive development.

Frostig (1961) has observed the cognitive adjustment of older children to perceptual difficulties. She concludes:

These findings all seem to confirm our impression that development of visual-perceptual processes is the major function of the growing child between the ages of three and seven, and that at this age level perceptual development becomes a most sensitive indicator of the developmental status of the child as a whole. If a child with perceptual disabilities can be detected and specific perceptual training instituted, he might be expected to benefit in toto rather than in perception alone.

Schulberg and Tolor (1961) have shown that the BVMGT is used most frequently when the question of possible neurological impairment arises. Psychologists are more confident in its use for the diagnosis of insult to the central nervous system than for any other purpose. In his comprehensive study of the frequency of test usage Sundberg (1961) found the BVMGT to be the most frequently used test of visual motor perception.

As previously discussed, Bender (1938, p.5) developed the BVMGT to assess neurological impairment as it effects
development. The extensive research in visual perception with the BVMGT (with both non-neurologically impaired and neurologically impaired children) partially explains the instruments popularity among psychologists.

Koppitz (1964) has developed a scoring system for use with the BVMGT based on developmental data. She has shown a lack of agreement and a low reliability between clinical judgements of experts and formal scoring systems. This is especially true in differentiating neurologically impaired from psychotic patients.

Wewetzer (1956) found that neurologically impaired children have difficulty recognizing the total configuration of their perceptions. He also reported that the performance of children on the BVMGT reflected their emotional attitudes. The non-neurologically impaired reacted favorably to the BVMGT. The neurologically impaired found the test to be a difficult and frustrating task. Wewetzer warns against the use of "single indicators" from the BVMGT. If the test results are to be meaningful, it would appear the entire protocol should be evaluated. For this reason, a formal scoring system which incorporates all the error possibilities is most accurate. Studies by Hanvick (1953), Shaw and Cruickshank (1956), as well as Barnes (1950) support Wewetzer's findings. Koppitz's scoring system incorporates BVMGT errors of perseveration, rotation, fusion, distortion, omission, and integration. This scoring system is one of
the better means of separating neurologically impaired from non-neurologically impaired children.

Reviewing eight such studies, Herbert (1964, p.200) reported significant differences between the performance of neurologically impaired children and non-neurologically impaired controls. In review of the research literature the BVMGT

1. is the most popular test of visual-motor perception function;

2. is used to predict neurological impairment in children;

3. tends to classify children homogeneously for placement into classes for the so-called "brain damaged syndrome".

Hunt (1959, p.77) and Shapiro (1962, p.66) both used the BVMGT with populations where visual motor difficulties were not as prevalent as other sensory and perceptual difficulties. These studies report the BVMGT to have poor predictive power. Hunt concluded that visual-motor perceptual problems are only one type of perceptual or motor problem that neurologically impaired children might have. It is possible that populations of children are being defined as "neurologically impaired" on the basis of only one criterion or perceptual test. Hunt (1959, p.77) summarizes:

successful performance by certain children with cerebral damage, on a task which did not penalize them for their disability highlights the futility of trying to present a description of a "typical brain injured child".
It would appear that diagnostic concepts of neurological impairment need to be based on the assessment of all the child's known avenues for learning. The research efforts needed are in the total assessment of each perceptual area of function. One area that has received very limited attention is auditory perception.

Auditory perception

Presently, there is an extensive amount of research in the field of visual motor perception. In contrast, research efforts attempting to study the auditory perceptual functions are limited. To quote Gallagher (1960, p.21), "In contrast to the visual motor area, other areas of sensory perception have been almost neglected."

Bocca and Calearo (1963, p.343) at the University of Sassani summarize an international problem:

The various tests aimed at exploring the central hearing processes are still insufficiently standardized; indeed, we know very little for certain about the modalities and the levels of integration, and each new test may show up some new disorder whose diagnostic value must then wait upon valid confirmation on the theoretical and clinical plane. Some of these tests may be considered truly indicative but since the clinical evidence they provide runs counter to general acceptance is difficult. But the facts are as they are, and they must help us, if not to demolish, at least to revise some particularly rigid ideas which may constitute an obstacle to the further progress of our knowledge in the field.

The development of psychological instruments to measure auditory perception functioning in children has been difficult. The complexities of the auditory sensory-
neural mechanism are evident in the lack of theoretical explanation of auditory perception. Although we are dependent upon auditory perception, we have failed to understand how it functions. Myerson (1956) writes,

We live immersed in a world of sound. It is probable that human beings spend more time in listening than in any other activity and yet we do not know how an individual learns to listen, how this function develops, or the ways in which it is influenced by psychological variables.

The profound absence of research and development of tests to assess auditory perceptual function is verified in reviewing the literature. Karlin (1942) has administered thirty-three tests felt to assess auditory perception. He found eight factors, using the statistical technique of multiple factor analysis, which provide significant correlations between tests. The tests were pitch quality discrimination, loudness discrimination, auditory integral for the perceptual mass, auditory resistance, speech of closure, auditory span formation, memory span, memory of incidental closure, an unidentifiable residual plane. He found no intercorrelations among these tests. Using the definition of auditory perception from this study, the majority of Karlin's tests were of auditory sensation, not perception.

The psycholinguistics model of Osgood (1957) as demonstrated in the Illinois Test of Psycholinguistic Abilities (ITPA) (Osgood, 1963, p.100) is the most extensive theoretically structured test of children's language
function. The ITPA assesses nine abilities hypothesized to delineate three levels of neural functioning. The three levels of neural organization are

a. projection, the level which mediates physiological reflexes,

b. integration, the level which mediates activities of a more automatic or habitual nature including the acquisition of linguistic symbol sequences and response chains, closure, and perceptual speed and the ability to predict future outcomes from past events,

c. representation, the level which mediates the meaning or significant of signs and symbols.

The three language processes expressed in this theory are decoding, association, and encoding. Encoding, as utilized in the Osgood Model, is visual and auditory perception as defined by this author. Osgood (1963, p.100) defines decoding as the reception, integration and intentional selection of input signals.

The development of a diagnostic test battery based on Osgood's Model was started at the Institute for Research on Exceptional Children, University of Illinois. The original test battery, called the Differential Language Facilities, was designed for use at a pre-school level. The test battery was renamed the Illinois Test of Language Ability and used by McCarthy (1957) in a study of the language functioning of cerebral palsied children. Subsequently,
the original test battery was abandoned, and the Illinois Test of Psycholinguistic Abilities (McCarthy and Kirk, 1961, 1963) was constructed for use with pre-school and primary school age children.

In brief, the channels of communication, psycholinguistic processes, and representative level of Osgood's model have been retained. Osgood's integration level, which was subdivided into an evocative and a predictive level, has been replaced by an "automatic-sequential level, which mediates activities requiring the retention of linguistic sequences and the execution of automatic habit chains", (McCarthy and Kirk, 1961, p.3). The nine psycholinguistic abilities which the test was intended to assess are:

I. Tests at the Representational Level

Tests at this level assess some aspect of the subject's ability to understand the meaning of symbols (decoding), to express meaningful ideas in symbols (encoding), or to relate symbols on a meaningful basis (association).

A. The Decoding Tests. Decoding is the ability to comprehend auditory and visual symbols that is, the ability to comprehend spoken words, written words, or pictures.

Test 1. Auditory decoding is the ability to comprehend the spoken words. It is assessed by a controlled vocabulary test.
Test 2. **Visual decoding** is the ability to comprehend pictures and written words.

B. **The Association Tests.** Association is the ability to relate visual or auditory symbols (which stand for ideas) in a meaningful way.

Test 3. **Auditory-vocal association** is the ability to relate spoken words in a meaningful way. This ability is tested with the familiar analogies test in which the subject must complete a test statement by supplying an analogous word.

Test 4. **Visual-motor association** is the ability to relate meaningful visual symbols.

C. **The Encoding Tests.** Encoding is the ability to put ideas into words or gestures.

Test 5. **Vocal encoding** is the ability to express one's ideas in spoken words.

Test 6. **Motor encoding** is the ability to express one's ideas in gestures.

II. Tests at the Automatic-Sequential Level

Tests at this level deal with the non-meaningful uses of symbols, principally their long term retention and the short term memory of symbol sequences.

A. **The Automatic Tests.** The abundant redundancies of language lead to highly overlearned or automatic habits for handling its syntactical and inflectional aspects without conscious effort. So
familiar are we with linguistic structure that we come to expect or predict the grammatical structure of what will be said or read from what has already been seen or heard. In speaking or writing, these automatic habits permit one to give conscious attention to the content of a message, while the words with which to express that message seem to come automatically.

Test 7. **Auditory-vocal automatic** ability permits one to predict future linguistic events from past experience. It is called "automatic" because it is usually done without conscious effort.

B. **The Sequencing Tests.** Sequencing is the ability to correctly reproduce a sequence of symbols; it is largely dependent upon visual and/or auditory memory.

Test 8. **Auditory-vocal sequencing** is the ability to correctly repeat a sequence of symbols previously heard. It is assessed by a modified digit repetition test.

Test 9. **Visual-motor sequencing** is the ability to correctly reproduce a sequence of symbols previously seen.

It is the contention of this researcher that these nine tests do not measure auditory perceptual function.
These tests seemingly do not represent a consistent attempt to determine the skills incorporated in the functions of auditory perception.

Strong (1964) factored 92 variables utilizing computer based factorial analysis. He found that the auditory decoding and auditory-vocal automatic subtests of the ITPA correlated .58 and .51 respectively with the "Brain Damage Syndrome". He found these two tests to correlate even lower with academic achievement. More importantly, when factored for auditory memory, these two subtests correlated the lowest of eight other tests of this skill. The reliability coefficients were in the low forties. None of the other seven subtests of the ITPA correlated well with any criteria.

Hasterok (1964) found that visual and auditory problems as seen in ITPA profiles were unsuited to answering the important question of the relationship between learning problems and perceptual or sensory problems. He felt that children cannot be matched for comparison purposes on the basis of sensory or perceptual problems. In a more realistic sense, the appropriate question was not asked. It would appear that the researcher reporting this study failed to investigate the perceptual complexities that comprise either visual or auditory function.

Hanley (1956) and Solomon (1960) also factored variables which were felt to be responsible for auditory perception. They found some inter-relationships. A review
of their work suggests the factors comprising auditory perception seem to depend more upon the methodology of the study than on determining the specific perceptual functions that comprise auditory perception. The difficulty in studying auditory perception seems to be that more than one perceptual function is present. Wepman (1960) theorizes,

Audition develops sequentially on at least three levels...
(1) Acuity: the ability of the ear to collect sounds from the environment and transmit them to the nervous system...
(2) Understandability: the ability of the central nervous system to extract and interpret meaning from the patterns transmitted to it...
(3) Discrimination and Retention: which permit the individual to differentiate each sound from every other sound and hold each in mind well enough and long enough for the individual to moderate his speech or to make accurate phonic comparisons.

There is agreement in the literature that the initial act of auditory perception is recognition of the sensory stimuli. Coffrey (1955) summates several well known authors on the importance of speech sound recognition as a basic concept underlying auditory perception. He feels auditory perception is the

a. translation of sounds into forms suitable for the nervous system,

b. segmentation into recognizable elements,

c. and comprehension.

When sound is correctly recognized as having meaning by the higher centers of the nervous system, retention of the meaning is possible. The neurochemical means by which the
central nervous system stores or retains previously learned material is still unexplained. A recent study (Brizier, 1962) suggests that memory, like all central nervous system functions, is a chemical process.

The operational measurement of retention has existed in many forms, in a variety of tests. Memory is said to be a factor in intelligence. It is generally measured by either a digit recall or connected word recall response.

Kenura (Melver, 1958) has shown that recall for dichotic digits is a response of the left dominant hemisphere as is all of the language function. Her research indicates that without an intact retention center, the recognition of verbal material is limited. The relationship between recognition and retention as the two functions in discrimination of sensory stimuli is supported by research in prolonged perceptual isolation. Zubeck (1960) found that when male adults were isolated for a week or longer in a dark, sound-proofed chamber their intellectual functions did not change. This impairment of recall, which inhibited recognition, lasted for a day following isolation.

Matzker (1959) found that patients with various types of brain pathology had poor discrimination. Standard audiometric techniques did not reveal hearing loss. The damage to the central nervous system seemingly did impair the auditory function of recognition and retention. Farguhar (1961) working with tests of auditory recognition,
found that "kindergarten children unable to articulate clearly have problems in auditory discrimination ability."
The interpretative or integrative function of auditory perception follows the meaningful recognition and retention of sounds. The two researchers that have written extensively about the integrative function of auditory perception have been Eisenson (1954) and Kephart (1960, p.235).

The problem is differentiating the sensory-perceptual rhythm from motor rhythm. The kinesthetic or motor rhythm is felt to be the "feeling" or out growth of perceptual rhythm (Strauss and Kephart, 1955). Seashore (1926) utilized separate instruments to measure the ability to sense rhythm and to produce coordinated rhythmic body (motor) movements. Eisenson (1954), Kephart (1960), and McCarthy (1964) believe rhythm to be a central language function, not a motor speech response. The interpretative function is supported in view of the language process. It is evident that central language is distinctly separate from expressive motor speech. There are children referred to as having central language difficulty; they can understand the symbolic meaning language but do not have expressive motor speech.
The importance of the temporal order of speech is described by Strauss and Kephart (1955, p. 81).

Certain of these sounds come to have a particular significance since they are commonly used in our language. The forms of language are made up of small typical units sounds which in themselves have no meaning but in certain customary arrangements make up the meaningful forms that are uttered. . . . Sounds are combined into words, and words are combined into phrases and sentences. Such combinations are the temporal series or units to which meaning is attached. A new perceptual task is introduced in going from single sounds to words or sentences. Sounds in words or sentence units must be analyzed and integrated throughout the central nervous system, following recognition and retention, in order to be given meaning appropriately. Each sound is given meaning by the central nervous system. The sound conveys information that arouses meaning.

Thus far, in this paper, three distinct perceptual functions have been described: (1) recognition, (2) retention, and (3) integration. Each of these functions contributes to the understanding of auditory perceptual information. Comprehension of auditory information is dependent upon -

1. the recognition of the words as meaningful units;
2. the retention of the recognized information;
3. the integration of meaningful language units into symbolic relationships to be comprehended.
Comprehension represents the final stage of auditory perception. Essentially, it is the ability of the learner to utilize auditory perceptual information meaningfully. This final complex act suggests that the sound stimuli coded for neural transmission has been processed by each of the distinct auditory perceptual functions already described. Auditory comprehension is the transient stage between perception and cognition. It is the development of a conceptual unit of information that has meaningful associations for the learner. Comprehension is the symbolic learning of language concepts. To know this symbol auditorily, enables the learner to attack many significant concepts of meaning to this one stimulus signal.

In reviewing the research in visual and auditory perception, it has been established that test development in visual perception far exceeds that in auditory perception. The next two sections of this chapter shall attempt to discuss the theoretical knowledge in explanation of auditory perception and the meaningful reception of language.

A neurological review of language reception

The four auditory perceptual functions that were specified in the above sections of the chapter are based upon a neurological model of auditory perception. This model assumes that language perception can be understood by knowing the impairments that occur.
This section shall attempt to discuss the theoretical implication of the neurological model. Chapter III will specify the materials used in assembling the experimenter test of auditory perception.

The neurologist Nielson (1962) has shown that damage in specific cortical loci or lesions causing neural dissociation between cortical loci give rise to four distinct receptive language impairments. He attributes language function to the association among the following four cortical areas:

1. Wernicke's Area of the temporal lobe (Areas 41 and 42 of Brodmann) is associated with the recognition of spoken language. Understanding of spoken language is developed in the temporal lobe in Areas 21 and 22. A destructive lesion in these areas can result in an auditory-verbal agnosia.

2. Broca’s Area in the frontal lobe (Area 44) contains the engrams for the memory of the motor patterns of speech. A lesion in this area causes a motor aphasia.

3. Area 37 and the posterior part of Area 21 of the temporal lobe are related to the recall of names and words, and also to language formation. Lesions in these areas may cause anomia, amnesic aphasia and formulation defects.

4. Angular Gyrus (Area 39) of the parietal lobe is associated with the visual recognition of the symbols of reading, writing, arithmetic, and others. A lesion in this area may result in varied combinations of alexia, agaphia, and scaldula.

It appears that there are four distinct auditory perceptual functions associated with the development of
meaningful language. When all areas function in a synchro-
ized manner, the result is the comprehension of aural lan-
guage.

In the cortex the neurological associations for audi-
tory perception are assumed to take place in the temporal
lobe. Areas 41 and 42 lie below the lateral fissure but
well within the superior temporal region. These loci are
supposedly responsible for the recognition of speech.

Following recognition, association is dependent upon
previous learning. If this association elicits a response
then retention and the memory processes are functional.
Auditory integration is felt to be accomplished by Areas 21
and 22, and Area 37. A section of the central nervous
system cranial to the lateral fissure (Area 44), the motor
speech area, is responsible for motor patterns of speech.

The Angular Gyrus (Area 39) (Chusid and McDonald,
1964, p.13) of the parietal lobe permits abstraction of the
auditory signal. In the temporal gyrus, Area 37, (p.13)
have been shown to be associated with the meaningful com-
prehension of language.

Auditory comprehension is the mediated use of
language within the central nervous system. When a child
hears a story read by his teacher he must:

1. recognize the sound elements as meaningful
information;
2. retain these units of information;
3. associate or integrate their symbolic relationship as language concepts.

In doing this he can comprehend the story and answer the teacher's questions about the story. In answering the questions using his own language concepts, he has comprehended the meaning of the teacher's story.

A child may hear speech sounds if areas of the central nervous system incorporated in auditory perception are damaged. However, his ability to recognize, retain, integrate, or comprehend auditory sensations as meaningful may be impaired. It is not satisfactory to assess the highest single perceptual function and assume specific understanding of the simpler perceptual functions. Each stage or level of function in the perceptual hierarchy must be examined separately if complete understanding of an existing auditory perceptual problem is to be found. Luria (1964) summarizes the need for complete assessment:

It becomes completely understandable that a higher mental function may suffer as a result of the destruction of any link which is a part of the structure of a complex functional system and consequently may be disturbed even when centers differ greatly in localization. However, and this is especially important when one or another link has been lost, the whole functional system will be disturbed in a particular way and symptoms of disturbance of one or another higher (mental) function will have a completely different effect, depending on the localizations of the damage. From this it should be clear that local damage of the brain cortex should not be related to a symptom (which might be of multiple significance.
and might have been worked by damage in various locations but to a factor which leads to the origination of a symptom.

Luria's statement suggests that tests of perception need to be developed which assess each specific perceptual function. It would probably be simpler to develop a single test to assess the most complex act of auditory perception. The assessment of the most complex perceptual function informs an examiner of the presence or absence of an auditory perceptual problem. It does not provide descriptive information as to the exact level of perceptual difficulty.

Educational evaluations depend upon specified information and the degree of development present in any perceptual function. Haeussermann (1958, p.119) writes,

Impairment of auditory functioning is not limited to our fictional child with cerebral palsy but will be found to exist also in non-handicap and in retarded children. A thorough knowledge of patterns of hearing behavior, of kinds of impairment in auditory functioning, and of the manifestations and ramifications of deviations is invaluable for any examiner of young children. It will help him in spotting subtle difficulties early. The importance of this aspect of the educational evaluation cannot be stressed too much. Unlike adults, who have known normal functioning in a given area, children who are handicapped from birth, cannot be expected to be aware of a lack or a deviation in their functioning. They are not yet able to realize that not everybody has the same difficulties by the use of the items of the evaluation and by his educated observation. That is why it is not enough to note the correctness or incorrectness of a performance alone, without noting the functioning pattern of the young organism as he mobilizes himself to respond.
To paraphrase Haeussermann, to know the correctness or incorrectness of a human performance is not enough. In order to plan special teaching techniques for any child, the evaluation or assessment must recognize all the functions that comprise a mode of learning. Specifically, the auditory perceptual process can be viewed as having four distinct functions. These four functions may be related to developmental functions as well as cortical loci in the central nervous system. The anatomic association between loci may indeed account for the actual perceptual functions.

Luria (1961, p.4-6) has recognized the interplay of localized cerebral involvement. He writes,

As contemporary neurological research has shown, even such elementary processes as skin or visual sensitivity or such phenomena as the knee jerk reflex have complex structures and many stages of localizations based on hierarchically structured "centers" (I.N. Felemonov, 1945; therefore disturbances of these functions can be accounted for by the destruction of different links in the system and as a rule are symptoms of multiple significance, the local significance of which may be made exact only as a result of special neurological analysis.

As was shown in the classical research of L.S. Uygotski (1956) and then in A.N. Leontiev's (1959) higher mental functions are the result of complex social-historical development. They are formed under the influences of peoples's concrete activity in the process of their communication with each other and in fact always represent complex functional systems based on jointly working zones of the brain cortex.

Luria has dissolved the difficulty that has surrounded the misconceptions that brain function is either totally associated or totally isolated in function. It
would appear that the brain can be damaged at levels that could cause difficulty in any one area of perception. The brain could be damaged in such a manner that above a functional level only specific kinds of learning skills would be inhibited. Moreover, it seems reasonable to conclude that neurological impairment is not similar in any given population of neurologically impaired children.

A theoretical review of auditory perceptual functioning

The neurological model basic to the development of the experimental test may be clarified by tracing neurally coded auditory sensations through the central nervous system. The sensation begins at the peripheral organ of hearing (the outer ear) and follows the auditory tract until it arrives at the level of final perceptual function.

Sound is the stimulus necessary to activate the organs of hearing. Under normal circumstances the aid in contact with a vibrating surface moves in a wave-like motion. These sound waves move in a pattern similar to the waves transmitted outward in a still body of water when disturbed by a foreign object, such as a rock.

Newby (1961) describes the production of sound waves:

...the air particles adjacent to the vibrating source are set in motion by the movements of the sound source. The moving particles next to the sound source in turn set the particles adjacent to them in motion. Thus the motion of each particle affects the position of the particle next to it, and a wave of particle movement
emanates in all directions from the vibrating source proceeding outward in concentric spheres at a set velocity which is determined by the temperature and density of the air. Under "standard" conditions of temperature and density, as defined by engineers, this particle displacement proceeds at a velocity of about 1100 feet per second.

Hearing is the process of neural coding sound stimulus for transmission as auditory sensations. Auditory sensation is dependent upon five processes.

1. The pinna of the external ear directs the sound into the auditory canal where it impinges on the tympanic membrane (eardrum).

2. The vibration of the tympanic membrane is passed through to the ossicular chain (incus, stapes, and malleus) of the middle ear which connect the eardrum of the outer ear with the fluid chambers of the inner ear.

3. The vibration of stapes in the oval window of the cochlea creates a hydraulic effect upon Reissner's Membrane. This hydrostatic pressure is transmitted through the oval window of the cochlea.

4. The hair cells and the tectorial rod are brought into contact by the hydrostatic pressure on the membrane of Reissner, thus initiating neural impulses.

5. The neural impulses are carried by the eighth nerve to the inferior olive, a portion of the thalamus brain.
Taylor (1964) has prepared an excellent review of the auditory pathways within the central nervous system.

His review begins:

The eighth nerve enters the brain stem at the medulla. Here the cochlear fibers divide into ascending restral and descending branches. After the divisions all the fibers are arranged in parallel bundles. The ascending fibers go to the dorsal nucleus but they also send short collaterals to the intermediate regions.

...The cochlear nuclei are described as having two parts, the dorsal cochlear nucleus and ventral cochlear nucleus.

Rasmussen has described a tract called the olive-cochlear bundle and belonging to the efferent auditory system. The fibers arise near the contralateral superior olivary region, cross the midline and reach the cells in the dorsal cochlear nucleus. These fibers leave the medulla between the two main branches of the vestibular nerve to reach the cochlear nerve. It is speculated that the fibers end in the outer and inner hair cells.

All these fibers pass upward toward the inferior colliculus. The main part of the fibers of the lateral lemniscus should in fact be relayed in the inferior colliculus and only a minor part which has been relayed in the superior olivary complex should pass on directly to the medial geniculate body which relays fibers from the cochlea.

From the medial geniculate body run axons to form the auditory radiation and reach the auditory cortex in the temporal lobe.

...It has been established that collaterals from all known sensory systems enter the central core of the brain stem reticular formation and that here a multisynaptic pathway is formed over which impulses are conducted to wide areas of the cortex.

From the medial geniculate bodies fibers radiate via the posterior third of the occipital part of the internal capsule together with sensory fibers of the optic radiation to reach the posterior three-fifths of the superior temporal gyrus and traverse temporal gyri.
The neurological model of the experimental test of auditory perception assumes the central nervous system in man functions in an associated manner.

As the human nervous system matures it first is capable of distinguishing stimuli. The afferent neural network presents information, upon being coded in the senses, at the central nervous system. The process of learning is initiated in the meaningful recognition, of this incoming sensory data as the perceptual process is begun.

The next phase is the retention of meaningful material in such a manner that storage for recall is possible. Mark (1962, p.79) has related the importance of memory as a feedback system to the meaningful integration of language.

The integration or association of perceptually recognized and stored material is well described by Meyers (1961, p.538). He believes that local areas of the brain are responsible for specific functions, but that the isolated functions do not contribute to higher learning until the localized functions of recognition and recall are integrated. Integration is the process by which the learner organizes previously learned material into meaningful units. Strauss (1955, p.81) and Goldstein (1939, p.260-261) both state that the integrative perceptual process is basic to recognizing the rhythmic units of sound.

The perceptual process next being assessed is comprehension. Comprehension requires that the auditory perceptual function be incorporated into a new response dimension.
To comprehend is to organize perceptual responses in a plane of abstraction that permits the development of new language concepts.

Comprehension is difficult to distinguish from cognition. It is undoubtedly the highest level of perception. Comprehension results in the use of all the perceptual processes so that learning and new concepts can be formed. Cognition is not dependent on auditory sensation to initiate novel responses as is auditory comprehension.

The historical overview and related research in this chapter show that psychologists depend upon visual motor perceptual tests diagnose neurological problems in children. The obvious reason is that numerous research efforts have been attempted in visual motor perception. This chapter shows that the research in auditory perception is scant and possibly even unreliable because of limited theoretical understanding. A neurological model has been developed upon which the assembling of the auditory perceptual test to be used in the study shall be based. Chapter III discusses the experimental instrumentation to be used in the design of this study. Included in methodological representation of Chapter III will be a description of subjects, their selection and matching, the instructions and procedures used with the experimental test, and the means of collecting data.
CHAPTER III

METHODOLOGY

In the first two chapters the predominant finding has been the limited research and theoretical understanding of auditory perception. Clinically and theoretically, auditory perception as an established concept lags far behind visual perception. Psychologists are dependent upon visual perceptual tests to identify neurologically impaired children. There are no commercial test batteries of auditory perception known to this researcher.

Therefore, it is the purpose of this study to assemble a Test of Auditory Perception. The following problems were raised as a result of this study. What is the ability of the auditory perceptual test to:

1. Differentiate experimental (neurologically impaired) subjects from a matched population of control (normal) subjects?

2. Discriminate four different stages or levels of auditory perceptual functioning according to a theoretical model?

3. Assess a different perceptual function in relationship to that function assessed by the Bender Visual Motor Gestalt Test?
4. Distinguish auditory perceptual patterns of strengths and weaknesses, when the test is (1) administered under normal testing conditions, and (2) administered in a controlled condition of background noise.

5. Differentiate neurologically impaired subjects under conditions of background noise, further determining the mean difference effects of background noise, administered as a controlled variable, between the subtests' scores of the Test of Auditory Perception?

General design

The Test of Auditory Perception identifies four perceptual functions and contains six subtests:

1. Recognition
   1a. Recognition of sounds
   1b. Recognition of words

2. Retention
   2a. Immediate memory for digits
   2b. Immediate memory for speech

3. Integration
   3a. Rhythmic structures

4. Comprehension
   4a. Aural comprehension of stories

The assembly of the test was based upon a neurological model of receptive language function, following a study of auditory perceptual problems, in brain damaged World War II veterans. According to the theoretical model, auditory
perceptual function has specific stages of development.
Each of these stages builds in hierarchical fashion resulting
in auditory comprehension. Difficulties in any stage of per-
ceptual function will result in perceptual problems, not
only at that stage, but in the final utilization of per-
ceptually received information.

The Test of Auditory Perception was administered
under two controlled conditions, on two different adminis-
trations. The test was administered once using normal
testing procedures; background noise was introduced as a
distractor during the second administration to determine the
effects of ambient noise on auditory perception.

Data were collected on both test administrations of
the Test of Auditory Perception (TAP) and from the adminis-
tration of the Bender Visual Motor Gestalt Test (BVMGT). These data provided information as to the ability of the test
scores (both the BVMGT and TAP) to discriminate neurologi-
cally impaired (experimental) subjects from normal (control)
subjects. The subjects were matched on: (1) sex, (2) years
in school, (3) chronological age, and (4) verbal intelli-
gence.

The hypotheses pertinent to the design of the
study are:

Hypothesis (I): There is no significant differ-
ence between the scores on the Test of Auditory Perception
for the
Hypothesis (II): There is no significant difference between the scores on the Test of Auditory Perception for the experimental (neurologically impaired) and control (normal) subjects when the tests are administered under conditions of background noise. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.

Hypothesis (III): There is no significant difference between the means of the auditory perceptual subtest, when the tests are administered under normal testing conditions and under conditions of background noise. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.

Hypothesis (IV): There is no significant difference in the relationship between the various subtests of auditory perception for: (1) the experimental population, (2) the control population, and (3) both populations.

Hypothesis (V): There is no significant difference in the relationships between the scores obtained on the Bender Visual Gestalt Test and the subtests of auditory perception for: (1) the experimental subjects and (2) the control subjects.

Hypothesis (VI): There will be a higher incidence of experimental subjects with auditory perceptual problems (assessed by the TAP) than those having visual motor perceptual problems (assessed by the BVMGT) when assessed under: (1) normal testing conditions and (2) conditions of background noise.
Description of the subjects

Selection criteria

Thirty children with known neurological insult were the experimental subjects. The experimental subjects were children who have been investigated and described as demonstrating "minimal" neurological damage, (Clements and Peters, 1962), (Strauss and Kephart, 1955, p.81) and (Clements, 1963).

The diagnosis of neurological impairment of a "minimal" degree is made when gross signs are not observable, but where discrepancies are found in:

1. a study of pre-natal, natal, and early development.
2. physical or behavioral development.
3. proprioceptive, perceptual and behavioral differences from normal, noted by pediatric neurological examination (including electroencephalography) and psychological examination.

The experimental subjects were selected on the basis of extensive evaluation by (1) a pediatrician, (2) a psychologist, and an (3) audiologist. This researcher did not serve as a member of the selection team.

An equal number (n=30) of the control subjects were selected on the matching criteria indicated on the following page. The control subjects had no known neurological damage. Neither the experimental nor control subjects had gross motor, speech, language, orthopedic, or epileptic involvements.
All the subjects selected:

1. Ranged from six to twelve years of age.
2. Were free of chronic illness or health problems which could interfere with their test performance at the time of study.
3. Demonstrated normal growth and development as was indicated by school and medical records.
4. Were normal in intelligence (I.Q. 85 or above) as shown on verbal tests of intelligence.
5. Were free of anxiety states or behavioral reactions that might interfere in personal-social relationships.
6. Were not known to have visual or refractory problems.
7. Were pretested and found to have normal audiometric findings.
8. Were not utilized as subjects, if they had been diagnostically screened on the BVMGT.

Matching Criteria The thirty control subjects were matched with the thirty experimental subjects on the following criteria:

1. Chronological age. The children ranged in age from six years to twelve years, five months with a mean of eight years and three months for the experimental subjects and eight years and nine months for the control subjects.
2. Years in school. The experimental and control subjects both spent an average of three years in school.

3. Sex. The number of boys and girls were almost equal in both populations.

4. Verbal intelligence. The two groups of subjects were selected on measures of verbal intelligence evidencing ability to abstract language within normal limits.

Table 1 shows the comparison values in each criteria used for matching. The results of the table indicate that the subjects were not significantly different on the matching criteria of intelligence or chronological age. A close approximation was established for years of training and sex. A difference of one subject also was obtained between the experimental and control subjects on the matching criteria of sex.

**TABLE 1**

MATCHING CRITERIA FOR THE EXPERIMENTAL AND CONTROL SUBJECTS SHOWING MEAN VALUES RANGE OF VALUES AND STATISTICAL DIFFERENCES

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Range</th>
<th>Mean</th>
<th>Years in School</th>
<th>Mean Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chronological Age</td>
<td>B</td>
<td>G</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In Years and Months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Verbal</td>
<td>Mean</td>
<td>Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intelligence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                  | 8.3* | 6 to 12-5 | 3.4 | 19 | 11 | 105.5 | 87-130 |
| Experimental     |      |           |     |    |    |        |        |
| Control          | 8.9* | 6 to 12-4 | 3.7 | 18 | 12 | 106.9 | 88-133 |

* Not significant at the .05 level (t=2.211)
** Not significant at any level (t=5.087)
Subject selection  From the results of Table 1 it seem permissible to assume that any difference in perceptual functioning between the experimental and control subjects was not influenced by factors of age, sex, years in school, or verbal intelligence. On all these factors, the control and experimental subjects may be regarded as similar.

All the experimental subjects were examined pediatri-cally concerning a neurological problem. Psychological assessment was added either at the time of the original diagnosis or when these children became possible candidates for this study. The audiological and other consults were also obtained following initial psychological screening.

All of the experimental subjects had been diagnosed in the Children's Hospital and were followed there medically. Many had been placed in the neurological classes of the Columbus Public Schools. The majority of the control subjects were examined in the hospital where they were screened as candidates for this study. A few were private patients whose medical records revealed non-significant pediatric (including neurologic) findings as well as normal developmental histories.

Only four electroencephalograph (EEG) tracings showed localized components. Three EEG tracings showed spiking of localization potential in the temporal parietal areas of the cortex. One subject displayed spiking in the occipital areas. The remainder of the population had "generalized cerebral dysrhythmia with no proximal components".
The records were inconsistent in reporting the frequency patterns showing significant spiking. Generally the six and fourteen cycle per second patterns were the ones most affected. The EEG tracings were not all administered under the same conditions; some were awake tracings and some sleep tracings.

The developmental histories indicated that thirteen of the experimental subjects had had encephalitis or meningitis. Ten of the experimental subjects had had California Encephalitis.

One of the subjects had had a severe fall at the age of two years. Two subjects had had high fevers for prolonged periods of time; one child had had a prolonged birth. Two mothers reported blueness in their babies at birth and two mothers reported the use of prolonged anesthesia during delivery. The problems associated with prenatal development range from the "spotting" of blood during pregnancy to kernicterus and rubella.

If commonality was lacking in etiology, the resulting sequelae was even more inconsistent. Most of the children were initially referred because of school problems. Twenty-four children were known to the schools as behavior problems primarily associated with hyperactivity or poor attention span.

The gross neurologic signs were not significant in most cases. Pediatric neurological examination revealed three boys to have leg clonus. One boy had a very slight
left hemiplegia. Several children showed poor digital pre-
prioception and finger localization. It was reported that
four subjects had been known to have "staring spells".
Three children reported early febril seizures and two chil-
dren had histories of seizures while they were younger. The
developmental histories of the experimental subjects gener-
ally showed pathological discrepancies.

None of the control subjects had abnormal develop-
mental histories. The medical records of the control sub-
jects reported no profound physical or behavioral problems.
The psychological reports on the control subjects did not
mention any perceptual problems.

Instrumentation used in the study

Assembly of the experimental instrument. The Test of
Auditory Perception was assumed to assess four specific per-
ceptual functions based upon a neurological model of language
reception.

The neurological model of auditory perception estab-
lished four auditory perceptual functions: (1) recognition,
(2) retention, (3) integration, and comprehension.

A description of each of the perceptual functions and
the tests utilized to assess the specific functions for each
of the areas:

1. **Auditory recognition** is the meaningful
recognition of sounds and words. The subtests used to deter-
mine auditory recognition

1b. The Huelsman Oral Word Discrimination, form B (Huelsman, 1949). This test requires the subject to distinguish a meaningful word presented aurally from five non-sense words.

2. Auditory retention is the recall of connected units of language. After speech sounds have been recognized, they must be retained if further association of their meaning is to take place.

2a. The immediate rote recall of digital units, memory for digits, was taken from the Illinois Test of Psycholinguistics Abilities (McCarthy and Kirk, 1963). The directions were altered to a pointing response of graphic number representations as in the Nebraska Test for Young Deaf Children (Hiskey, 1941).

2b. The immediate meaningful recall of words, memory for connected speech, was based on the Sentence Memory Test (McCarthy and Olson, 1964) which demonstrates a test-retest reliability of .65.

3. Auditory integration is the ability of the listener to bring together disassociated auditory stimuli. The integrative function of language has been shown to be most closely approximated by having children reproduce rhythmic patterns.
3a. Stambak has developed a test of Rhythmic Structures (Stambak, 1965). The child was requested to duplicate tapping responses to pre-recorded patterns.

4. Auditory comprehension is the sum ability of the child to receive, associate, express, and interpret units of language. It is the final complex auditory perceptual act based on all the functions previously established.

4a. The test of auditory comprehension was the listening comprehension section of the Durrell Analysis of Reading Difficulty (Durrell, 1955, p.8) administered aurally.

The test material compiled in the study was not used as had been intended by the developing author(s). Either the methods of response, or the methods of presentation were altered for the purpose of assessing auditory perception. The subtests were presented in the simplest possible manner in order to make the test an uncomplicated measure of auditory perception. The difficulties of assembling such a test were:

(1) The perceptual stimuli must be received solely by the auditory mechanism and not by other sensory systems.

(2) The response mechanism should not become complex or the perceptual measurement may be of the subjects motor response, rather than that of the perceptual intake system intended.
Standardized instrumentation: The Bender Visual Motor Gestalt Test

The subjects were administered the BVMGT (Bender, 1938) as a measure of visual perception. This test consisted of nine figures which were presented one at a time and which the subject was asked to copy. The Koppitz Developmental Scoring System (Koppitz, 1964) was used as a means of providing an objective measure of visual perception. The Koppitz Scoring System identifies BVMGT errors of (1) rotation, (2) fusion, (3) perseveration, (4) failure to integrate, (5) angulation, and (6) loss of design. Test-retest reliability has been determined from .88 to .96 showing significance at the .001 level.

The BVMGT scored according to Koppitz, was utilized as the test of visual perception because

1. It shows high reliability and validity in evaluating visual-motor perceptual development.

2. It has shown to be the fourth most popular test (Sundburg, 1961 p. 83) used by psychologists and the most popular test of visual motor perception.

3. It is the most frequently used diagnostic screening instrument for school age children suspected of being neurologically impaired.

The BVMGT assesses several visual perceptual errors in copying response; it does not assess many functions of visual perception. The only complex battery of visual
motor perception is the Frostig Test of Visual Perceptual Development (Frostig, Lefever, and Shittlesey, 1961). The Frostig test could not be used in this study because the norms did not extend into the age ranges of the subjects being assessed.

**Construction of the experimental test**

The tape recording of the experimental test was made on electro-magnetic tape. The original recording was made by placing the tape recorder (Wallensak-T-1500) into a sound-treated chamber (Industrial Acoustics Company, Model 1402). The stimulus input was established at sixty decibels and was controlled through a volume unit meter on a Beltone Console Audiometer, Model 15-A. The level of stimulus input was recorded at a pre-determined level on the tape recorder. The output levels were determined by playing the test tape and identifying the levels of sound intensity differences on the tape recorder volume switch. Thus, by knowing the level of recorded input a test tape was made in such a manner that it could be played back on the same tape recorder at known levels of output. The original test tape recording was made with a known output, free from any interfering noise in the background.

The second test of auditory perception involved the recording of controlled background (classroom) noise. The test tape of noise was made by replaying the original test
tape and recording it through a free field on a second recording. Two sources of controlled input were needed. The test stimulus signal was played through one console audiometer (Beltone Model 15-A) as before. Simultaneously, the background noise was introduced through a second Beltone Console Audiometer (Model 15-A) into the free field of the tape recorder.

Classroom noise was initially recorded during a regular school day in a first grade classroom. The initial measures of the noise in the classroom during the recording was sixty-six to eighty-nine decibels, (Sound Level Meter, Type 1551-C, General Radio Co. C-Scale). The test stimulus signal going through one audiometer had an input of sixty decibels. The classroom noise input through the other audiometer was at fifty-four decibels. The background noise was recorded at a reduced level of loudness.

The signal to noise ratio was 60/54 decibels. This has been shown by one researcher (Licklider and Miller, 1951 p.1049) to be the lowest limit at which noise interferes with a stimulus signal on adults. To this researcher's knowledge, the point at which the stimulus signal is distorted by background noise is unknown for children.

It seemed scientifically reliable to establish a signal-to-noise ratio of 60/54 decibels when:

1. The noise level was less than the recorded classroom noise.
2. The noise level was less than the actual sound level of the classroom.

3. Previous research with adults indicates that a range from 4 decibels below to 18 decibels above the stimulus signal does not reduce the meaning of the stimulus signal.

The background noise was used as one criterion measure. It was not the test but a variable to be controlled in order to research the effect of such a distractor as classroom noise in the background of auditory stimuli being presented to both normal and neurologically impaired children. It was felt by this researcher that neurologically impaired children would have a great deal of difficulty in obtaining auditory perceptual information when it is surrounded by classroom noise. Therefore, the Test of Auditory Perception with noise could be an excellent discriminator of children with neurological impairment.

Experimental testing procedures:

*administration of the Test of Auditory Perception*

The children serving as subjects were tested individually. The testing was carried out in time blocks of ten to fifteen minutes. Rest or play periods served as intervals between the three blocks of time necessary for completion of the testing. A total time for all the subtests in the auditory perceptual battery was twenty to forty-seven minutes including the instructions and examples.
The two tests of auditory perception were administered on different days. Both tests, the one containing noise and the one free of noise, were similar in test content. Therefore, it was necessary to randomize the administration of the tests among the subjects.

An interval of two weeks elapsed between the administration of the two tests to reduce any positive transfer. This has been shown to be a period of maximum human forgetting (Robinson, 1961 p.23).

The TAP including the background noise, was administered the first subject. This usually took three separate periods of testing. After two weeks, the test without background or ambient noise was administered. For the next subject, the test without background or ambient noise was administered first. This alternating procedure was utilized first among the experimental subjects; then an identical procedure was utilized for the control subjects.

All of the testing took place under the same rigorously controlled conditions. The subjects were accustomed to the examining room. They had been there during previous psychological assessment. The room used was quiet, being sound treated and having no window openings to the halls and streets. The noise level of the room was established at an average of 56 decibels (sound pressure) for a twenty four hour period.
The sound level recording of the room was made on a sound-level meter (General Radio Company, Model 1351-B) and recorded on a sound-level recorder (Brul-Kjaer, Type 1375). The sound-level meter was used with a slow needle response on the C-scale. The paper speed of the sound-level recorder was .003 millimeter per second.

The children were seated comfortably at a table. The tape recorder was placed immediately behind them, so as not to distract them. The directions were given for each section of the Test of Auditory Perception on the recording. An example of the directions for each test appears in this chapter. Examples were given with each section and other examples were read to the subjects until they fully comprehended what was expected.

The speaker of the tape recorder was placed at a distance of three feet behind the children. The recordings were played at a constant level of sixty decibels. This was determined by knowing the level of output. The tape recorder was experimentally tested for sound intensity output differences. The differences were marked on the recorder output volume control unit. The output was determined by playing the experimental tape at a distance of three feet from the microphone of the sound level meter type 1551-C, General Radio Co., C-Scale (.0002 dynes per square centimeter).
The use of a tape recorder for the administration of standardized tests has not received a great deal of emphasis. One recent article in the *Journal of School Psychology* (Mowers, 1965) lists several reasons for using tape recorded instructions with group tests. A conspicuous reason mentioned was the uniformity of instructions. While the author was careful to emphasize the need for completely uniform test directions, he failed to mention the importance of controlling the intelligibility of the stimulus signal.

The tape recorder as a means of administering the tests of auditory perception is important. It provides precise control of the stimulus signal or the test materials being presented each subject. Through the use of tape recorded instructions, the test instructions were also controlled for each subject. This means that every subject received the same instructions and stimulus signal for all the tests of auditory perception. Trained technicians did the testing. This was done to reduce any experimenter bias.

**Instructions for the Test of Auditory Perception**

The instructions were tape recorded. Following the instructions for each subtest, examples were presented. If the subjects did not comprehend the recorded examples, additional examples were given by the examiner. A written description of the instructions for each subtest is given in the appendix (Appendix A).
Administration of the Bender Visual Motor Gestalt Test

The BVMGT was administered by placing a test card in the upper left hand corner of an 8½ by 11 inch sheet of plain white paper. The card and paper were both held in position in such a manner that the subjects could not turn them. Subjects were not permitted to redraw any design or correct for cues. The first drawing was the one accepted to be scored.

The subjects were administered the BVMGT while sitting at a table adjusted to fit them. The test was not timed and there was no verbal prompting.

The pencil was a hexagon shaped, number two lead. As with the Test of Auditory Perception, trained technicians collected the BVMGT data before the initial auditory perceptual test was administered.

Collection of the data

Each subtest comprising the Test of Auditory Perception was scored for the number of correct responses. An example of the scoring record blank appears in the appendix (Appendix B). Each item could be scored easily since it was either completely correct or it was recognizably wrong. The precaution of not using speech impaired children was taken, therefore avoiding problems in scoring this test.

The test of visual perception was scored according to a system developed by Koppitz (1962). This system
accounts for a total of twenty-five possible errors from the nine test cards.

The normative data obtained according to the Koppitz Developmental Scoring System was used to score the BVMGT. It appears in the appendix (Appendix C). Koppitz (1964, p.1) predicted that children normal in intellectual development, performing at a year or more below a normal development level in visual motor perception (BVMGT) will probably have difficulty in school. A child functioning at minus one standard deviation below the mean level for his age group is functioning approximately at one and one-half years below the mean in visual motor perception. Koppitz believes that this is a significant criteria in determining the possibility of brain damage. Therefore, the criterion cut off used with the BVMGT was the minus one standard deviation (-1 S.D.).

The experimental Test of Auditory Perception has not been standardized on a normal population. The control subjects in this study served in this capacity since they represent a sample of children from chronological age six through twelve years with no known auditory impairments.

The same criteria cut off was used for the Test of Auditory Perception as that used with the test of visual perception, the minus one standard deviation (-1 S.D.). If this criteria or cut off score is used for the experimental subjects, then the frequency of subjects known to be neurologically impaired and discriminated by both the test
of visual perception and the various subtests of auditory comprehension can be determined. A discussion of these results will follow in Chapter Four and Chapter Five. The developmental scoring used with the Test of Auditory Perception is shown in the appendix (Appendix C).

The present chapter presented the general design of the study, the description, selection, and matching of subjects, the experimental instrumentation, and method for data treatment.

The chapter to follow presents the statistical analyses of the data necessary to make possible the acceptance or rejection of the null hypotheses.
CHAPTER IV

TREATMENT OF DATA, DISCUSSION, AND CONCLUSIONS

This chapter presents the null hypotheses with the data, discussion, and conclusions concerning each hypothesis.

Analysis of the data

The statistical procedures of t-test (Fisher) and multiple correlation were used to treat the data. The statistical programming was completed on an IBM 7094 with the cooperation of the Statistical Laboratory and Computer Center, The Ohio State University, Department of Mathematics.

The basic measures were in raw data. This permitted inter-group comparisons to be made without assignment of mathematical weights or standard scores based on a population not a part of the original study. The value of using raw data as the simplest most apt means of data treatment has been discussed by Boneau (1965, p. 62).

The problem (P) was to determine if a subject belonged in the experimental or control population on the basis of the test. The t-tests were employed to determine if the tests differentiated among the children (subjects) placing the
experimental or control subjects into the proper pre-determined groups. The statistical problem is to have the test discriminate the subjects and not the subjects the test, the test being the variable that is changed or manipulated by the experimenter, the independent variable. The value earned by the test \((X)\) was employed to calculate the probability that a score of that magnitude was dependent on the test. If the \(t\) is significant, the answer is positive. The test score does assign the child to the experimental population because of its magnitude. If the \(t\) was not significant the test score was not statistically different to permit a subject to be placed in the experimental population. The formula is:

\[
P(X) = \frac{B_0}{B_1 X}
\]

The correlational method determined the significance of relationship between the TAP subtests and the BVMGT in assigning a child to one population or the other. The BVMGT \((Y)\) and the Auditory Perceptual Subtest \((X)\) were compared by inserting the values for:

\[
Y = \frac{B_0}{B_1 X}
\]

Relationships were determined when the value \((X)\) exceeds the value \((Y)\) at an appropriate level of confidence. Information pertaining to the mean, standard deviation, and sum of squares necessary for deriving the \(t\)-test values for the Test of Auditory Perception and the Bender Visual Motor Gestalt Test is shown in Table 2.
### Table 2

**Summary Table Showing Mean, Standard Deviations, and Sum of Squares for the Subtests of Auditory Perception and the BVMGT for the Experimental and Control Subjects**

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Sum of Squares</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recognition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sounds</td>
<td>13.4</td>
<td>6.9</td>
<td>2.4 3.6</td>
</tr>
<tr>
<td>Words</td>
<td>37.6</td>
<td>9.6</td>
<td>13.1 9.2</td>
</tr>
<tr>
<td><strong>Retention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digits</td>
<td>12.9</td>
<td>7.7</td>
<td>3.5 2.6</td>
</tr>
<tr>
<td>Sentences</td>
<td>32.5</td>
<td>9.9</td>
<td>15.9 6.1</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>8.4</td>
<td>14.5</td>
<td>4.4 3.4</td>
</tr>
<tr>
<td><strong>Comprehension</strong></td>
<td>26.3</td>
<td>13.8</td>
<td>11.4 8.0</td>
</tr>
<tr>
<td><strong>BVMGT</strong></td>
<td>1.2</td>
<td>4.3</td>
<td>2.0 3.6</td>
</tr>
</tbody>
</table>

**Data, discussion, and conclusions for each of the hypotheses**

Hypothesis (I): There is no significant difference between the scores on the Test of Auditory Perception for the experimental (neurologically impaired) and control (normal) subjects. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.
Data

To test the first hypothesis, the differences between the mean subtest scores for the experimental and control subjects was determined. The resulting $t$-test values were established to be significant at the .01 level. The pertinent data regarding the test of this hypothesis are presented in Table 3.

**TABLE 3**

THE $t$ TEST OF EACH AUDITORY PERCEPTUAL SUBTEST BETWEEN THE MEANS OF THE EXPERIMENTAL AND CONTROL SUBJECTS

<table>
<thead>
<tr>
<th>Function</th>
<th>Subtest</th>
<th>Diff.</th>
<th>$t$</th>
<th>Significant Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition</td>
<td>Sounds</td>
<td>11703</td>
<td>4.230</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Words</td>
<td>89220</td>
<td>5.123</td>
<td>.01</td>
</tr>
<tr>
<td>Retention</td>
<td>Digits</td>
<td>9543</td>
<td>6.375</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Sentences</td>
<td>60220</td>
<td>4.769</td>
<td>.01</td>
</tr>
<tr>
<td>Integration</td>
<td>Tapping</td>
<td>4680</td>
<td>2.761</td>
<td>.01</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Stories</td>
<td>43714</td>
<td>1.918</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

The $t$-test values between the mean test scores for the experimental and control subjects are significantly different when they exceed 2.660. Table 3 shows that the $t$ values were in excess of the established level for the auditory function of recognition, retention, and integration. Auditory comprehension did not show a $t$ value in excess of the 2.660 level.
Discussion

On the basis of the data contained in Table 3, significant differences were obtained at the .01 level, between the experimental and control subjects, on auditory recognition, retention, and integration. Significant differences between the means of the two populations were not obtained on auditory comprehension. If auditory perception does develop in stages or levels, it may be that certain levels develop more rapidly than others, or are less affected by cerebral insult.

Auditory comprehension was assumed to be the highest stage or level of auditory perceptual function. It is dependent on the development of the other levels or stages of auditory perception. It may be that "minimal" neurologically impaired children can obtain sufficient meaning at the less complex stages of development to answer simple questions over highly redundant story material by comprehending only a few key words.

Conclusions

The first null hypothesis was not rejected. The Test of Auditory Perception discriminated the experimental from control subjects on three functions or levels of auditory perception: (1) recognition, (2) retention, and (3) integration. For these three functions the first null hypothesis could be rejected. The $t$-test was not signifi-
cant between the two populations at the .01 level on the perceptual function of auditory comprehension.

**Hypothesis (II):** There is no significant difference between the scores on the Test of Auditory Perception of the experimental (neurologically impaired) and control (normal) subjects when the tests are administered under conditions of background noise. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.

**Data**

To test Hypothesis II the t-test was used to determine significant differences between the mean TAP subtest scores for the experimental and control subjects. This hypothesis is similar to Hypothesis I, with the exception that the test scores were obtained while the test was being administered in a background of noise. Table 4 indicates the pertinent data with respect to the test of this hypothesis.

If the level of significance is established at the .01 level, the t value must exceed 2.660. It is interesting to note that by inspection all of the t values are far in excess of 2.660. It would appear that when background noise was used with the test tape recording, it enhanced the power of TAP to discriminate the experimental from the control subjects.
TABLE 1

THE t VALUE OF DIFFERENCE BETWEEN THE MEANS OF THE EXPERIMENTAL AND CONTROL SUBJECTS FOR EACH TAP SUBTEST ADMINISTERED UNDER CONDITIONS OF BACKGROUND NOISE

<table>
<thead>
<tr>
<th>Perceptual Area</th>
<th>Subtest</th>
<th>Diff.</th>
<th>t</th>
<th>Significant Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition</td>
<td>Sounds</td>
<td>7403</td>
<td>8.017</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Words</td>
<td>52696</td>
<td>9.5265</td>
<td>.01</td>
</tr>
<tr>
<td>Retention</td>
<td>Digits</td>
<td>7436</td>
<td>6.396</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Sentences</td>
<td>43111</td>
<td>7.235</td>
<td>.01</td>
</tr>
<tr>
<td>Integration</td>
<td>Tapping</td>
<td>3697</td>
<td>3.790</td>
<td>.01</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Stories</td>
<td>32623</td>
<td>4.901</td>
<td>.01</td>
</tr>
</tbody>
</table>

Discussion

The results of Hypothesis I indicated the Test of Auditory Perception successfully discriminated the experimental from the control subjects on three subtests: (1) auditory recognition, (2) auditory retention, and (3) auditory integration. Research with children having difficulties in visual perception tend to show that these children have increased problems when the test stimulus is enclosed or partially surrounded in a background of ambient visual stimuli. To this author's knowledge, auditory closure has not been researched. The ability of the child to close out unwanted auditory stimuli when confronted with ambient noise in the background is unknown.
Confronted with this information, it was hypothesized that background noise would add to the ability of the TAP to discriminate experimental from control subjects. Noise as a factor or variable seems to be a different but difficult dimension when added to a test of auditory perception. The problems associated with using noise in a test of this nature are many as research has not been applied to the use of noise as a factor in perception. The problem of the level of loudness, the type of noise, and what noise means with normal children have not been researched adequately. Predominantly important in the study of noise and the purpose for using noise in this study is that ambient background noise seems to be a daily occurrence in normal kindergarten and primary classrooms.

Conclusions

Hypothesis II was rejected. Significant differences between the experimental and control subjects occurs for each area of auditory perception tested under conditions of controlled background noise.

Hypothesis (III): There is no significant difference between the means of the auditory perceptual subtests, when the tests are administered under normal testing conditions and under conditions of background noise. The perceptual functions assessed are: (1) recognition, (2) retention, (3) integration, and (4) comprehension.
Data

To test Hypothesis III the significant difference between the means of each subtest administered under conditions of background noise and under normal testing conditions was obtained for all subjects. The $t$-test was used to determine if the difference between the means was statistically significant at the accepted .01 level. The subtest scores obtained under normal testing conditions were compared to those under subtest administration in background noise.

Table 5 indicates the pertinent data with respect to the test of this hypothesis.

### TABLE 5

**THE SIGNIFICANT DIFFERENCE BETWEEN THE MEANS OF THE SUBTEST SCORES ADMINISTERED IN BACKGROUND NOISE AND UNDER NORMAL TESTING CONDITIONS**

<table>
<thead>
<tr>
<th>Subtests of Auditory Perception</th>
<th>Sum of Squares</th>
<th>$t$</th>
<th>Significant Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory Recognition (sounds)</td>
<td>15102</td>
<td>4.068</td>
<td>.01</td>
</tr>
<tr>
<td>Auditory Recognition (words)</td>
<td>1214</td>
<td>3.5898</td>
<td>.01</td>
</tr>
<tr>
<td>Auditory Retention (digits)</td>
<td>387</td>
<td>1.9447</td>
<td>N.S.</td>
</tr>
<tr>
<td>Auditory Retention (sentences)</td>
<td>6997</td>
<td>3.3374</td>
<td>.01</td>
</tr>
<tr>
<td>Auditory Integration</td>
<td>587</td>
<td>1.3951</td>
<td>N.S.</td>
</tr>
<tr>
<td>Auditory Comprehension</td>
<td>3917</td>
<td>4.5938</td>
<td>.01</td>
</tr>
</tbody>
</table>
The results of Table 5 indicate that background noise is a discriminating factor on four TAP subtests. The \( t \) values for the TAP subtests of auditory recognition, sentences in the perceptual area of auditory retention, and auditory comprehension were significantly different at the .01 level.

Discussion

The preceding hypothesis has shown background noise to be a significant discriminator when added to the Test of Auditory Perception in distinguishing the experimental from control subjects. The question now being raised is the difference between the means of the subtests that have been obtained, one under conditions of background noise and the other under normal testing conditions. The practical value in determining if background noise is a significant discriminator has direct application for further research in the development of tests of auditory perception. Background noise was found to be a significant factor in the difference scores obtained between the subtests. Therefore, further research must be applied to this important variable. The next chapter will discuss the implication of using noise in further research.

Noise was not a factor of significance unless meaningful language units were used as test material. The two subtests that did not reveal a significant difference between their means under conditions of background noise and under
normal testing conditions were comprised of: (1) memory for digits, and (2) auditory integration of rhythmic structures. It seems to be the synthesis of the language unit that noise inhibits.

Conclusions

Hypothesis III was not rejected. There were significant differences at the .01 level between the two test administrations, conditions of background noise and normal testing conditions, on four of the subtests: (1) the two subtests of auditory recognition, (2) the subtest of auditory retention for sentences, and (3) the test of auditory comprehension. The subtests of auditory retention for digits and auditory integration did not show a significant difference when administered under the two test conditions. An explanation for the lack of significant difference on these two tests may be due to the kinds of test material used. Background noise seems to affect only meaningful language units. The implications of this finding shall be discussed further in Chapter V.

Hypothesis (IV): There is no significant difference in the relationship between the various subtests of auditory perception for: (1) the experimental population, (2) the control population, and (3) both populations.

Data

The fourth hypothesis was tested by obtaining the multiple correlation between the subtests for the experi-
mental population, control population, and total population. The levels of significance at which the correlations indicate a statistical relationship between the two subtests were established at the .01 and .05 levels. If the correlations were high, a statistical relationship was felt to exist between the two tests being compared at the accepted level of significance.

Table 6 shows both the correlational findings and the level at which these values reach statistically significant differences.

In Table 6 the correlational values between subtests range from .03 to .75 for all the subjects, .05 to .58 for the experimental subjects, and -.23 to .69 for the control subjects. Generally, the correlations become higher as the levels or stages of auditory perception become more complex.

Discussion

The subtests were based on a neurological model of auditory perception. The theoretical model implies that auditory perceptual functions take place at various stages or levels. The integration of perceptual functions leading to a total skill development depends upon the partial or total ability of the preceding function to provide the learner meaningful information at that stage of performance.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Recog. x Recog. (S) (W)</td>
<td>.29 .05 .13 .32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Reten. (S) (D)</td>
<td>.27 .05 .17 .17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Reten. (S) (Se)</td>
<td>.21 .01 .32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Integ. (S)</td>
<td>.039 -.14 .05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Compre. (S)</td>
<td>.041 -.23 .14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Reten. (W) (D)</td>
<td>.53 .01 .23 .46 .01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Reten. (W) (Se)</td>
<td>.47 .01 .21 .44 .05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Integ. (W)</td>
<td>.30 .05 .005 .20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recog. x Compre. (W)</td>
<td>.56 .01 .48 .66 .01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reten. x Reten. (D) (Se)</td>
<td>.70 .01 .62 .61 .01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reten. x Integ. (D)</td>
<td>.56 .01 .48 .38 .05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reten. x Compre. (D)</td>
<td>.66 .01 .45 .64 .01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reten. x Integ. (Se)</td>
<td>.45 .01 .01 .62 .01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reten. x Compre. (Se)</td>
<td>.59 .01 .36 .40 .05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integ. x Compre.</td>
<td>.75 .01 .69 .58 .01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The auditory recognition subtests of speech sounds, and to a lesser extent words, show low positive correntational values with the other subtests. Therefore, the subtest areas of recognition were not significantly different from the other subtests at an acceptable level. The other subtests show high relationships, establishing significant \( t \) values at the .01 and .05 levels. Briefly, it would appear that the majority of subtests do assess different perceptual functions for all three populations. The more complex functions of auditory retention, integration, and comprehension obtained higher correntational values. It would appear that the basic tests of the more simple or uncomplex perceptual functions tend to show less overlap of the function they assess. The subtests of auditory recognition are the basic perceptual functions that do substantiate or inhibit success at the next higher level of perceptual function. Therefore, it is possible that the perceptual skill essential to auditory recognition is reflected in each of the other subtests.

Conclusions

The decision to reject or accept Hypothesis IV is not clearly established for any of the three populations. As was stated in the discussion, the trend is for increased relationships to be established at the higher levels of auditory perceptual functioning. There was little difference in the trend of relationships for any of the three populations.
For the total population there were ten significant relationships between the subtests, nine of which were at the .01 level. If ten of fifteen possible subtest relationships are significant, then it might appear that the subtests are dependent upon one another as the model suggests. Since auditory recognition was generally not significant with the other lower level skills, it may be assumed that the tests do assess different perceptual functions.

The only conclusion drawn is that the complex test battery as assembled for this study provides more descriptive information at each stage or level of perceptual development than would a test measuring a single perceptual skill. Children do show patterns of auditory perceptual strengths and weaknesses.

Hypothesis (V): There is no significant difference in the relationships between the scores obtained on the Bender Visual Motor Gestalt Test and the Subtests of Auditory Perception for: (1) the experimental subjects and (2) the control subjects.

Data

To test Hypothesis V the correlational values between the BVMGT and each of the TAP subtests were determined. The \( t \) values for the correlations were established as representing significant differences when they exceeded the .01 and .05 levels. The pertinent data regarding the test of this hypothesis are presented in Tables 7 and 8.
**TABLE 7**

THE CORRELATIONAL VALUES BETWEEN THE 
BVMGT AND EACH OF THE TAP SUBTESTS FOR 
THE EXPERIMENTAL AND CONTROL POPULATIONS

<table>
<thead>
<tr>
<th>Tests being compared</th>
<th>Covariance</th>
<th>Correlation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exper.</td>
<td>Control</td>
<td>Exper.</td>
<td>Control</td>
</tr>
<tr>
<td>BVMGT x Aud. Rec. (sounds)</td>
<td>-7.332</td>
<td>-1.903</td>
<td>-.562</td>
<td>-.368</td>
</tr>
<tr>
<td>BVMGT x Aud. Rec. (word)</td>
<td>-1.163</td>
<td>-1.078</td>
<td>-.348</td>
<td>-.397</td>
</tr>
<tr>
<td>BVMGT x Aud. Ret. (digits)</td>
<td>-3.713</td>
<td>-2.731</td>
<td>-.384</td>
<td>-.37</td>
</tr>
<tr>
<td>BVMGT x Aud. Ret. (sentences)</td>
<td>-1.011</td>
<td>-1.213</td>
<td>-.192</td>
<td>-.368</td>
</tr>
<tr>
<td>BVMGT x Aud. Integ. (integration)</td>
<td>-1.904</td>
<td>-4.508</td>
<td>-.151</td>
<td>-.492</td>
</tr>
<tr>
<td>BVMGT x Aud. Comprehension</td>
<td>-1.871</td>
<td>-5.772</td>
<td>-.644</td>
<td>-.244</td>
</tr>
</tbody>
</table>

**TABLE 8**

THE t VALUES AND SIGNIFICANT DIFFERENCES FOR THE CORRELATIONS 
OBTAINED BETWEEN THE BVMGT AND THE TAP SUBTESTS FOR THE 
EXPERIMENTAL AND CONTROL SUBJECTS

<table>
<thead>
<tr>
<th></th>
<th>Degrees of Freedom</th>
<th>Control t</th>
<th>Sig. L.</th>
<th>Experimental t</th>
<th>Sig. L.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auditory Recognition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sounds</td>
<td>28</td>
<td>1.863</td>
<td>.05</td>
<td>2.836</td>
<td>.01</td>
</tr>
<tr>
<td>Words</td>
<td>28</td>
<td>2.385</td>
<td>.05</td>
<td>3.118</td>
<td>.01</td>
</tr>
<tr>
<td><strong>Auditory Retention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digits</td>
<td>28</td>
<td>1.301</td>
<td>N.S.</td>
<td>1.020</td>
<td>N.S.</td>
</tr>
<tr>
<td>Sentences</td>
<td>28</td>
<td>1.518</td>
<td>N.S.</td>
<td>2.0364</td>
<td>N.S.</td>
</tr>
<tr>
<td><strong>Auditory Integration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>4.076</td>
<td>.01</td>
<td>2.449</td>
<td>.05</td>
</tr>
<tr>
<td><strong>Auditory Comprehension</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>1.754</td>
<td>.05</td>
<td>3.680</td>
<td>.01</td>
</tr>
</tbody>
</table>
Coefficients were obtained to determine the degree to which subtests of the TAP assess a different perceptual function than is tested by the BVMGT. The mean BVMGT results when correlated with the subtests of the TAP show a wide range of negative values.

In interpreting the coefficients, it is important to avoid the conclusions that a positive correlation represents two factors as having the same cause. Or, by contrast, a negative correlation suggests the two entities are distinctly opposite. The direction of the correlation (positive or negative) between the two tests, one a test of auditory perception and the other the test of visual perception, is only indicative of the ability of the tests to vary or remain homogeneous in what they assess.

Table 7 shows the correlation coefficient for the control and experimental populations. It can be seen from this table that all the relationships are negative between the BVMGT and the subtests of auditory perception. The subtests of auditory perception seem to assess a different function as indicated by the direction (negative) of the relationship. The \( t \) values obtained in response to the fourth hypothesis determined the significant differences between the correlational relationships. The conclusion is that the two tests measure different functions. Table 8 indicates that the subtests of the TAP are significantly different at the .01 and .05 levels for the functions of
auditory recognition and integration. The experimental subjects showed no significant difference for auditory retention subtests. The control subjects showed no significant differences for both the subtest of auditory retention (sentences) and auditory comprehension. The inconsistencies among the correlational coefficients for the various subtests may be explained in knowing that children do not show equal or consistent patterns of perceptual development.

The tests of significance of difference between the BVMGT and the TAP subtests show that the subtests of auditory recognition, auditory integration, and auditory comprehension are decidedly significant for all subjects. The only subtest which failed to show a significant difference in relationship to the Bender Visual Motor Gestalt Test was the subtest of auditory retention. It may be that this test and the BVMGT are somewhat alike, not in what they assess, but that both call upon the subject to seek a high degree of stimulus closure. Stimulus closure is the ability of the subject to eliminate all irrelevant stimuli, focusing solely on the test stimulus.

Conclusions

The decision to reject or accept null Hypothesis V is not clearly established for either the experimental or control subjects. The correlational values range from -.15 to -.64. The direction of the relationship was consistently
negative between all of the subtests. As explained in the
discussion, the negative direction (negative numbers)
probably indicates that the two tests, the test of visual
perception and the Test of Auditory Perception, are assess-
ing different perceptual skills.

It appears that the subtests of the TAP are not only
positive and significantly high in degree of relationship
with the BVMGT (null Hypothesis V) but tend to assess two
different skills warranting diagnostic study of each per-
ceptual function, auditory and visual perception. The fact
that neither Hypothesis IV nor Hypothesis V can be completely
rejected is probably due to the perceptual patterns of
strengths and weaknesses among subjects. This fact in itself
tends to support the need for complex batteries of perceptual
tests which assess different levels or stages of perceptual
functioning.

Hypothesis (VI): There will be a higher incidence of
experimental subjects with auditory perceptual problems (assessed by
the TAP) than those having visual motor perceptual problems (assessed
by the BVMGT) when assessed under:
(1) normal testing conditions and
(2) conditions of background noise.

Data

Hypothesis VI is stated as a clinical predictor. A
clinical criterion was determined at the minus one standard
deviation (-1 S.D.), for both the TAP and BVMGT. Essentially
if a subject produced more errors on the BVMGT than were
produced by a similar subject (age and intelligence) it was felt clinically that his score exceeded the criterion cutoff.

The same clinical criterion was utilized for the TAP subtests except that the subject must fail two of the six subtests. Since the TAP was administered under normal testing conditions and then administered a second time under conditions of background noise, both administrations were compared separately. The raw scores of the auditory perceptual subtests were the number of correct responses made by the subject. If the correct response number was not within the minus one standard deviation (−1 S.D.) on two subtests it was felt the experimental subjects were clinically not functioning at an auditory-perceptual-developmental level similar to the normal (control) subjects. The minus one standard deviation was obtained from the control subjects since there was no previous standardization for the TAP.

The pertinent data regarding this hypothesis are presented in Tables 9 and 10. Table 9 shows the number of experimental and control subjects for each test administration who were identified as functioning poorer developmentally (more errors) than the criterion permitted on the BVMGT and TAP. The subjects had to perform beyond the criterion level on two of the subtests before they were considered as identified on the Test of Auditory Perception.
Table 9

**THE NUMBER OF SUBJECTS IDENTIFIED BY THE BVMGT AND THE TAP AT THE CLINICAL CRITERION UNDER NORMAL TESTING CONDITIONS AND UNDER CONDITIONS OF CONTROL TEST BACKGROUND NOISE**

<table>
<thead>
<tr>
<th>Conditions of background noise</th>
<th>Exper.</th>
<th>Control</th>
<th>Normal testing conditions</th>
<th>Exper.</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>BVMGT</td>
<td>8</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>TAP</td>
<td>29</td>
<td>4</td>
<td>23</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Table 10 shows the number of subjects identified by each of the TAP subtests at the clinical criterion for both test conditions. In this table it can be seen that each of the subtests has different abilities, under the two test conditions, to discriminate experimental subjects at the criterion cutoff.

Table 10

**THE NUMBERS OF SUBJECTS IDENTIFIED BY EACH TAP SUBTEST UNDER NORMAL TESTING CONDITIONS AND CONDITIONS OF BACKGROUND NOISE AT THE CLINICAL CRITERION**

<table>
<thead>
<tr>
<th></th>
<th>Recognition</th>
<th>Retention</th>
<th>Integration</th>
<th>Comprehension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sounds</td>
<td>Words</td>
<td>Digits</td>
<td>Sentences</td>
</tr>
<tr>
<td>Noise</td>
<td>26</td>
<td>29</td>
<td>21</td>
<td>29</td>
</tr>
<tr>
<td>Normal</td>
<td>20</td>
<td>21</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Discussion

Many clinicians feel that by using the Kopitz Developmental scoring system that children with visual perceptual problems may be identified for neurological referral
if they do not obtain a score within the minus one standard deviation. For this reason, the cut off criterion was established for both the BVMGT and TAP at the minus one standard deviation (depending on the scoring, errors, or number right).

The ability of the BVMGT and the Test of Auditory Perception to identify both experimental and control subjects at the minus one standard is demonstrated in Table 9. It can be seen that under the conditions of background noise the TAP discriminated twenty-nine of the thirty experimental subjects. The TAP may have discriminated some false positives. That is, some control subjects may have visual or perceptual problems as severe as the experimental subjects. What is demonstrated is the difficulty of identifying the so-called "minimal" neurologically impaired child through one test of perception without other supporting data.

Table 10 characterizes the ability of each of the TAP subtests to discriminate the experimental subjects at the established criterion. The results of the table show that five of the six subtests under conditions of noise have more ability to discriminate experimental subjects than under normal testing conditions. The subtest of auditory integration was the only subtest which did not:

1. Discriminate more subjects under conditions of background noise than under normal psychometric conditions.
2. Discriminate a substantial number of experimental subjects at the established criterion.

The results tend to indicate that when background noise is introduced under controlled conditions into the administration of the test, that many more experimental subjects (neurologically impaired) are discriminated. This was true for the auditory perceptual functions of: (1) recognition, (2) retention, and (3) comprehension.

Conclusions

The findings of Hypothesis VI show that:

1. The BVMGT identifies eight of the experimental population at the minus one standard deviation. In other words, in relation to their mental development and chronological age, eight of the thirty experimental subjects were discriminated as having visual perceptual problems.

2. The TAP administered under the condition of noise identified twenty-nine of the experimental population at the first criterion cut off on two or more of the subtests.

3. The TAP identified twenty-three of the experimental population as having auditory perceptual problems on two or more of the subtests.

4. Two control subjects were identified as having visual perceptual difficulties on the BVMGT.

5. The TAP identified four control subjects who did no better than the experimental subjects on two or more subtests.
6. Under conditions of no background noise, five control subjects had difficulties in auditory perception at the established criteria on two subtests.

7. The subtests show a wide degree of difference in their ability to discriminate the experimental subjects at the predetermined criterion. All the subtests discriminated more subjects under conditions of background noise except the subtest of auditory integration.

8. The three functions of auditory recognition, retention, and comprehension discriminated a substantial number of experimental subjects at the predetermined criterion.

Summary of the data

Significant differences between auditory perceptual subtest scores for experimental and control subjects were found to exist. The Test of Auditory Perception discriminated the experimental subjects on subtests of recognition, retention and integration at the .01 level. When controlled background noise was introduced into the auditory perceptual test all the subtests discriminated the experimental from control subjects at the .01 level. Background noise was determined to be a significant discriminator among four of the TAP subtests that utilize test materials containing meaningful language.

The relationships between the subtests were found to represent significant differences for both the experimental
and control subjects on several of the subtests. The subtest of auditory recognition generally does not relate significantly with the other auditory perceptual subtests as the more basic functions of auditory perception tend to relate to a lesser degree with the other subtests than the higher skills of auditory integration and comprehension. There is a significant difference relationship between the BVMGT and the majority of the TAP subtests. These two perceptual tests show a negative correlation indicating that each assesses a different function.

The present chapter has reported the treatment of the data, discussion, and conclusions in response to each hypothesis. In the following chapter the summary, conclusions, and implications for further research are discussed.
CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

This chapter presents the summary, a discussion of the conclusions of this research, and the needs for further research.

Summary

The data collected indicated that a Test of Auditory Perception (TAP) did discriminate neurologically impaired children (experimental subjects) from a matched population of normal children (control subjects). The subjects were matched on the variables of sex, chronological age, verbal intelligence, and years in school. The experimental test was administered under two conditions. One administration was under normal testing conditions, the second under conditions of controlled background noise. Background noise was found to increase the ability of the TAP to discriminate between the experimental and control subjects.

Presently, children with suspected neurological impairment are identified through the use of visual motor perceptual tests. The most commonly used such test is the Bender Visual
Motor Gestalt Test. Low negative correlations were found between the BVMGT and the TAP. A clinical criterion, established at the minus one standard deviation, indicated that the TAP subtests discriminated more experimental subjects than did the BVMGT.

1. Data were obtained to indicate the relationship between the various TAP subtests which indicate patterns of auditory perceptual strengths and weaknesses.

2. The assembly of the TAP was based on a neurological model. This model attempted to identify four distinct auditory perceptual functions.

3. Six subtests were used to assess the four auditory perceptual functions described by the neurological model. The auditory perceptual functions and subtests were:

1. Auditory recognition
   1a. Templin Test of Sound Discrimination
   1b. Huelsman Word Recognition Test, Form B

2. Auditory retention
   2a. Memory for Digits (McCarthy, 1963)
   2b. Memory for Sentences (McCarthy, 1963)

3. Auditory integration
   3a. Stambak (1965) Rhythmic Structures

4. Auditory comprehension
Conclusions

The primary purpose of this investigation was to determine the ability of the TAP to discriminate between the experimental and control subjects. The first two hypotheses were related to –

(1) The ability of the TAP to discriminate the experimental from control subjects under normal testing conditions.

(2) The ability of the TAP to discriminate the experimental from control subjects under conditions of background noise.

The findings indicate that:

1. The TAP discriminated the experimental from the control subjects on the subtests of auditory recognition, retention, and integration at the .01 level when administered under normal testing conditions.

2. The TAP subtest of auditory comprehension did not discriminate the subject populations at the designated level of significance when administered under normal testing conditions.

3. The TAP discriminated the subject populations at the .01 level on all the subtests under conditions of background noise.

The second major area of concern was to determine the pattern of auditory perceptual strengths and weaknesses
through: (1) the relationship between the various auditory perceptual subtests and (2) the relationship between the BVMGT and the TAP subtests.

The data indicated:

1. Positive correlations existed among eight of the fifteen TAP subtests.

2. Lower correlations existed between the auditory perceptual subtests of recognition and retention than for the higher level skills of integration and comprehension.

3. There were negative correlations between the BVMGT and all the TAP subtests.

4. Significant differences existed between the correlation of the BVMGT and the TAP subtests of recognition, integration, and comprehension. Significant differences were not obtained between the TAP subtests of auditory retention and the BVMGT.

The effects of background noise as a criterion variable on the TAP test materials indicated that (1) noise interferes as a distractor on auditory perceptual test material when meaningful language units are used, and (2) noise does not interfere as a distractor on auditory perceptual material, such as memory for digits and rhythmic structures.

There were significant differences between the
scores of the TAP subtests of recognition, retention for sentences, and comprehension at the .05 and .01 level when the tests were administered in background noise as opposed to quiet conditions. The subtests which did not show any significance were the retention for digits and the integration subtest, a test of rhythmic tapping.

The clinical question posed was which test - the BVMGT or the TAP subtests - discriminated the larger number of experimental subjects at the pre-established criterion at the minus one standard deviation the results indicated:

1. The BVMGT discriminated eight of the experimental subjects at the clinical criterion.

2. The TAP subtests discriminated twenty-nine of the experimental subjects at the clinical criterion in background noise.

3. The TAP discriminated twenty-three of the experimental subjects at the clinical criterion when administered under normal testing conditions.

4. The BVMGT identified two control subjects as having visual-motor difficulties.

5. The TAP subtests identified four of the control subjects as having auditory perceptual problems when administered under conditions of background noise and four control subjects when administered under normal testing conditions.
Implications from this research

The implications from this research suggest that:

1. The Test of Auditory Perception can discriminate neurologically impaired children from a matched population of normal subjects. This may suggest that tests of auditory perception should be used in the initial screening of children with suspected neurological problems.

2. Children seemingly show different patterns of auditory perceptual strengths and weaknesses. A Test of Auditory Perception assessing a single perceptual stage or level of function may not be limited as a diagnostic instrument. Of even greater consequence, diagnostic information concerning only one level or stage of an auditory perceptual problem does not permit prescriptive teaching based on a descriptive diagnosis of the auditory perceptual process.

3. The results of this study indicate that visual-motor perception and auditory perception are two distinct functions. Visual-motor perception, as assessed by the BVMGT, has been shown to be a good predictor of neurological impairment. The BVMGT is often used as a routine measure of visual motor perception. Auditory perceptual tests are rarely administered. The data suggest that both auditory and visual-motor perception should be assessed in the psychological examination of a child with learning and behavior problems.
4. Background noise was shown to be a distractor of some consequence when used with the Test of Auditory Perception. Children do not receive auditory information in conditions of controlled quiet, even in the classroom. The classroom noise used in this study was recorded between 66 to 89 decibels. If children with auditory perceptual problems are prone to increased difficulty when exposed to background noise, then noise should —

(1) Be controlled in the classroom, even on an individual basis.

(2) Be utilized in a controlled manner within the structure of a teaching technique to reduce any detrimental effect.

(3) Be further studied to determine the effect different types of noise have on perception.

The subsequent section of this chapter will discuss research possibilities that may clarify the effects different noise backgrounds have on auditory perception.

Implications for further research

Controlled background noise was found to be a discriminating factor of clinical significance, when introduced as a variable into the Test of Auditory Perception. The term distractor is used purposefully. Research audiologists believe that background noise has either a masking effect or a distracting influence. The difference is in the use of the noise. A masking noise covers the same
frequency bands of sound as the stimulus signal. It interferes in the intelligibility of the signal. This author believes that neurologically impaired children would do as well in receiving intelligible speech signals as would the non-neurologically impaired. This is probably borne out in clinical audiology, where there is usually little difference noted between the speech reception thresholds in noise of the two populations mentioned. However, the clinical audiologist has often noted that the so-called "minimally brain damaged" have a super-sensitiveness to noise. Many such children become uncomfortable when exposed to noise. In other words, the noise distracts their attention, causing a change in the focus of their "goal set". It inhibits their ability to seek "closure" or establish a gestalt pattern. Noise is a stimulus distractor. It does the same thing in the auditory background that visual background stimulus, such as flicker fusion, does in the presence of visual stimulus (Werner and Thuma, 1942).

Before other tests of auditory perception using noise in the background can be constructed, several variables involving the effects of background noise with children must be investigated:

1. The noise level (intensity) at which noise ceases to be a distractor and assumes masking characteristic for certain frequencies should be determined. This is known for adults, but not for children.
2. There are roughly three different kinds of noise. Research is needed to determine the difference in distractability qualities of the various patterns of noise. Noise may be:

2a. White, or cover the entire frequency spectrum;
2b. Saw tooth, or cover frequency ranges, such as the speech frequencies;
2c. Situational, or the kind of noise found in the classroom.

3. The next question for further research concerns the duration, or time sequence under which noise is administered. Should noise be administered as:

3a. A steady state, presented constantly at one frequency and intensity level;
3b. Alternated patterns, so that the frequency and time are continuously changing;
3c. Periodic patterns, be presented for so many parts of a second, in an off-on manner?

4. An encompassing question regarding noise, but one directly related to the classroom, is the effect that different patterns of noise have on specified teaching activities. This study showed that not all auditory sub-tests were affected by noise. Noise was not a discriminator
in the auditory retention of digits, nor in the auditory integration of rhythmic structures. Noise was a distractor when language units, sounds, or words were presented. A research effort should be directed toward determining whether the frequency, time and intensity components of classroom noise tend to:

4a. Distract certain children, such as those with minimal neurological impairment;

4b. Interfere with specific kinds of learning tasks.

The effects of noise upon auditory perceptual skills may serve as one entire area of research. Another major area of research related to this study should include the determination of the relationship between patterns of auditory perceptual strengths and weaknesses in predicting academic achievement. It may be possible to use the TAP patterns to predict those children who may develop academic problems. To research the predictive power of this test, a large sample of school age children with specific learning problems should be studied. By assigning previously weighted scores to the TAP subtests and to the correlated areas of academic achievement, predictive scores for skills of academic achievement could then be obtained.

The TAP should be useful in research of children with speech and language problems. It may assist researchers
in understanding the relationship of delayed speech to the auditory reception of meaningful language.

One of the primary purposes of this study was to determine if the TAP subtests would distinguish specific areas of auditory perceptual functioning. The neurological model basic to the design of the TAP subtests should permit a psychologist to establish the reason for auditory perceptual problems in children as was done with the veterans having receptive language problems. The correlational values tentatively suggest that specific levels or stages of auditory perceptual function were assessed by the TAP subtests. This research has established that normal and neurologically impaired children display inter-subject strengths and weaknesses on the six subtests. Through further work with this test, and cooperative multi-disciplinary study including pediatric neurological evaluations of children, a differential diagnostic instrument may result.

When such tests have been constructed, descriptive diagnosis of children's behavior or learning problems may be made in order that prescriptive teaching can be planned. In introducing the concept of descriptive diagnosis, further research should be brought to the age old question as to the exact dimension of children's learning difficulties.
The present chapter has represented a review of this study, a summary of the data, and conclusions. A discussion of research needed in auditory perceptions and the major philosophical implications underlying the present study in response to the original purposes were provided.
APPENDIX A

INSTRUCTIONS FOR EACH AUDITORY PERCEPTUAL SUBTEST
1. Auditory Recognition

1a. Templin Test of Sound Discrimination

You're going to listen to two pairs of speech sounds. If you listen carefully, you will be able to tell if the two sounds are the same or if they are different. If the two sounds are alike or the same, you will say same. If the two sounds are not alike, or different, say different.

Try this on four examples to see if you understand.

Ta-Ta
Wa-Wa
Na-Ma
Ta-Da

That's fine, now tell me if the rest of these are the same or different.

1b. Huellesman Word Recognition Test

Listen carefully to the following list of speech sounds. In each group of five speech sounds, one will be a word you have heard before, the others are not words but meaningless speech sounds. Say the word that makes sense. Repeat the word that is meaningful. Wait until you have heard all five examples, then say the real word.

Howie
Houie
House
Touse
Mousees

That's fine, now tell me the real word for each of these five sounds.

2. Auditory Retention

2a. Memory for Digits

Listen to the numbers that I say. When I am finished point to the numbers I have said. Point to the numbers on the card in front of you. Point to them in the order that I say them. Don't point until I have said all the numbers.
Let's try some examples for these numbers:
1-2
9-6
5-2-1
6-8-0
That's fine, be sure to point to the numbers in the same order as I say them.

2b. Memory for Sentences

Listen carefully, you will hear me say a sentence. Say the sentence exactly as I say it.
For example, now say:
1. Baby likes bananas.
2. I drink milk.
That's fine, let's try some more sentences. Say them back to me just as I say them. Are you ready?

3. Auditory Integration

3a. Rhythmic Tapping Sequences

I am going to make some tapping sounds. I want you to make them just the way I do. Use your block and try these examples. Wait until I have made all the sounds before you start.
Are you ready?
1. ***
2. ***
That's fine, now make the sounds just the way I do.

4. Auditory Comprehension

4a. Listening for Paragraph Meaning

I am going to read a story. Listen carefully, as I am going to ask you some questions when I have finished.
Are you ready? (They then hear the story.)
APPENDIX B

RECORD SCORING FORM FOR THE TEST OF AUDITORY PERCEPTION
**TEST FORM FOR THE EXPERIMENTAL MEASURES OF AUDITORY PERCEPTION**

**CHILD'S NAME** ___________ **C.A.** _______ **M.A.** _______ **I.Q.** _______

Time begun ______ Time ended _____ Subjects status ______

Conditions: (N) (Q)
1 1
2 2

<table>
<thead>
<tr>
<th>Noise</th>
<th>Sound Discrimination Test 1</th>
<th>Quiet Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$D$</td>
<td>1 $D$</td>
</tr>
<tr>
<td>2</td>
<td>$D$</td>
<td>2 $D$</td>
</tr>
<tr>
<td>3</td>
<td>$D$</td>
<td>3 $D$</td>
</tr>
<tr>
<td>4</td>
<td>$D$</td>
<td>4 $D$</td>
</tr>
<tr>
<td>5</td>
<td>$D$</td>
<td>5 $D$</td>
</tr>
<tr>
<td>6</td>
<td>$D$</td>
<td>6 $D$</td>
</tr>
<tr>
<td>7</td>
<td>$D$</td>
<td>7 $D$</td>
</tr>
<tr>
<td>8</td>
<td>$D$</td>
<td>8 $D$</td>
</tr>
<tr>
<td>9</td>
<td>$D$</td>
<td>9 $D$</td>
</tr>
<tr>
<td>10</td>
<td>$D$</td>
<td>10 $D$</td>
</tr>
<tr>
<td>11</td>
<td>$D$</td>
<td>11 $D$</td>
</tr>
<tr>
<td>12</td>
<td>$D$</td>
<td>12 $D$</td>
</tr>
<tr>
<td>13</td>
<td>$D$</td>
<td>13 $D$</td>
</tr>
<tr>
<td>14</td>
<td>$D$</td>
<td>14 $D$</td>
</tr>
<tr>
<td>15</td>
<td>$D$</td>
<td>15 $D$</td>
</tr>
<tr>
<td>16</td>
<td>$D$</td>
<td>16 $D$</td>
</tr>
<tr>
<td>17</td>
<td>$D$</td>
<td>17 $D$</td>
</tr>
<tr>
<td>18</td>
<td>$D$</td>
<td>18 $D$</td>
</tr>
<tr>
<td>19</td>
<td>$D$</td>
<td>19 $D$</td>
</tr>
<tr>
<td>20</td>
<td>$D$</td>
<td>20 $D$</td>
</tr>
</tbody>
</table>

Total ____ right

Total ____ right
## Test 2: Word Discrimination

<table>
<thead>
<tr>
<th>Test</th>
<th>Red (noise)</th>
<th>Blue (quiet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. go</td>
<td>noise</td>
<td>quiet</td>
</tr>
<tr>
<td>2. two</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. boat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. come</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. make</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. ball</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. play</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. house</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. down</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. where</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. funny</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. find</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. fun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. came</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. our</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. soon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. there</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. rabbit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. thank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. hen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. please</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. went</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. pretty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. white</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. happy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. new</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. guess</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. under</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. friends</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. lady</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. deep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. queer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38. done</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total score right noise |
Total score right quiet |
## Auditory Retention Test 3

<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
<th>Noise</th>
<th>Quiet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 1-2</td>
<td>1-2</td>
<td>11. 2-5-4-9-9</td>
<td>2-5-4-9-9</td>
</tr>
<tr>
<td>2. 9-6</td>
<td>9-6</td>
<td>12. 6-1-6-3-7</td>
<td>6-1-6-3-7</td>
</tr>
<tr>
<td>3. 5-2-1</td>
<td>5-2-1</td>
<td>13. 4-5-9-1-4</td>
<td>4-5-9-1-4</td>
</tr>
<tr>
<td>4. 6-8-9</td>
<td>6-8-9</td>
<td>14. 9-1-7-5-3</td>
<td>9-1-7-5-3</td>
</tr>
<tr>
<td>5. 9-7-6</td>
<td>9-7-6</td>
<td>15. 8-9-6-4-3</td>
<td>8-9-6-4-3</td>
</tr>
<tr>
<td>6. 4-3-4</td>
<td>4-3-4</td>
<td>16. 6-3-9-7-3-5</td>
<td>6-3-9-7-3-5</td>
</tr>
<tr>
<td>7. 6-6-1-1</td>
<td>6-6-1-1</td>
<td>17. 6-9-2-8-7</td>
<td>6-9-2-8-7</td>
</tr>
<tr>
<td>8. 6-3-5-8</td>
<td>6-3-5-8</td>
<td>18. 3-8-9-1-7-5</td>
<td>3-8-9-1-7-5</td>
</tr>
<tr>
<td>9. 4-4-2-4</td>
<td>4-4-2-4</td>
<td>19. 6-4-5-8-4-1</td>
<td>6-4-5-8-4-1</td>
</tr>
<tr>
<td>10. 5-7-4-5</td>
<td>5-7-4-5</td>
<td>20. 8-2-9-4-7-5-3</td>
<td>8-2-9-4-7-5-3</td>
</tr>
</tbody>
</table>

| Total       | Total       |

## Test 4 Sentence Memory Test

1. I drink milk.
2. A telephone/ is wonderful.
3. A caterpillar/ becomes a butterfly.
4. People on television/ sometimes play pianos.
5. Potatoes/ and tomatoes/ grow in the garden.
6. Grandmother is ironing handkerchiefs/ and baking biscuits.
7. Elizabeth carried her basket of vegetables/ quickly away.
8. Twenty engineers/ carrying flashlights/ hurried to their locomotives.
9. Many little children/ gathered around/ the Christmas morning breakfast.
10. Workmen/ digging under water/ found many alligators resting there.
12. Turn left/ then south/ and follow the Red River/ east.
13. Trombones,/ tweezers,/ scales,/ and pumps/ are made of metal.
14. The yellow sunflowers/ turned their lovely faces/ toward the rising sun.
15. The man/ who was here/ sells brushes and combs/ to housewives.
16. If I were you,/ I would tell the police/ the whole story.
118

Test 4 (contd)

17. The people thought the world was flat/ but Columbus proved them wrong.  __________  __________
18. I heard about the accident/ on the radio/ three or more hours ago.  __________  __________
19. Mary Jones and Helen Smith/ promised to write/ or call/ or to do both.  __________  __________
20. The boys prepared the ground/ for the flower-beds/ and the farmer/ planted the seeds.  __________  __________
21. They were supposed to arrive/ at three o'clock/ but their plane/ was grounded because of fog.  __________  __________
22. Miss Clark's fourth grade class/ will meet in the auditorium today/ to see a movie/ about Indians.  __________  __________
23. I am amazed/ at his leaving us so quickly/ since he spent all day with us/ last week.  __________  __________
24. The lawyers,/ judge/ and jury/ all worked together for months on the case/ before finding the man/ guilty of murder.  __________  __________

Score  Score
Noise _________  Quiet _________

Auditory Integration

Test 5  A Test of Rhythm

```
<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
</tr>
</thead>
<tbody>
<tr>
<td>**</td>
<td></td>
</tr>
<tr>
<td>*</td>
<td></td>
</tr>
<tr>
<td>***</td>
<td></td>
</tr>
<tr>
<td>** **</td>
<td></td>
</tr>
<tr>
<td>* **</td>
<td></td>
</tr>
<tr>
<td>***</td>
<td></td>
</tr>
<tr>
<td>** *</td>
<td></td>
</tr>
<tr>
<td>****</td>
<td></td>
</tr>
<tr>
<td>** *</td>
<td></td>
</tr>
<tr>
<td>** **</td>
<td></td>
</tr>
<tr>
<td>***</td>
<td></td>
</tr>
<tr>
<td>** **</td>
<td></td>
</tr>
<tr>
<td>*</td>
<td></td>
</tr>
<tr>
<td>**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Score  Score
Noise _________  Quiet _________
```
### Test 6: Auditory Comprehension

#### Grade 1 Reading Level

<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
<th>The Cat and the Dog</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1. What did the boy have?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. What was he going to give her?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. What happened when he called to her?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Where was the cat?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. What was she doing?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. What happened or what did the boy do next?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. What happened next?</td>
</tr>
</tbody>
</table>

#### Grade 2 Reading Level

<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
<th>Dick's Birthday Present</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1. What did Dick do when he woke up?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. What day was it?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. What did he find on his chair?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. What did Dick hear?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. What did Dick do then?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. What was in the basket?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. What did the dog do?</td>
</tr>
</tbody>
</table>

#### Grade 3 Reading Level

<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
<th>The Accident</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1. What was this story about?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. What had the boy been doing?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. What was he riding?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. What came down the road?</td>
</tr>
</tbody>
</table>
Grade 3 Reading Level (contd)

<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
<td>______</td>
<td>5. Why didn't he see the car coming?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>6. How fast was the car going?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>7. What happened to the boy?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>8. What happened to the bicycle?</td>
</tr>
</tbody>
</table>

Grade 4 Reading Level

<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
<td>______</td>
<td>Peter Cooper's Engine</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>1. What did Peter Cooper build?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>2. What was it used for?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>3. How far away was the town?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>4. What was the engine hooked to?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>5. How fast did it go?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>6. How long did the trip take?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>7. What surprised the people?</td>
</tr>
</tbody>
</table>

Grade 5 Reading Level

<table>
<thead>
<tr>
<th>Noise</th>
<th>Quiet</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
<td>______</td>
<td>Uses of Kites</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>1. What was this story about?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>2. What have kites been used for in war?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>3. What did one general use kites for?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>4. What was he going to build?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>5. What do some people in China make?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>6. What are these kites supposed to do?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>7. What has the weather bureau used kites for?</td>
</tr>
<tr>
<td>______</td>
<td>______</td>
<td>8. How high has a kite gone?</td>
</tr>
</tbody>
</table>
Grade 5 Reading Level (contd)
Noise  Quiet

9. How much can some kites lift?

Grade 6 Reading Level
Noise  Quiet  History of Baseball

1. What is called the national sport?

2. What were some of its early names?

3. When was it first played in colleges?

4. What is said about its equipment?

5. What was responsible for its growth?

6. What happened to baseball after the Civil War?

7. What happened in the countries where the soldiers were stationed?

8. Who is said to welcome the baseball season?

Above Grade 6 Reading Level
Noise  Quiet  General St. Clair's Defeat

1. What accounted for defeat in the first war waged by the United States?

2. How many men did General St. Clair have?

3. What were they going to do?

4. What did they neglect to do?

5. Where did the Indians attack?
APPENDIX C

STANDARDIZATION DATA FOR THE BVMG T AND TAP
NORMATIVE DATA FOR THE KOPPITZ DEVELOPMENTAL SCORING SYSTEM

<table>
<thead>
<tr>
<th>Age Group</th>
<th>N</th>
<th>Mean Bender</th>
<th>Standard Deviation</th>
<th>Plus/minus one Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-0 to 5-5</td>
<td>81</td>
<td>13.6</td>
<td>3.61</td>
<td>10.0 to 17.2</td>
</tr>
<tr>
<td>5-6 to 5-11</td>
<td>128</td>
<td>9.8</td>
<td>3.72</td>
<td>6.1 to 13.5</td>
</tr>
<tr>
<td>6-0 to 6-5</td>
<td>155</td>
<td>8.4</td>
<td>4.12</td>
<td>4.3 to 12.5</td>
</tr>
<tr>
<td>6-6 to 6-11</td>
<td>180</td>
<td>6.4</td>
<td>3.76</td>
<td>2.6 to 10.2</td>
</tr>
<tr>
<td>7-0 to 7-5</td>
<td>156</td>
<td>4.8</td>
<td>3.61</td>
<td>1.2 to 8.4</td>
</tr>
<tr>
<td>7-6 to 7-11</td>
<td>110</td>
<td>4.7</td>
<td>3.34</td>
<td>1.4 to 8.0</td>
</tr>
<tr>
<td>8-0 to 8-5</td>
<td>62</td>
<td>3.7</td>
<td>3.60</td>
<td>.1 to 7.3</td>
</tr>
<tr>
<td>8-6 to 8-11</td>
<td>60</td>
<td>2.5</td>
<td>3.03</td>
<td>.0 to 5.5</td>
</tr>
<tr>
<td>9-0 to 9-5</td>
<td>65</td>
<td>1.7</td>
<td>1.76</td>
<td>.0 to 3.5</td>
</tr>
<tr>
<td>9-6 to 9-11</td>
<td>49</td>
<td>1.6</td>
<td>1.69</td>
<td>.0 to 3.3</td>
</tr>
<tr>
<td>10-0 to 10-5</td>
<td>29</td>
<td>1.6</td>
<td>1.67</td>
<td>.0 to 3.3</td>
</tr>
<tr>
<td>10-6 to 10-11</td>
<td>31</td>
<td>1.5</td>
<td>2.10</td>
<td>.0 to 3.6</td>
</tr>
</tbody>
</table>

Total 1106
DATA FOR THE TESTS OF AUDITORY PERCEPTION TO BE USED IN THE DEVELOPMENTAL SCORING SYSTEM

<table>
<thead>
<tr>
<th>C.A.</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
<th>Test 5</th>
<th>Test 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*N</td>
<td>**Q N</td>
<td>Q N</td>
<td>Q N</td>
<td>Q N</td>
<td>Q N</td>
</tr>
<tr>
<td>6-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>12</td>
<td>13</td>
<td>30</td>
<td>36</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>S.D.</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>-1 S.D.</td>
<td>9</td>
<td>12</td>
<td>23</td>
<td>33</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>7-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>13</td>
<td>13</td>
<td>40</td>
<td>44</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>S.D.</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>9</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>-1 S.D.</td>
<td>11</td>
<td>11</td>
<td>34</td>
<td>35</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>8-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>12</td>
<td>15</td>
<td>19</td>
<td>32</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>S.D.</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>-1 S.D.</td>
<td>11</td>
<td>9</td>
<td>15</td>
<td>24</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>9-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>11</td>
<td>16</td>
<td>31</td>
<td>44</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>S.D.</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>-1 S.D.</td>
<td>9</td>
<td>25</td>
<td>25</td>
<td>36</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>10-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>13</td>
<td>16</td>
<td>41</td>
<td>45</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>S.D.</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>-1 S.D.</td>
<td>11</td>
<td>14</td>
<td>31</td>
<td>35</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>11-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>16</td>
<td>15</td>
<td>52</td>
<td>56</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>S.D.</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>-1 S.D.</td>
<td>15</td>
<td>14</td>
<td>47</td>
<td>53</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>12-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>17</td>
<td>16</td>
<td>39</td>
<td>50</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>S.D.</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>-1 S.D.</td>
<td>17</td>
<td>15</td>
<td>34</td>
<td>40</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

(n=30) *
Noise

** Quiet
BIBLIOGRAPHY
BIBLIOGRAPHY

Barnes, T.C. "EEG Validity of Borshack, Hunt, and Bender Gestalt Test," American Psychologist 1950, 5, 322.


Galton, Francis Inquiries into Human Faculty and Its Development. London: Macmillan, 1883.


Halstead, Ward C. and Wepman, T.M. Aphasia Screening Test. The Department of Medicine, University of Chicago, Chicago 37, Illinois 1947.

Hanvick, L. "A Note on Rotation on the Bender Gestalt Test as Predictors of EEG Abnormalities in Children," Journal Clinical Psychology, 1953, 9, 399.


Hiskey, Marshall Nebraska Test of Learning Aptitude for Young Deaf Children. University of Nebraska, Department of Educational Psychology, Lincoln, Nebraska, 1941.


Koppitz, E.M. *The Bender Gestalt Test with Human Figure Drawing Test for Young School Children.* Columbus, Ohio, Dept. of Education, 1962.


Lerea, L. "An Investigation of Auditory Figure-Ground Perception," *Journal Genetic Psychology,* 1961, 98, 229-237.


Melven, Brenda "Psychological Defects Produced by Temporal Lobe Excision," *Publication of the Association of Nervous and Mental Disorders,* 1958, 36, 24-51.


The Ohio State Department of Education, Division of Special Education, 3201 Alberta Street, Columbus, Ohio.


Osgood, E.E. "Motivational Dynamics of Language Behavior," Nebraska Symposium on Motivation, Nebraska; Lincoln University of Nebraska Press, 1957.


Siegenthaler, B.M. "Speech Reception in Noise for Cerebral Palsied Children," ASHA, 1959, 1, 82.


Wewetzor, K.H. "Bender Gestalt Test with Children," Diagnostic Psychology, 1956, 4, 74.