AN ABSTRACT OF THE THESIS OF

EVAN L. EVANS for the degree of DOCTOR OF PHILOSOPHY

in EDUCATION presented on April 30, 1982

TITLE: AN ASSESSMENT OF ELECTROPHYSIOLOGICAL AND AUDITORY PROCESSING INSTRUMENTS IN RELATION TO LEARNING DISABILITIES

Abstract approved: Redacted for privacy
Dr. Frank Cross

The Purposes of the Study

The purpose of this study was to determine if two (2) central auditory processing tests, and an electrophysiologic assessment would prove to be discriminating between children labeled "learning disabled" from those of a control group.

The Procedures

Two (2) groups of twenty (20) students were selected for this investigation. The first group were children that had previously been identified as having learning disabilities by the school, while the remaining students acted as a control group. All students were randomly selected, met minimum eligibility criterion and were required to provide signed informed parental consent forms. Anon-

imity as to which group each individual belonged was maintained throughout the data collection and reduction procedures.

The data generated were behavioral test scores from the Goldman-Fristoe-Woodcock (G.F.W.) Selective Attention Test, and the Staggered Spondaic Word (S.S.W.) Test, (Katz, 1969). An electrophysiologic measurement, Brainstem Auditory Evoked Potentials (B.A.E.P.) provided neurologic information of the auditory pathway.

A multifactor analysis of variance from the statistical Package for Social Sciences (S.P.S.S.) was used with the Goldman-Fristoe-Woodcock Selective Attention Test, and the Staggered Spondaic Word Test information. A Fortran Program for Difference in Proportions was used with the Brainstem Auditory Evoked Potentials procedures.

The Summary Of Findings

Both behavioral instruments, the Goldman-Fristoe-Woodcock Selective Attention Test, and the Staggered Spondaic Word Test, differentiated the labeled learning disabled children from the control group. The Staggered Spondaic Word Test demonstrated a left-right ear difference present in the normal condition, but not present in the labeled learning disabled children to the same degree.

The Brainstem Auditory Evoked Potentials procedures demonstrated a difference between the groups based upon Wave V. Not only was Wave V more aberrant in the learning disabled children, but this abnormality decreased with increasing age.

It is the finding of this study that the condition "learning disability" has at least two (2) components; one (1) able to be observed and measured behaviorally, the other observed and measured electrophysiologically.

Summary of Conclusions

There was convincing evidence that the neurologic information obtained through electrophysiologic measurements was developmentally or maturationally linked.

This study provides information which will have a direct impact not only on early identification, teacher expectations and federal funding, but on the very definition of "learning disability".

AN ASSESSMENT OF ELECTROPHYSIOLOGICAL AND AUDITORY PROCESSING INSTRUMENTS IN RELATION TO LEARNING DISABILITIES

by

Evan L. Evans

A DISSERTATION

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

DOCTOR OF PHILOSOPHY

June, 1982

APPROVED:

Redacted for privacy

Professor of Education
in charge of major

Redacted for privacy

Head of Department of Education

Redacted for privacy

Dean of Graduate School

Date thesis is presented: April 30, 1982

Typed by Chloe Lynn Evans for: _

DEDICATED TO THE LOVING MEMORY OF MY FATHER, RUSSELL EVANS, AND THE PRAYERFUL SUPPORT OF MY MOTHER AND FAMILY.

ACKNOWLEDGEMENTS

Many caring and dedicated people have given invaluable assistance in the completion of this Study.

I wish to express my most sincere appreciation and gratitude to Dr. Frank Cross, Dr. Mary Jane Wall, and Dr. Jay B. McSpaden, for their guidance, interest and encouragement throughout this project.

Appreciation is also extended to Dr. Emery Hilderbrandt, Dr. Harlan Conkey, Dr. Arthur Gravatt, and Dr. Kenneth Ahrendt for their advice and assistance as committee members.

Special acknowledgements are made to: Dr. Michael Hand, for statistical assistance; Dr. Glenn Dorn, Superintendent, and members of the Jefferson, Oregon School District Board, for their permission and support in conducting this investigation in their district; Marion Education Service District for the use of the audiologic van and technical support, and for their encouragement.

A particularly grateful acknowledgement goes to Penny Steward, Julie Bratten, and Lynn Scoggins for their support, assistance and encouragement with the details that permitted this investigation to take place.

And, last but not least, a final thank you to my wife, Chloe not only for her typing of this project, but for her continuous emotional support, and to my son Paul, for understanding and never questioning why dad was gone 'most every night'.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

AN ASSESSMENT OF ELECTROPHYSIOLOGICAL AND AUDITORY PROCESSING INSTRUMENTS IN RELATION TO LEARNING DISABILITIES

CHAPTER I

INTRODUCTION

A current problem facing educators is the lack of an operational definition for learning disabilities that is concise, definitive and simultaneously exclusive of other handicapping conditions.

The evolution of our current definition of learning disabilities is prima facie evidence that the disorder is difficult to describe. Most often the disability is described from a behavioral observation. The behavior may be poor academic performance. It may also be poor coordination. Often, it may manifest itself as disruptive behavior.

Background Of The Problem

The learning disability phenomenon appears to be comprised of many different components. Among these, (which appear to be significant to any definition,) are academic, behavioral, and even as some suggest, neurologic factors.

Neurologically, the sensory systems responsible for information transport and delivery, become much more complex as the neural pathways proceed inward and upward to the brain. This complexity is the result of the integration of more and more afferent (input) neurons from different sensory modalities blending their component information to make up the aggregate or gestalt. The significance of this concept may best be illustrated through a currently used screening device.

Learning disabled children are often identified with various screening instruments, one of which emphasizes perceptual-motor tasks. These instruments assess behaviors as it relates to the individual as she/he perceives herself/himself in space, i.e, balance.

Another screening device used for identification of learning disabled children employs auditory perceptual tasks.

Both sensory information for balance and hearing share a contiguous afferent neural pathway. If that afferent pathway is not neurologically mature, or is pathologic, information arriving at the brain for processing could be less than complete. The brain processes information that arrives, whether or not it represents an accurate completion of the input signal.

This suggests that measurement of the transmission of signal along the nerve fibers may provide insight as to the location of possible lesions. Lesions include the broad spectrum of anatomic and physiologic entities that interfere with normal function. Foremost among these is developmental neural delay.

We have available to us instruments that are sensitive to specific areas along the auditory pathway. These instruments are presently employed clinically, in the differential identification of the foci of lesions in the practice of audiology. If these instruments are capable of discriminating between children labeled "normal" and those labeled as being "learning disabled", earlier identification might be possible. In addition, the implications for differential remediation strategies would be immense.

Statement Of The Problem:

The problem is to ascertain if central auditory processing tests, and an electrophysiologic assessment will prove to be discriminating between children labeled "normal" and those labeled as being "learning disabled".

Specifically, will the Goldman-Fristoe-Woodcock "Selective Attention Test"; Katz's "Staggered Spondaic Word Test", and Brainstem Auditory Evoked Potentials, (BAEP), demonstrate significantly different scores between normal children and children identified as having learning disabilities?

Assumptions:

The following assumptions underlie this study:

The heterogeneous nature of those individuals grouped in this study includes a wide range of differences. It is assumed that these differences are randomly distributed within each group and will not, therefore, bias the results of this study.

The school district's eligibility criteria for the learning disabilities program is selective, and uniformly applied. It is assumed that children currently receiving services for learning disabilities are representative of that disorder.

Limitations Of The Study:

Although "learning disabilities" is a generic description representing a variety of possible entities, and input mechanisms, our attention has been limited to factors involving the auditory system alone for purposes of this study.

The selection of instruments is not to be construed as exhaustive, even within the limits of the auditory modality, merely as representative.

Participants in this study represent a serial sample of children labeled "learning disabled" and a sample matched for age and sex alone from a randomly selected group of children labeled "normal".

HYPOTHESES:

In order to examine the potential for some significant neurologic differences between learning disabled and non-learning disabled groups, both behavioral and physiologic test procedures must be utilized in assessing performance. To that end, the following hypotheses are set forth.

<u>Staggered Spondaic Word Test:</u>

1) H_o There is no significant difference of total test scores as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of total test scores as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

2) H_o There is no significant difference of test scores for the right ear as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of test scores for the right ear as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

3) H_o There is no significant difference of test scores for the left ear as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of test scores for the left ear as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

4) H_o There is no significant difference of test scores for the right ear attributed to sex as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of test scores for the right ear attributed to sex as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

5) H_o There is no significant difference of test scores for the left ear attributed to sex as measured by the Staggered

Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of test scores for the left ear attributed to sex as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

6) H_o There is no significant difference of test scores obtained for the right ear and those of the left ear as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of test scores obtained for the right ear and those of the left ear as measured by the Staggered Spondaic Word (SSW) Test between children labeled as being learning disabled and those of a control group.

Goldman-Fristoe-Woodcock Selective Attention Tests:

7) H_o There is no significant difference of test scores obtained on the "fan"

subtest of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of test scores obtained on the "fan" subtest of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

8) H_o There is no significant difference of test scores obtained on the "cafeteria" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of test scores obtained on the "cafeteria" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

9) H_o There is no significant difference of test scores obtained on the "voice" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled

and those of a control group.

H_a There is a significant difference of test scores obtained on the "voice" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

10) H_o There is no significant difference of total test scores as measured by the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

H_a There is a significant difference of total test scores as measured by the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

Brainstem Auditory Evoked Potentials:

11) H_o There is no significant difference in latency values between those children labeled as being learning disabled and those of a control group for the occurrence of Waves I, III and V for the right or left ear as measured by the Brainstem Auditory Evoked Potentials.

H_a There is a significant difference in latency values between those children labeled as being learning disabled and those of a control group for the occurrence of Waves I, III and V for the right or left ear as measured by the Brainstem Auditory Evoked Potentials.

12) H_o There is no sigificant difference in central conduction times of two administrations to the same ear between those children labeled as learning disabled and those of a control group, when comparing Waves I-III, I-V, and III-V for the right ear.

H_a There is a significant difference in central conduction times of two administrations to the same ear between those children labeled as learning disabled and those of a control group, when comparing Waves I-III, I-V, and III-V for the right ear.

13) H_o There is no significant difference in central conduction times of two administrations to the same ear between those children labeled as being learning disabled and those of a control group, when comparing Waves I-III, I-V, and III-V,

for the left ear.

14) H_o There is no significant difference in latency values for the occurrence of Wave V between ears at the same sensation level, when comparing those children labeled as being learning disabled and those of a control group.

H_a There is a significant difference in latency values for the occurrence of Wave V between ears at the same sensation level, when comparing those children labeled as being learning disabled and those of a control group.

15) H_o There is no significant difference in the superimposability of two successive stimulus runs for the right ear between those children labeled as being learning disabled and those from a control group.

H_a There is a significant difference in the superimposability of two successive stimulus runs for the right ear between those children labeled as being learning disabled and those from a control group.

16) H_o There is no significant difference in the superimposability of two successive stimulus runs for the left ear between those children labeled as being learning

disabled and those from a control group.

H_a There is a significant difference in the superimposability of two successive stimulus runs for the left ear between those children labeled as being learning disabled and those from a control group.

17) H_o There is no significant difference in amplitude reduction at any one of the Peaks (I, III, V) when comparing the results of both ears, between those children labeled as being learning disabled and those from a control group.

H_a There is a significant difference in amplitude reduction at any one of the Peaks (I, III, V) when comparing the results of both ears, between those children labeled as being learning disabled and those from a control group.

18) H_o There is no significant difference in wave shape abnormalities of Peaks I, III, V, of either ear between those children labeled as being learning disabled and those from a control group.

H_a There is a significant difference in wave shape abnormalities of Peaks I, III, V, of either ear between those children labeled as being learning disabled and those from a control group.

19) H_o There is no significant difference as to "peak presence" or absence, of the first five (5) of the Jewett Seven (7) peaks when comparing those children labeled as being learning disabled and those from a control group.

H_a There is a significant difference as to "peak presence" or absence, of the first five (5) of the Jewett Seven (7) peaks when comparing those children labeled as being learning disabled and those from a control group.

20) H_o There is no significant difference in latency values for the occurrence of Wave V between ears at the same sensation level, by age groups, when comparing those children labeled as being learning disabled and those of a control group.

H_a There is a significant difference in latency values for the occurrence of Wave V between ears at the same sensation level, by age groups, when comparing those children labeled as being learning disabled and those of a control group.

DEFINITION OF TERMS

Amplitude Reduction:

Refers to Brainstem Auditory Evoked Potential Tracings; the maximum deflection of a specific wave. When looking at the same wave between two (2) successive runs, is the height (amplitude) of the wave reduced by 50%?

Audiometric Evaluation:

Pure Tone Audiometric evaluation utilizing 500 Hertz (Hz) or cycles per second, 1000Hz, and 2000Hz. Minimal eligibility requires that the average of the above frequencies be no worse than 20dB for each ear.

Auditory Pathway:

Refers to both the peripheral and central auditory sensory systems. Specifically refers to the afferent neurological pathway from the Organ of Corti to Heschl's gyrus in the Sylvian fissure of the temporal lobes of the brain (see Figure #4)

Auditory Stimulus:

Pertaining to the organ of hearing. A stimulus, either a tone or speech that is presented via headphones.

Brainstem Auditory Evoked Potentials:

Minute electrophysiological measurements obtained by surface electrodes measuring neural activity to an auditory stimuli. These electropotentials are preamplified and sent to an averaging processor resulting in a graph of neurological activity usually within the first 10 milliseconds following onset of auditory stimulation.

Central Auditory Disorders; Dysfunction:

Refers to central nervous system disorders, specifically of the auditory pathway, usually from the cochlear nerve as it passes through the brainstem, cerebellum, thalamus, and cortex.

Central Conduction time:

Refers to the latency or time value between one wave and another wave. These measurements were made between Wave I-III, Wave I-V, and Wave III-V, between two successive administrations to the same ear. The latency values were judged to be the same if they were within .2 msec of each other.

Central Testing:

Specialized tests that have demonstrated a sensitivity to disorders involving the central nervous system utilizing the auditory modality by stressing the integrity of the system. (i.e., complex speech messages and/or competing messages.)

Conductive Hearing Loss:

A type of hearing loss common to children, often due to the presence of a fluid in the middle ear space. The fluid may be described as Middle Ear

Effusion, Otitis media. A conductive loss is usually not considered to be a permanent hearing loss, but may often be present yet unnoticed.

Demyelination:

A breakdown in the myelin sheaths or protective covering around the nerve fibers located along the neural pathway.

Dichotic:

A condition in which two separate signals are presented, one to each ear at the same time.

Diotic:

A condition in which two separate signals are presented, together, at the same time into one ear.

Electrophysiology:

A branch of science concerned with electrical phenomena that are associated with physiological processes. Electrical phenomena are prominent in neurons and effectors.

Electrophysiologic Measurements:

Pertaining to the study and measurement of minute changes in electrical potentials as the afferent system transports its information to the brain.

Impedance Audiometry:

A measurement technique that assesses the resistance of an acoustic signal to pass through the external auditory canal, tympanic membrane and the middle ear system.

Inter-Peak Latency:

Compares latency or time differences for Peak V between ears, to stimulus presentations made at the same intensity, or sensation level. Differences greater than .2 milliseconds suggest a dysfunction along the auditory pathway.

Intra-Peak Latency:

Measurement of the central conduction time between peaks I-III, I-V, and III-V, for the same ear. Measurements are made for time differences between peaks by comparing two successive stimulus runs on the same ear. This conduction time is thought to be abnormal if it exceeds $\pm$.2 milliseconds between the two stimulus runs when comparing the same peaks.

Latency:

A measurement of time between two points, peaks or waves.

Learning Disabled:

Those children who have met the Jefferson School District's eligibility criteria for learning disabilities (see learning disability)

Learning Disability:

Taken from Jefferson School District 14-J and used in this study.

"Specific learning disability" means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think speak, read, write, spell, or do mathematical calculations. Children with a specific learning disability are unable to profit from regular classroom methods and materials without special educational help, and are, or will become, extreme under-achievers. These deficits may be exhibited in mild to severe difficulties with perception (the ability to attach meaning to sensory stimuli), conceptualization, language, memory, motor skills, or control of attention.

The team may not identify a child as having a specific learning disability if the discrepancy between ability and achievement is primarily the result of:

a. Visual handicap (as determined by a licensed optometrist or Opthamologist), hearing impairment (as determined by a licensed audiologist or physician), orthopedic impairment or other health impairment (as determined by a licensed physician),

b. Mental retardation (as determined by a qualified examiner such as a school or certified psychologist),

c. Emotional disturbance (as determined by qualified educational authorities), or,

d. Environmental, cultural, or economic disadvantage (to be determined by the placement team).

The child is assessed in all areas related to the suspected disability including, where appropriate, health, vision, hearing, social and emotional status, general intelligence, academic performance, communicative status, and motor abilities.

Lesion:

Pertaining to a wound, or injury; a pathological change in the tissues.

Middle Ear Effusion:

A term to describe several different conditions of the middle ear producing a conductive hearing loss, and thereby interfering with the reception of auditory stimuli.

Peak Latency:

(See inter-peak latency or intra-peak latency)

Peak Presence:

Are all five peaks described by Jewett & Williston present for both ears? The level where the peak is missing or aberrant is thought to represent the level of dysfunction in relation to the anatomical site.

Peripheral Hearing Disorders:

Disorders of the outer and middle ear systems. These are typically assessed via pure tone and impedance measurements. Representative of peripheral hearing disorders, but not limited to, would be conditions of impacted cerumen (wax) and Otitis Media.

Pure Tone Sensitivity:

A person's ability to hear various puretone frequencies. The usual frequencies tested included 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz and 8000Hz. Our present method requires the individual to make a behavioral response (raising the hand,) to indicate they heard the tone.

Randomization Process:

The utilization of a table of random numbers for purposes of selecting participants from a pool of eligible students.

Response Stability:

Response stability is demonstrated by the ability to superimpose two (2) successive stimulus runs of the same ear. Nodar reports that the peak where response stability is lost suggests the level of dysfunction in relation to the anatomical site.

Selective Attention:

Refers to the ability to concentrate on, or selectively attend to and perceive a primary signal when presented in a variety of environmental noise or competing messages.

Sensori-Neural:

A hearing loss occurring in the cochlea, or nerve fibers extending from the cochlea to the temporal lobes. This type of hearing loss has been described as a permanent hearing loss.

Spondaic Words:

Words with two (2) syllables having equal stress on each syllable, (i.e., airplane, toothbrush, sidewalk, hotdog).

Staggered Spondaic Words Test:

Developed by Jack Katz, Ph.D., in 1962 as a test to assess the central auditory system. A dichotic speech procedure using spondaic words in an overlapping fashion.

Superimposability:

Refers to the tracings of two successive stimulus runs on the same ear, at the same sensation level being identical with regard to the wave presence, amplitude, latency of waves, etc.

Tympanograms:

A graphic record of the compliance (ability to move) of the tympanic membranes and middle ear system. These are usually described as being either Type A, B, or C. Type A Tympanograms represent a normal condition, while B and C represent various states of abnormal compliance.

Waves:

Refers to the graph of Brainstem Evoked Potentials, with each wave being generated by different anatomical sites along the auditory pathway. (Jewett and Williston 1971.)

Wave I. Generated by the VIIIth Cranial Nerve (Auditory Nerve)

Wave II. Generated from the cochlear nucleus.

Wave III. Generated from the regions of the Superior Olivary Nucleus.

Wave IV. Thought to originate from the Ventral Nucleus of the Lateral Lemniscus.

Wave V. Generated from the Inferior Colliculus.

Waveshape Abnormality:

Abnormalities in the shape or contour of the wave, i.e., flattening, broad based peaks or additional peaks.

THE HISTORICAL DEVELOPMENT OF LEARNING DISABILITIES AS AN ENTITY

CHAPTER II

The determination as to whether learning disabilities is or is not a new phenomenon to education is purely academic. It is of importance to note that only recently have educators had to face this problem.

Local school districts are currently under a federal mandate to identify and serve all handicapped students. They receive federal money to assist in implementing services to children identified as "handicapped".

"Learning Disabilities" is a specific category within Public Law 94-142, thereby requiring school officials to identify and serve learning disabled children as being handicapped students. This becomes a problem for several reasons, not the least of which is, that too few people can agree upon a definition of what learning disabilities should include. In fact, some have not accepted even the term "learning disability" itself.

A review of the literature indicates that only twelve (12) states had legislation referring directly or indirectly to children with learning disabilities by 1969. Ten (10) of these twelve (12) states passed this legislation after 1963. By 1975, however, all states had legislation that provided for the development of programs for the learning disabled child. (Gearheart, 1977)

The most confusing aspect of this plethora of legislation was terminology.

Most states used the term "learning disability" or "specific learning disabilities". Other terms that were used included "perceptual and communicative disorders", "language disorders", "neurological impairments", and "learning disorders". (Gearheart, 1977)

In the hope of clarifying some of the confusion, the Bureau of Education For The Handicapped established a blue ribbon advisory committee headed by Dr. Samuel Kirk. The following is taken from their report of January 31, 1968. (Special Education For Handicapped Children: First Annual Report, 1968)

> Confusion now exists with relationship to the category of special learning disabilities. Unfortunately, it has resulted in the development of overlapping and competing programs under the headings of 'minimal brain dysfunction,' 'dyslexia,' 'perceptual handicaps.' To serve as a guideline for its present program, this committee suggests the following definition. Children with special learning disabilities exhibit a disorder in one or more of the basic psychological processes involved in understanding or in using spoken or written languages. These may be manifested in disorders of listening, thinking, talking, reading, spelling, writing, or arthmetic. They include conditions which have been referred to as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, developmental phasia, etc. They do not include learning problems which are due primarily to visual, hearing, motor handicaps, mental retardation, emotional disturbance, or to environmental disadvantage.

Others have their own definitions. Joseph Wepman (Gearheart, 1977) for example, proposed:

> Specific learning disability refers to those children of any age who demonstrate a substantial deficiency in a particular aspect of academic achievement because of perceptual or perceptual motor handicaps regardless of etiology or other contributing factors. The term perceptual relates to those mental (or neurological) processes from which the child acquires his basic alphabet of sound and form. The term perceptual handicap refers to inadequate ability in such areas as the following: recognizing fine differences between auditory and visual discriminating features underlying the sounds used in speech and in orthographic forms used with reading; retaining and recalling those discriminated sounds and forms in both short and long term memory; ordering the sounds sequentially, both in sensory and motor acts; distinguishing figure ground relationships; recognizing spacial and temporal orientations, obtaining closure; integrating intersensory information, relating what is perceived to specific motor functions.

Johnson and Myklebust proposed the term "psychoneurological learning disabilities," as a definition in the first chapter of their book entitled: "Learning Disabilities: Educational Principles And Practices." They propose the following:

> In those having a psychoneurological learning disability, it is the fact of adequate motor ability, average to high intelligence, adequate emotional adjustment, together with a deficiency in learning that constitutes the basis for homogeneity.

Their use of the term "psychoneurological" indicates their belief that the disorder is one of behavior and that the causation is neurologic.

Regardless of the actual cause, local districts identify, label and receive federal dollars based upon this definition from the Federal Registry of November 29, 1976.

> Children with specific learning disabilities mean those children who have a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in imperfect ability to listen, think, speak, read, write, spell, or do mathematic computations. Such disorders include conditions as perceptual dyslexia, and developmental aphasia. Such terms do not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps of mental retardation, of emotional disturbance, or of environmental disadvantage.

It goes on to say:

> A child has a specific learning disability if: 1) the child does not achieve commensurate with his or her age and ability levels in one or more of the areas listed below when provided with learning experiences appropriate for the child's age and ability levels, or 2) if a child has a severe discrepancy between academic achievement and intellectual ability in one or more of the following areas.
>
> Those areas specifically identified are: oral expression, listening comprehension, written expression, basic reading skills, reading comprehension, mathematics computations, mathematics reasoning, or spelling. A severe discrepancy between achievement and intellectual ability means achievement in one or more of the areas listed above which falls at or below 50% of the child's expected achievement level on intellectual ability, age and previous intellectual experiences considered.

From a financial point of view, these definitions did little to console lawmakers concerned that much of the funding intended for other disorders would now be given to those programs dealing with learning disabilities.

They resolved their problem in this way. Public Law 94-142 provides that the States may serve up to twelve (12) percent of their total educational population as being "handicapped." But, it also proscribes that no more than 1/6 of those served as "handicapped" may be served as "learning disabled." This would, then, protect services to programs for other handicapping conditions from the over-application of funds by those working with learning disabilities.

Poor Results May Be Reflective Of Our Understanding The Problem

There are, at present, large numbers of special education programs for children with learning disabilities. Elizabeth Koppitz (1972) reported a longitudinal study involving one-hundred-seventy-seven (177) children with a mean age of eight years eleven (8-11) months. Over a five (5) year period, she found that one fourth (1/4) of these children were returned to their regular classrooms. One-fourth (1/4) moved out of the district, and one-half (1/2) of the children continued to need special education treatment in special classrooms. In a related study, Gottesman, Bellmont, and Kaminer (1975) reported on fifty-eight (58) of seventy (70) children with similar results.

Our inability to specifically define the origin or nature of the disorder may account for these poor results. A more objective definition is needed.

Subjective behavioral definitions tend to allow excessive amounts of "academic liberties" and "labeling". The labels when inappropriately applied may only serve as "self-fulfilling prophesies." If a child is called "retarded," one expects less. The records show that the child achieves less.

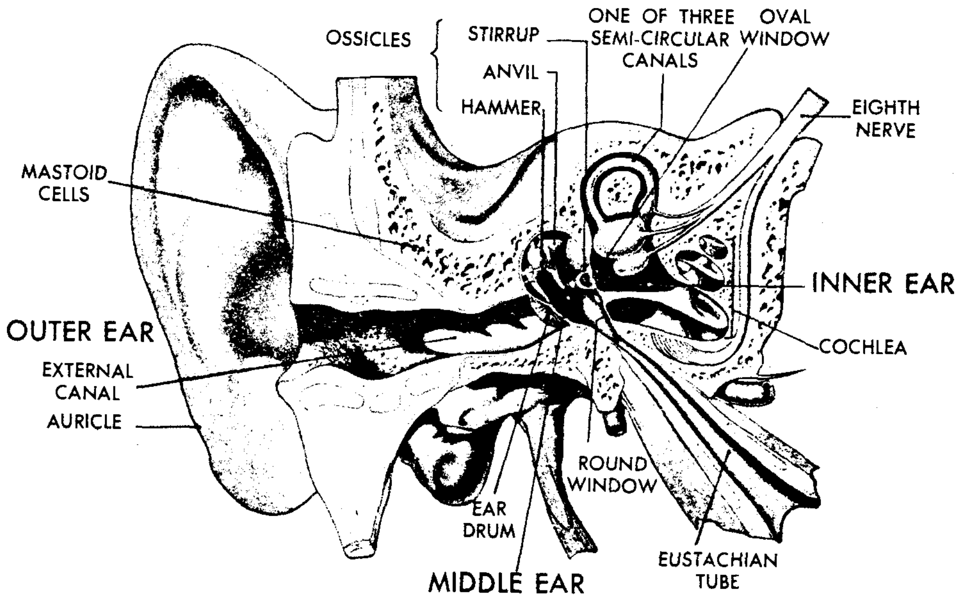
In 1976, Foster, Schmidt and Sabbatino did a study in which they asked teachers to observe a video tape of a child and rate deviant behaviors. Half were told that the child was normal. Half were told that the child was learning disabled. Predictably, the teachers who were told that he had a learning disability found significantly more deviant behaviors than those told that he was normal. The "label" is appropriate only if it enables the child to obtain proper intervention that s/he requires.

Evaluation Of The Auditory System

The auditory system is divided into three (3) general areas for purposes of evaluation. The outer ear consists of the pinna, external auditory canal and the tympanic membrane. The middle ear consists of three bones, (malleus, incus, stapes) the middle ear cavity and eustachian tube. The inner ear consists of the cochlea, acoustic nerve (VIII), brainstem and temporal lobes of the brain. (See figure #1)

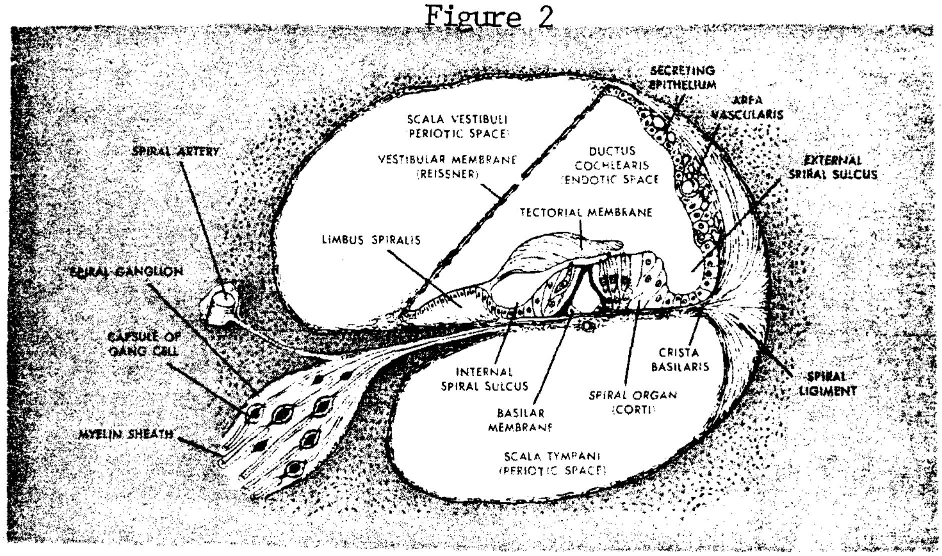
The evaluation of the "peripheral" system generally assess the outer and middle ear. During this evaluation, attention is drawn to the presence or absence of middle ear effusion. Most authors include the cochlea in the peripheral category, thereby including puretone stimulus

Figure 1



Section of Ear, Taken from "Audiology" Newby, Hayes A., 2nd Edition Appleton-Century-Crofts. 1964 pg. 16.

Figure 2



Cross section of cochlear canal. (From A.T. Rasmussen, Outlines of Neuro-Anatomy, 3rd Edition, Dubuque, Ia., Wm. C. Brown Co.

sensitivity as part of the peripheral evaluation.

The Central Auditory Evaluation consists of the Acoustic Nerve (VIII), brainstem, and temporal lobe information. Traditionally, we have erroneously relied upon the individual's pure tone sensitivity as being representative of the entire system.

The Limitations Of "Peripheral" Test Results

Often the Audiologist, or Speech and Language Pathologist informs parents that their child's hearing is within normal limits. They may further assert that any learning difficulties the child may have are not based within the auditory system. The basis for these statements is the finding that the child has normal sensitivity to pure tones. This reassuring statement is not warranted in many children with learning disabilities.

It is easy to be critical of those making inaccurate statements. It is not so easy to offer alternative methods, or instruments which may assess the central auditory system so that reassuring statements that are accurate can be made.

Assessment of the peripheral system must be done first. Minimal hearing loss has an important effect upon learning and learning disabilities. Northern states, "the mere presence of otitis media may be considered as presumptive evidence that a hearing disability exists." (Northern and Downs) Similarly, Needleman in 1977 indicated that minimal hearing losses showed significant differences between groups as measured by the Templin-Darley Articulation Test (1969), the Goldman-Fristoe Woodcock Test of Auditory Discrimination (1970) and the sound blending sub-test of the Illinois Test Psycholinguistic Abilities (Kirk et al 1968). Differences in performance decrease as the subject's ages increased, but the experimental group (those with a hearing loss) never caught up with the control group. The authors make a plea for educating both parents and professionals on the effects of intermittent loss due to recurrent otitis media. They stress the need for early intervention to prevent or compensate for language delay.

Other authors investigating learning disabilities found middle ear pathology to be a common disorder among those that were so identified. Masters and Marsh reporting in the Journal of Learning Disabilities, (February, 1978), found that a significantly greater proportion of learning disabled subjects were identified as having middle ear pathology. Further, the incidence of middle ear pathology for the learning disabled group was unusually high. Brooks, (1974) reported incidences as high as 25% for the learning disabled group against 13% for a control group. They state that while a cause and effect relationship cannot be assumed, it is imperative that when selecting candidates for studies in learning disabilities middle ear pathology must be ruled out as a contributing factor.

The evidence is very strong that learning disabled children have more episodes of potentially debilitating middle ear effusion. Further, the evidence is strong that the neurological development of the auditory pathway is directly dependent upon the neurons being stimulated auditorily.

Webster and Webster, (1977), created conductive hearing losses operatively in mice at three (3) days of age. They also deprived litters of mice of sound by surgically closing the mothers' larynges and rearing them in a sound-attenuated chamber. These two (2) groups, plus a normal control group, were sacrificed at forty-five (45) post natal days and their brains examined. Both the operated group and the deprived groups were found to have central morphological defects. These constituted significant differences from the brains of the control group. In the experimental groups, these differences were found: 1) smaller neurons of the globular cell group and medial nucleus of the trapezoid body; 2) fewer neurons of the dorsal cochlear nucleus; and 3) fewer neurons per unit area in the central nucleus of the inferior colliculus. (Northern and Downs, 1978)

In addition, Webster and Webster were able to study a normal human child's brain and one of a profoundly deaf nine (9) year old child with maternal rubella syndrome. The findings were consistent with the earlier studies on mice, yet more prominent.

More recently, Webster and Webster (1978) reported a study showing that the central effects of the early conductive losses of mice were not reversible. They demonstrated this irreversibility by restoring the hearing of a group of early-deprived mice, and found that signficiant differences formerly reported remained even after long periods of normal hearing.

The authors speculate "...that there is a critical developmental period in which proper meaningful sound must be received from the central auditory system to mature normally". (Northern and Downs, 1978)

Clearly, recent studies involving disorders of the auditory modality have been pointing to the inner most mechanism as the "new frontier." "Contemporary clinical audiology must go beyond the differential assessment of the the peripheral auditory system if the learning disabled population is to be adequately evaluated."

A new set of clinical tools is required to help identify the hidden dysfunctions of the central auditory nervous system. The more subtle deficiencies of auditory functions in many patients with brain stem or brain lesions and learning disabilities may elude detection if standard tests alone are used. The reason probably lies in the complex nature of the auditory system itself.

<u>The Complexity Of The Central Auditory System:</u>

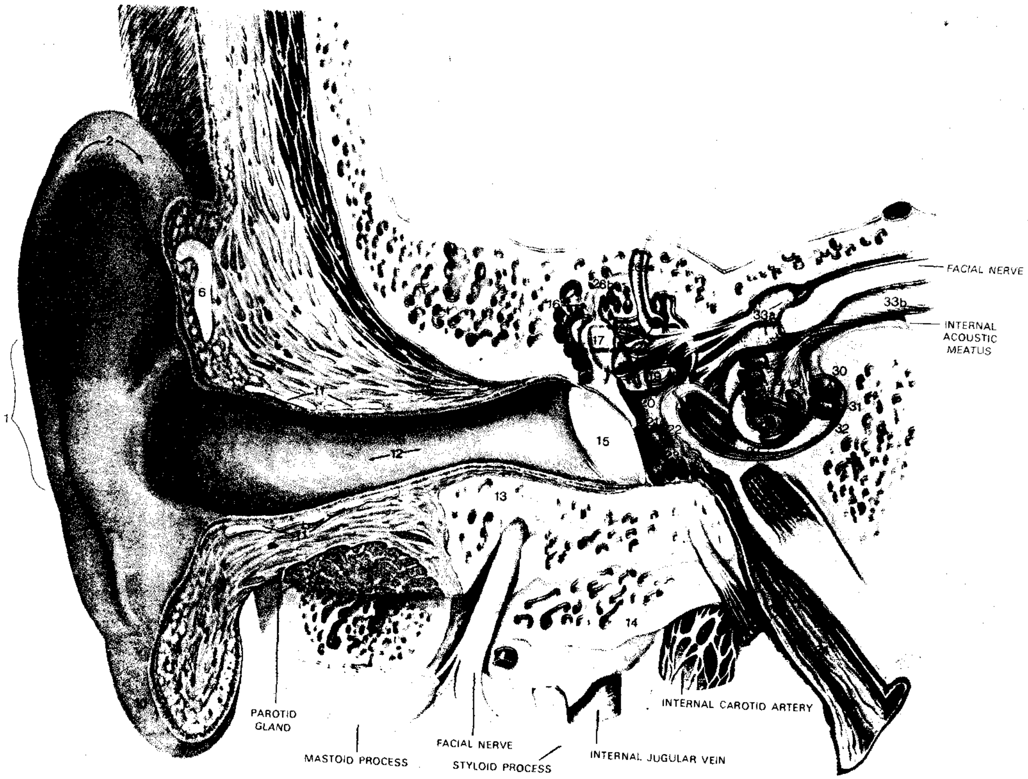
It is necessary to understand the anatomical structure and physiological function of the system if one is to develop clinical tools that can differentiate central problems from those of the periphery.

The primary fibers of the auditory pathway begin at the level of the spiral ganglion located in the modiolus at the foundation of the cochlea. Fibers distal to the spiral ganglion are stimulated by the organ of corti, or "haircells." (See Figures 2 & 3) Proximal fibers extend to form the cochlear nerve. The fibers of the cochlear nerve bifurcate and terminate at the dorsal and ventral cochlear nuclei upon entering the brainstem at roughly the junction of the medulla and the pons. (See Figure 4) (Everett, Sundsten, and Lund, 1971; Matzke and Foltz, 1972 Whitfield 1967.) At this point, the signal has been transferred to neural firings in the ipsi-lateral cochlear nuclei for purposes of recoding. (Carhart 1969) The central auditory pathway is taken to begin at the synapse of the first and second ordered neuron along the afferent pathway at the cochlear nuclei. (See Figure #4)

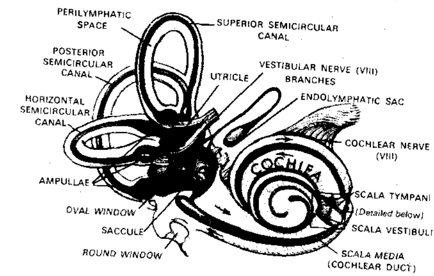
Jerger (1960) describes the "bottleneck principle." This principle states that the transmission of complex stimuli such as speech, comes from across a labyrinth or "bottleneck" along cranial nerve VIII and in the lower brainstem area. If a lesion occurs at this point, marked reduction in the comprehension of speech messages will be observed.

Medially, from the cochlear nuclei, the complexity of

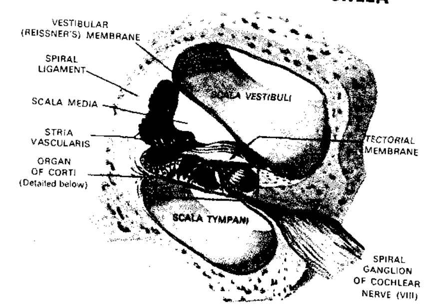
Figure 3



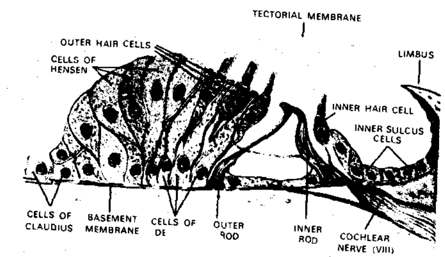
THE MEMBRANOUS LABYRINTH



SECTION THROUGH THE COCHLEA



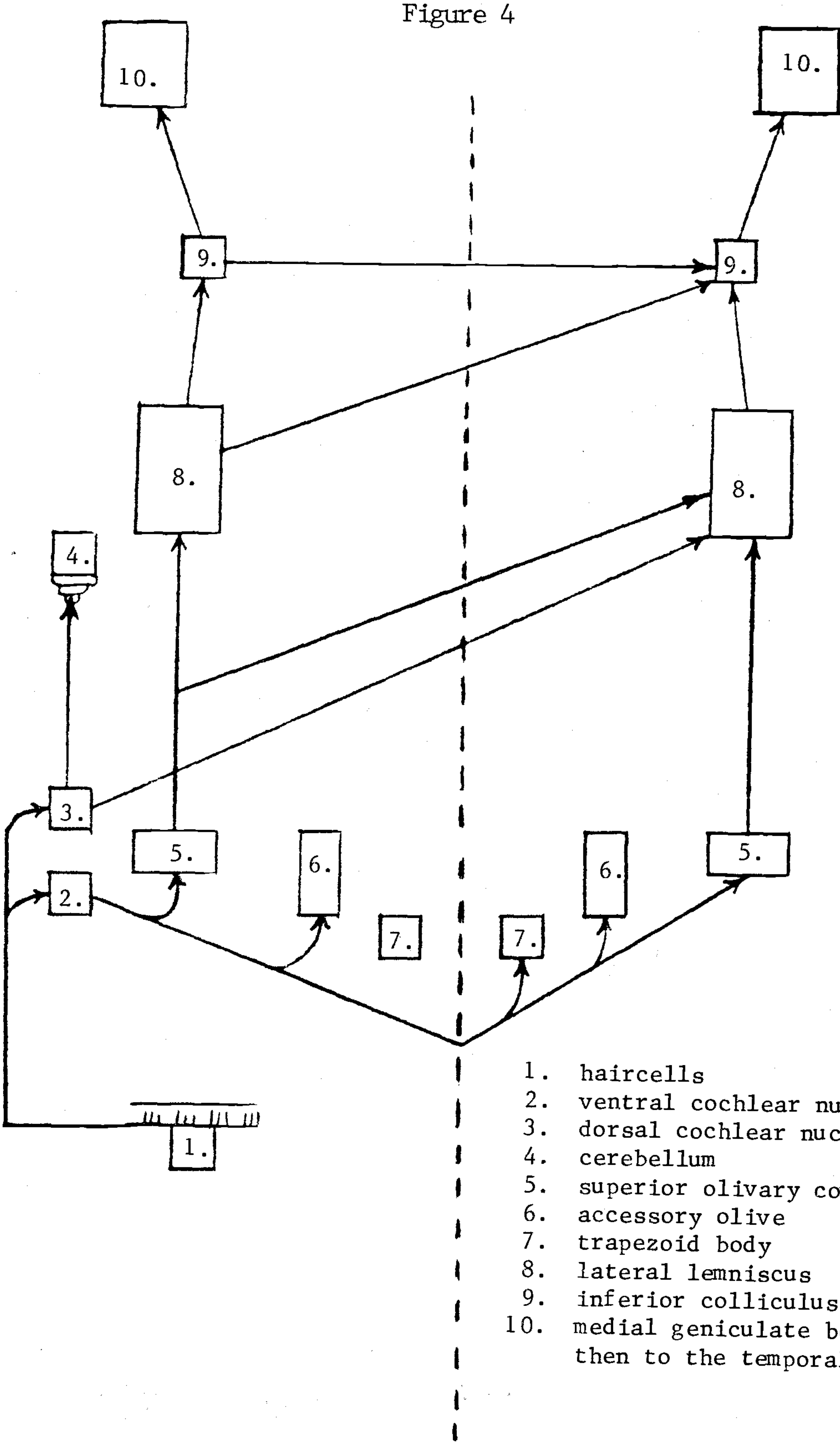
DETAIL OF THE SPIRAL ORGAN OF CORTI



1. AURICLE (PINNA)
2. HELIX
3. FOSSA OF HELIX (SCAPHA)
4. ANTIHELIX
5. CRUS OF HELIX
6. CARTILAGE OF AURICLE
7. BOWL (CONCHA)
8. TRAGUS (NOT SHOWN)
9. ANTITRAGUS
10. LOBE
11. EXTERNAL ACOUSTIC MEATUS (CARTILAGINOUS PART)
12. EXTERNAL ACOUSTIC MEATUS
13. EXTERNAL ACOUSTIC MEATUS (BONY PART)
14. TYMPANIC PART OF TEMPORAL BONE
15. EARDRUM (TYMPANIC MEMBRANE)
16. ATTIC (EPITYMPANIC RECESS)
17. HAMMER (MALLEUS)
18. ANVIL (INCUS)
19. STIRRUP (STAPES) IN OVAL WINDOW
20. PROMONTORY
21. UMBO
22. ROUND WINDOW
23. TYMPANIC CAVITY
24. AUDITORY (EUSTACHIAN) TUBE
25. TENSOR TYMPANI MUSCLE (CUT)
26. SEMICIRCULAR CANALS
    - 26a. SUPERIOR
    - 26b. POSTERIOR
    - 26c. HORIZONTAL
27. AMPULLAE
28. VESTIBULE (CONTAINING UTRICLE AND SACCULE)
29. COCHLEA
30. SCALA TYMPANI (TYMPANIC CANAL)
31. SCALA MEDIA (COCHLEAR DUCT)
32. SCALA VESTIBULI (VESTIBULAR CANAL)
33. ACOUSTIC NERVE (VIII)
    - 33a. VESTIBULAR DIVISION
    - 33b. COCHLEAR DIVISION

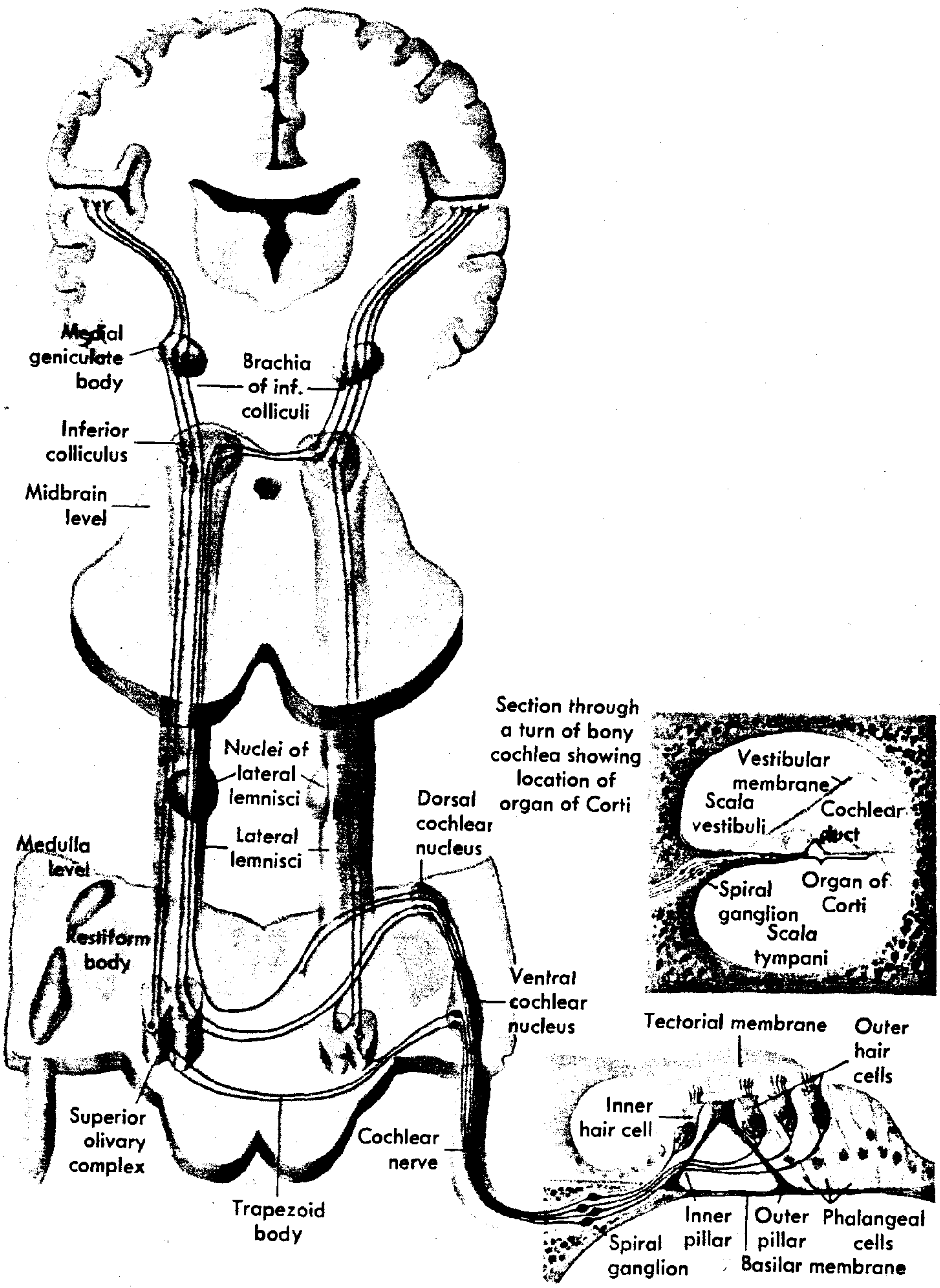
PRESENTED BY

Figure 4



1. haircells
2. ventral cochlear nucleus
3. dorsal cochlear nucleus
4. cerebellum
5. superior olivary complex
6. accessory olive
7. trapezoid body
8. lateral lemniscus
9. inferior colliculus
10. medial geniculate body
then to the temporal lobes

Figure 5



CIBA

the central auditory system increases, and the complex signal transmitted to the auditory cortex follows various routes. Because of the diversity and the redundancy of both the pathways and the speech signal itself, lesions of the central auditory pathways tend not to manifest themselves during conventional audiometric pure tone tests. This has been referred to as the "Subtlety Principle," by Jerger. (1960)

These factors were also discussed by Bocca and Calearo in 1963. They stated that central auditory disorders are not evidenced on standard differential diagnostic tests of aural pathology. If there is a loss or lesion in the central auditory system, the speech signal (with its generic redundant characteristics) will be transmitted to and interpreted by the auditory cortex. This leads one to believe that central auditory disorders might best be detected if the redundancy of speech is reduced sufficiently to challenge the integrity of these higher auditory centers.

Most of the auditory fibers from the cochlear nuclei decussate. They may terminate in the trapezoid body, the superior olivary complex, or the reticular formation. (Carpenter, 1972) Because of the ipsilateral contralateral routing of the fibers from the cochlear nuclei to the superior olivary complex and/or trapezoid body, a binaural phenomenon is initiated at this level of the brain stem. (Carhart 1969) Localization ability is thought to occur at the superior olivary complex (Walsh, 1957; Galambos, Schwartzkopff and Rupert, 1959)

There is a specialized neural network in the central portion of the brain stem. This neural network is referred to as the reticular formation or reticular activating system (RAS). The ascending reticular activating system (which dispatches projections upward to the surface of the cerebral cortex) receives sensory input from each sensory end organ and is influential in the neuro-integration. French (1957) considers the reticular formation to be the principle control system in the central nervous system. This network has been described as a "general alarm mechanism." When activated by incoming sensory stimuli it arouses the cortex in order that incoming information can be interpreted. Magoun, (1963), refers to the reticular activating system as discriminative, infering that this system aids the cortex in selecting signals which are of a focal importance, while inhibiting others. At least one author has used this information to postulate that learning disabled children may have reticular system failures in this discrimination task. This might allow too many sensory signals to stimulate the child (Ayres 1972). One could hypothesize a faulty reticular activating system hindering the learning process (which is of importance to the transmission of auditory information). Obviously, an unalerted cortex would be unprepared to perform efficiently.

It is reasonable that inhibitory, facilitative and integrative functions might be disturbed in a variety of ways accounting for the different behaviors observed in learning disabled children. In some children, attention is continually interrupted as they are attracted to rapidly changing signals in their environment. Others may suspend central nervous processing because of these changing stimuli. Such children seem to function efficiently only in the absence of competing sensory input. Moreover, sensory channels may become "jammed" in unpredictable ways.

Goldstein (1967) has taken another position. He theorizes that the reticular formation is not primarily a cortical alerting system. He believes that the cerebral cortex is alerted via the rapid "transmission lines" of the central auditory system, - the lateral lemnisci. When discriminatory action is necessary, efferent tracts from the cortex course through the reticular activating system carrying auto-corrective and integrative messages.

From the trapezoid and superior olivary complex, the majority of ipsilateral and contralateral fibers extend to the appropriate lateral lemniscus, inferior colliculus, and medial geniculate body. At these levels, it is theorized that more recoding of binaural and monaural stimuli occurs (Carhart, 1969). Further, electrophysiological studies suggest that the nucleus of the inferior colliculus might be an integration and reflex control center. (Matzke and Foltz, 1972) In some areas of the primary auditory projection pathway, tertiary fibers also arise (such as the superior olivary complex) which decussate and terminate at various levels.

The medial geniculate body is the final sub-cortical level in the higher auditory system prior to fiber connections in the cortex. The synapse between the third-and fourth-order neurons in the medial geniculate bodies is considered the rostral termination of the brain stem. (Carhart 1969)

A substantial body of evidence suggests that the human auditory system is finally represented by projections to both left and right temporal lobes from each ear (Sparks, Goodglass and Nichol, 1970). It is also generally agreed that the crosses or contralateral pathways are dominant. Further, ipsilateral pathways seem to serve a secondary role. In this way, each ear has a greater influence on its contralateral than it does on its direct ipsilateral temporal lobe.

Basic to this discussion is the commonly accepted theory that the left temporal lobe in most humans (85%) is dominant for linguistic processes while the right temporal lobe is dominant for nonlinguistic functions. This characteristic is maintained even though there are important transverse connections between the two brain hemispheres via the corpus callosum and the anterior commissure.

Assessment Of The Central Auditory System

The audiologist utilizing auditory tests can generally divide pathologic responses of the auditory system into at least five (5) general areas: conductive, cochlear, retro-cochlear, brainstem and temporal lobe.

Our primary concern is the assessment of the Central Auditory System, which is comprised of the Eighth Cranial Nerve, brainstem and temporal lobes.

Lynn and Gilroy (1972, 1974, 1975) have been particularly successful in demonstrating the clinical value of central auditory nervous system tests. They have demonstrated systematic performance characteristics on central auditory tests in patients with lesions of the brain and brainstem. They found the Rapidly Alternating Speech Discrimination Test (Williford 1976) and the Staggered Spondaic Word (SSW) Test (Katz, 1962) useful in locating low brain stem lesions. They also found the Low Pass Filtering Test and Williford's Competing Sentences Test helpful in identifying superficial and deep lesions within the cerebrum.

Smith and Resnick (1972) used a dichotic binaural fusion test for identification of brain stem lesions. The technique was based on Matzker's (1959) Test in differentiating patients with brain stem lesions from normal, cochlear impaired and brain pathology cases. They found performance depressed in the dichotic conditions as opposed to the diotic in those with brain stem involvement.

Sentence type stimuli has been employed (clinically) in identifying the foci of lesion in adult patients with damage to various areas of the brain. Sentence materials have also been used to confirm the presence of central auditory processing difficulties with learning disabilities. Jerger in 1965, Jerger and Jerger 1974, Jerger and Sparks in 1975, and Jerger and Jerger 1975 have developed competing message paradigms for measuring the function of the central auditory sytem. Their rationale for the development of this technique was to avoid the use of single words and single syllable words in particular.

These paradigms would use sentences which are purposefully and systematically diverted from the standard rules of grammar and syntax. They recorded these sentences with a competing message. This creates stress in the auditory system to make it easier to assess the integrity of the central auditory pathway itself.

Williford (1968) developed a competing sentence test for the specific purpose of evaluating the central auditory functions. Unlike Jerger, the Competing Sentence Test is composed of simple natural English sentences. This test avoided dependence on identification of highly transient single words, particularly mono-syllabic words. Further, it simulated language construction that one might encounter in everyday life. It was hoped that the test might provide insight into a subject's ability to process standard forms of spoken language. Thus, factors of temporal patterns, acoustic spectra, linguistic features, and syntactical characteristics were considered as important attributes of the signal.

Jerger and Jerger, (1975) investigated the clinical validity of central auditory tests. They found that the Staggered Spondaic Word Test to be the best of the procedures used in identifying cerebral lesions and Synthetic Sentence Identification Test in the ipsilateral competing mode to be the best for locating brain stem lesions. They indicated the Staggered Spondaic Word Test to be quite variable as a brain stem test. However, since they combined all of their brain stem patients, they were no doubt including low brain stem cases with high brain stem cases.

A study conducted by Lasky and Tobin in 1973, found that competing auditory messages that are non-linguistic do not interfere with the performance of either normal or the learning disabled. Of more importance, they found that linguistic competing auditory messages do interfere with the performance of children with learning disabilities but do not interfere with the performance of normal children.

Evaluation of central auditory function in learning disabled children would, therefore, seem to hold great promise.

Electrophysiologic Assessment

Electrophysiologic measurements have been described since the late 30's, with Jewett and Williston (1971) first describing surface recorded potentials made available with brainstem auditory evoked potential techniques. Since then, Starr and Achor (1975) found that brainstem auditory evoked potential (BAEP) techniques were of assistance in evaluating the mechanisms of coma, the localization of mid-brain and brainstem tumors, the localization of demyelinzation in the brainstem and the presence of diminished brainstem circulation.

Nodar and Orlowski (1970) found that infants that had recovered from or were at risk for Sudden Infant Death Syndrome (SIDS) by clinical criteria demonstrated abnormalities on two or more of seven criteria of brainstem auditory evoked potential techniques. In 1980, Rosenblum Arick and Krug et al demonstrated similar abnormalities using brainstem auditory evoked potential techniques on children diagnosed as being autistic.

A review of the literature in the area of learning disabilities also supports the concept that auditory perceptual tasks are sensitive to neurologic conditions within the system. Sabatino, 1969, and Jerger and Jerger in 1968 both demonstrated high correlations between auditory perceptual tasks and neurological impairments. Hecox Galambos and McKean have observed the maturation of the brainstem evoked response potential in infants from birth to the first few years of life by measuring the latency of the constituent waves. Wave V, the most prominent and repeatable wave, increases in latency as a function of age through the first eighteen (18) months of life. Wave I, which reflects activation of the VIIIth nerve also decreaes in latency with increasing age. Latency changes extend beyond six (6) months for Wave V. Therefore, neuroprocesses must account for continued latency shifts such as increased myelinization of the upper brainstem and further synapto-genesis. (Cone, 1980)

A review of Russian literature indicates that the Soviet Union is concerned with what appears to be a similar problem. Instead of the label "learning disabled children", they use the title "developmental backwardness." The basic premise that all handicapped children have difficulty in interacting with their environment is drawn from the work of Vygotski. It is his finding that "all handicapped children have difficulty in speech communication, verbal meditation, speed of information processing, coding processing, intra-sensory connections, orientation reflexes, and additional responses." Instead of studying brainstem evoked potentials they have been studying farfield recordings of E.E.G. or electroencephlogram patterns of these "developmentally backward" children. They find that about 50% of them have abnormal E.E.G.'s. The pathological findings are persistent against a background of general maturation, with normal E.E.G.'s obtained between the ages of ten (10) and twelve (12). (Hewett, and Wilderson, 1974)

This review of the literature has provided several potential assessment alternatives. It appears that one of the most promising would be a combination of the Staggered Spondaic Word Test (Katz), The Selective Attention Test from Goldman-Fristoe-Woodcock along with the Brainstem Auditory Evoked Potential Techniques.

PROCEDURES

CHAPTER III

The procedures necessary to facilitate an assessment of learning disabilities utilizing electrophysiological and auditory processing instruments include the following logistic segments:

1. Selection of the School District in which the research was to be carried out.
2. Minimum eligibility criterion.
3. Selection of the Population.
4. Equipment.
5. Instruments Of Measurement.
6. Procedures For Gathering Data.
7. Statistical Application.

Selection Of The School District

The selection of the school district was such that it was of sufficient size so as to have its own "team" approach to the identification of learning disabilities. The district was also large enough to offer remedial services for other disorders in addition to learning disabilities. Therefore, the district did not concentrate its efforts solely with the learning disabilites subspeciality. The district was in compliance with all laws, Public Law 94-142 and Oregon Department of Education's Administrative Rules Chapter 581.

The selected district was of sufficient size so as to supply both a learning disabilities pool and a control pool from which candidates were randomly selected.

The district provided a supportive role both in granting permission for the study as well as minimal support staff for a "double blind" study with random selection of candidates and record keeping.

For our purposes, the district was centrally located and housed at one facility. This reduced the administrative effect between schools. It also permitted greater consistency between measurements by reducing the need to move equipment.

Jefferson, Oregon, with a population of 1,742 and an average daily membership (ADM) of 980 in the schools was selected as being the site for this investigation. The Superintendent, Dr. Glenn Dorn, and the Jefferson School Board graciously granted permission for the investigation to take place within their district and the utilization of their facilities.

Minimum Eligibility Criterion Of Candidates

Minimum eligibility requirements for candidates from which a random selection would take place was divided into two (2) general areas: A) the minimum eligibility necessary to be a member of the normal or control group, and B) the minimum eligibility necessary to be a member of the learning disabled group.

To be an eligible member of the normal or control pool, it was necessary that each child: 1) be within six (6) months of grade level as measured by the most recently administered achievement test, 2) not have been referred for a learning disability, 3) be between the ages of six (6) years six (6) months and eleven (11) years six (6) momths, 4) be able to demonstrate bilateral Type A (normal) tympanograms shortly before administration of any evaluative procedure utilizing tapes or auditory stimuli, 5) must have demonstrated an average pure tone threshold through the speech range (500, 1,000, 2,000 Hz) of not worse than 20 dB bilaterally.

The minimum eligibility requirements for the learning disabled group were as follows: 1) they must presently be receiving services through the learning disabilities program, 2) they would be eligible for the list of learning disabilities based upon either a referral for reading or mathematics 3) they must range in age from approximately six (6) years six (6) months to eleven (11) years, six (6) months, 4) they must be able to demonstrate bilateral Type A (normal) tympanograms shortly before administration of any evaluative procedure utilizing tapes or auditory stimuli, 5) they must be able to demonstrate an average pure tone threshold through the speech range (500, 1,000, 2,000 Hz) of not worse than 20 dB, bilaterally.

Selection Of The Population

In order to insure the anonymity of group placement of subjects, personnel from the local school district were asked to prepare six (6) lists of students as described: 1) a list of boys that have not been referred for learning disabilites programs, 2) a list of girls that have not been referred for learning disability programs, 3) a list of boys who have met the learning disabilities criteria for math, 4) a list of girls that have met the learning disabilities criteria for math, 5) a list of boys that have met the learning disabilities criteria for reading, 6) a list of girls that have met the learning disabilities criteria for reading. These six lists of names were to have been prepared from the total school population, either being a member of the control group pool or meeting the minimum requirements for admission into the learning disability group pool. From these lists of names, using a table of random numbers, the populations of both groups were selected. The list of possible candidates numbered one-hundred (100).

The parents of the possible candidates were provided with an explanation of the test procedures and were asked to sign "informed parental consent forms." (Copy included in Appendix) These forms had previously been approved for use by the Oregon State University Committee for the protection of human subjects as well as the Superintendent and Board of the Jefferson School District.

Only those students that returned signed "informed parental consent forms" were allowed to participate in the next step of the investigation.

It was our intent to acquire a pool of twenty (20) control group members and twenty (20) learning disabled subjects. While it was intended to match groups by sex, i.e., equal referrals for reading and math, the actual distribution of the same is shown below.

Control Population (n=20) 16 male 4 female

Learning Disabled (n=20)

Referral for:		Boys	Girls	Total
1.	Reading	5	1	6
2.	Math	4	2	6
3.	Both	7	1	8
	Total	16	4	20

Equipment

All audiometric evaluations were completed utilizing a Dahlberg 9103 Speech Audiometer. This audiometer employs standard audiometric TDH-39 earphones and MX41/AR cushions. The audiometer was electronically calibrated with daily "biological" checks prior to use.

Impedance measurements were made with an American Electromedics Model 86AR Tympanometer, utilizing the standard "Rock" probe tips provided with each unit. This instrument was electronically calibrated prior to this investigation and checked daily via biological tests. This unit has a "printer" which provides a hard copy of each tympanogram.

Stereo tape cassettes were played through a Realistic Stereo Cassette Player Model 14-607. The taped presentations were routed through the Dahlberg Audiometer. Speech presentations routed from the Stereo Cassette Player were calibrated prior to this investigation, and were checked daily via the sound pressure level meter.

Cassette tapes used for administration of both the Goldman-Fristoe-Woodcock, (G-F-W) Auditory Selective Attention Test, and Jack Katz's Staggered Spondaic Word (SSW) Test are part of the commercially available materials for these procedures.

Both tapes were first generation copies, and administered at 3/4 ips (standard speed) at an intensity level of 50 dB HL.

Sound pressure level measurements were made using a Realistic Sound Pressure Level Meter, Model 42-3019. This instrument was calibrated against a Fonix, Type 5,000 Electroacoustic Analyzer traceable to the National Bureau of Standards.

All measurements were calibrated to American National Standards Institute, 1969 (ANSI-1969) standards.

A sound treated room was built into a 1969 Dodge/ Cabana Motor Home. The purpose of this conversion was to provide a mobile testing suite for audiologic evaluations throughout Marion County, Oregon. The mobile testing unit was made available during this investigation, by Marion County Education Service District, Salem, Oregon. Utilizing the mobile unit, it was possible to administer all evaluations in a similar environment.

Brainstem Auditory Evoked Potentials (BAEP) results were obtained utilizing a Teledyne T-A 1000 Electric Response Audiometer. Responses were obtained via standard preparation techniques and placement of electrodes. For purposes of this investigation, the controls were pre-set as follows:

1. Delivery of 2048 presentations per run
2. 1,000 Hz at 75 dB
3. 20 Presentations per second
4. 10 millisecond window
5. .2 micro volts/cm
6. Less than 5,000 ohms resistance to the electrodes.

For purposes of consistency, the white electrode was always the "test" electrode. Also, the left headphone was consistently used as the "test" speaker (TDH-39), and cushion (MX41AR). Measurements of latency were consistently read from the unit and transcribed immediately to the graphic record following each run.

Instruments Of Measurement

For the purposes of this investigation, three (3) instruments were selected, Brainstem Auditory Evoked Potentials, the Staggered Spondaic Word Test (SSW) by Jack Katz, and the Goldman-Fristoe-Woodcock Auditory Selective Attention Test.

One of the newest advances in current audiometric research is patterned after the electroencephlograph. This technique utilizes minute electrical impulses measured from the brain using electrodes taped to the head. Electrical activity in the brain is picked up by these electrodes, pre-amplified, and then routed to a microprocessing computer.

This computer separates random brain activity from electrical activity evoked when a stimulus is inserted into the ear. The stimuli is delivered through earphones at a very rapid rate. Testing can be completed within one (1) hour. The computer is capable of representing the elicited electrical potentials in graphic form. This permits assessment of time (latency) relationships of the signal passage through the primary auditory pathways of the brain stem. Often, it is possible to trace the auditory nerve through the brain stem until it reaches the temporal lobes. This information permits statements regarding the processing of the signal along the auditory pathway. Statements, however, cannot be made regarding the brain's processing of that acoustical information, only that the information did arrive at the various neurological "way stations," along the auditory pathway.

The procedure is physiologic, presenting no noxious stimuli and is possible irrespective of age or patient condition.

The Brainstem Auditory Evoked Potential technique employs perhaps the least subjective means of evaluating auditory anatomic competence. It is accomplished by measuring the time of passage and strength of neuro-electrical stimulation from the hair cells of the cochlea to its arrival at the upper levels of the brainstem.

Goldman-Fristoe-Woodcock, (1976) indicate that their test of Selective Attention is sensitive to neurologically impaired children in that these children exhibit particular difficulty in handling auditory figure ground perceptual tasks. The Goldman-Fristoe-Woodcock Selective Attention Test is divided into four sub-tests. The first sub-test has the target word in a quiet background. Sub-test 2, presents 33 target words in a fan-like noise background. Sub-test 3 presents 33 target words in a cafeteria noise background. And sub-test 4 presents 33 target words presented with a voiced competing message repeating a story. The competing message to the target word ratio being in each of the sub-tests at a less than equal competing level, gradually increases to a level louder than the target word.

The task of the child is to point to the appropriate picture when given a choice of four (4) pictures, one of which is the target word that has been presented via a taped presentation. It addresses itself to the question as to how well a child can selectively attend to the target word in various types of environmental or background noise.

Selective attention, then, is the ability to focus or concentrate specifically on a selected signal while ignoring the background. This ability to focus is often called auditory figure-ground. The ability to attend selectively is critical in the learning situation that contains diverse auditory stimuli, i.e., a typical classroom.

The third instrument used in this study is an instrument devised by Jack Katz, Ph.D., entitled the "Staggered Spondaic Word Test." In developing the Staggered Spondaic Word Test (SSW) Katz sought a task free of contamination of peripheral hearing disorders which rquire little patient sophistication but would be sensitive to central auditory disorders. Spondaic words were chosen to reduce test errors due to peripheral hearing problems, and because they are essentially 100% intelligible over a wide range of intensities.

Each test item is composed of a spondaic pair recorded in a partially overlapping fashion. For example, the right ear may hear "up" right-noncompeting (R-NC) while "stairs" right-competing (R-C) and "down" left-competing (L-C) are heard in the right and left ears respectively at the same time. And, "town" left-non-competing (L-NC) is heard in the left ear.

Right Ear		Left Ear
(R-NC)		(L-NC)
"Up"	"stairs" (R-C)	
	"down (L-C)	Town"

Tests such as the Staggered Spondaic Word Test are sensitive to central auditory dysfunctions. They show reduced performance in the ear opposite the involved hemisphere. They are specific to the identification of temporal lobe disorders.

Procedures For Gathering Data

The procedures for obtaining data on the Goldman-Fristoe-Woodcock Auditory Selective Attention Test were as follows:

Sometime between fourteen (14) days and seven (7) days prior to the administration of the Goldman-Fristoe-Woodcock Selective Attention Test, participants were shown pictures used by the Goldman-Fristoe-Woodcock Selective Attention Test singly and in random order until they could repeat all of the names of the picture cards without assistance. A time lapse of at least seven (7) days between the training sessions and the actual administration of the evaluation was followed to reduce any carry-over effect.

During the evaluation, the subject was seated in a sound treated room with the test items in front of him or her. The earphones were placed over his or her ears with the examiner using a monitor so as to be able to both monitor the taped presentation and record the subject's response on standard recording forms, provided by the Goldman-Fristoe-Woodcock Selective Attention Test. These tests were then scored and placed in the individual's file of test performance.

The Staggered Spondaic Word Test administration procedures were very nearly the same as used in the Goldman-Fristoe-Woodcock Selective Attention Test. At least seven (7) days prior to the actual administration and not exceeding fourteen (14) days the administration of the Staggered Spondaic Word Test, participants were given the words that would be used on the Staggered Spondaic Word Test individually and in random fashion. This was done to eliminate the possibility of vocabulary as being a consideration or a contaminant in this study. A time lapse of at least seven (7) days between the training session and the actual administration was followed to reduce any carry-over effect.

During the evaluation, the subject was seated in a sound treated room with the examiner monitoring both the taped presentation and recording the subject's response on standard recording forms provided by the Staggered Spondaic Word Test Battery. These were then scored and placed in the individual's file of test performance.

The procedure for obtaining data on the Brainstem Auditory Evoked Potentials Test were as follows:

Each of the participants were brought out to a mobile testing unit that contained a sound treated room in which had been placed the Teledyne TA 1000 Auditory Evoked Potential Brainstem Unit.

Prior to administration, all systems were checked, calibrated and recorded on the individuals form as being in compliance and in good working order.

The administration of this procedure followed standard principles and practices for preparation and placement of electrodes, as well as for general Brainstem Auditory Evoked Potential Techniques.

The subject was asked to relax, close his/her eyes and rest. After completion of the first test run on the right ear, latency values were recorded for the peaks that had occurred. With no changes, a second successive run was again recorded with the latency values being printed on the graph.

After two successive runs on the right ear both the earphone and the white electrode were changed to the left ear. Again, two successive test runs were administered with the latency values being printed on the graph paper following each run.

The graphic data from the Brainstem Auditory Evoked Potential Techniques was placed in the students file of test performance.

Following the completion of all evaluations, the tests were taken from each students' file and scored individually. From this data, a master list of information was assembled for computer analysis.

Statistical Application

The analysis of the data generated within this investigation lends itself to a multi-factor analysis of variance paradigm, specifically, for the Staggered Spondaic Word Test and the Goldman-Fristoe-Woodcock Selective Attention Test. In these instances, there would be a three (3) factor comparison with the possibility of three (3) interactions.

In this way, it would be possible to compare the learning disabilities group with the control group.

(N/LD)

It would allow a comparison of the males with the females to ascertain if there appears to be a sex factor.

(M/F)

It would allow a comparison of subject; thereby permitting us to learn more about those whose disability is either reading or mathematics.

(R/Ma)

It would allow a comparison of Learning Disability by sex.

(La*Sx)

It would permit a comparison of Learing Disability by subject matter.

(La*Sj)

It would permit a comparison of the subject matter with sex.

(Sj*Sx)

The analysis of the Brainstem Auditory Evoked Potentials would be along seven (7) conventional criteria (Starr and Achor, Nordar, Stockard and Rossiter, et al) The seven (7) essential criteria are 1) peak latency 2) intrapeak latency 3) inter-peak latency 4) response stability 5) amplitude, 6) wave shape 7) peak presence.

In an effort to compare these criteria within the same individual as well as cross populations, it was necessary that subjective decisions be made based upon the definition of each of the criteria as described in the definition of terms. It then becomes possible to apply consistency tests, or a standard test for difference in proportions. This is the instrument that would be proposed for use with the Brainstem Auditory Evoked Potential Test Results.

Nodar found that Starr and Achor's latency measurements to be reliable for certain presentation levels. In normal populations, the peak latencys for the seven (7) Jewett peaks are predictable within certain tolerances (usually .2 msec). This criteria will be used consistently throughout the data analysis of the Brainstem Auditory Evoked Potential information. In order to have consistency among the seven criteria enumerated earlier, we are proposing the following questions to be a part of each of the individual participants evaluation from the Brainstem Auditory Evoked Potential Technique.

1) Peak Latency: Question: Are the peaks within .2 msec of the norms set by Starr and Achor?

Wave I	Wave III	Wave V
yes-no	yes-no	yes-no

2) Intra Peak Latency: Question: Are the central conduction times within .2 msec of being equal between administrations of the same ear?

Between Waves I-III	Waves I-V	Waves III-V
yes-no	yes-no	yes-no

3) Inter Peak Latency: Question: Is the latency of the occurrene of the Jewett V within .2 msec between ears at the same SL?

yes-no

4) Response Stability: Question: Are the results of two (2) successive stimulus runs superimposable within the same ear?

yes-no

5) Amplitude: Question: When comparing the results of both ears, at any one of the peaks, (I, III, V,) is the amplitude of that wave reduced by 50%?

Wave I	Wave III	Wave V
yes-no	yes-no	yes-no

6) Waveshape: Question: Is there any abnormality in the shape of

the waves the waves, between Wave I through Wave V? (An normality here means a "flattening" of the peaks, broad based peak, additional peaks, etc.)

Wave I	Wave II	Wave III	Wave IV	Wave V
yes-no	yes-no	yes-no	yes-no	yes-no

7) Peak Presence: Question: Are the first five (5) of the seven (7) Jewett peaks present?

Wave I	Wave II	Wave III	Wave IV	Wave V
yes-no	yes-no	yes-no	yes-no	yes-no

FINDINGS

CHAPTER IV

The purpose of this study was to determine the feasibility of utilizing central auditory processing instruments and an electrophysiologic assessment for purposes of identifying labeled learning disabled children from a control group.

The three (3) different instruments employed during this investigation were the "Staggered Spondaic Words Test", (SSW) by Katz (1969), the Goldman-Fristoe-Woodcock Test of "Selective Attention" (1974) along with Brainstem Auditory Evoked Potentials.

Raw data generated by each of these instruments was placed in an individual file until the completion of all assessment procedures.

During the data reduction process, raw data was transferred to raw data composite sheets which could then be fed into the computer at Willamette University. Dr. Michael Hand, of Willamette University's Graduate School processed the raw data by using a Multifactor Analysis of Variance Paradigm contained in the Standardized Statistical Package for the Social Sciences (SPSS) Program, for both the Selective Attention and Staggered Spondaic Word instruments. It should be noted that the data generated by the Brainstem Auditory Evoked Potentials Technique was analyzed by a procedure for evaluating differences in proportions.

Traditionally, statistical levels of confidence of .01 or .05 are typically used in the reporting of non-behavioral investigations where variability is quite low.

For purposes of this investigation, a statistically confident level of .100 has been adopted.

The results of the data analysis are reported following each hypothesis as follows:

Staggered Spondaic Word Test

1) H_o There is no significant difference of total test scores as measured by the Staggered Spondaic Word (SSW) Test between children labeled as learning disabled and those of a control group.

Table #1 illustrates that we need to reject the null hypothesis by virtue of a significance level of F=.007.

Therefore, the alternate hypothesis is retained:

H_a There is a significant difference of total test scores as measured by the Staggered Spondaic Word Test between children labeled as learning disabled and those of a control group.

2) H_o There is no significant difference of test scores for the right ear as measured by the

TABLE # 1

THE SIGNIFICANT DIFFERENCE
OF SSW TOTAL TEST SCORES BY COMPARING
THE LD GROUP WITH THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	354.025	1	354.025	8.025	0.007
LD	354.025	1	354.025	8.025	0.007
Explained	354.025	1	354.025	8.025	0.007
Residual	1676.348	38	44.114		
Total	2030.373	39	52.061		

*Significant at greater than the .100 level

Staggered Spondiac Word (SSW) Test between children labeled as being learning disabled and those of a control group.

Table #2 illustrates that we need to reject the null hypothesis by virtue of a significance level of F=.017.

Therefore, the alternate hypothesis is retained:

H_a There is a significant difference of test scores for the right ear as measured by the Staggered Spondaic Word Test between children labeled as being learning disabled and those of a control group.

3) H_o There is no significant difference of test scores for the left ear as measured by the Staggered Spondaic Word Test between children labeled as being learning disabled and those of a control group.

Table #3 illustrates the need to reject the null hypothesis by virtue of a significance level of F=.007.

Therefore, the alternate hypothesis must be retained:

H_a There is a significant difference of test scores for the left ear as measured by the Staggered Spondaic Word Test between children labeled as being learning disabled and those of a control group.

4) H_o There is a significant difference of test

TABLE # 2

THE SIGNIFICANT DIFFERENCE
SSW TEST SCORES FOR THE RIGHT EAR BY
COMPARING THE LD GROUP WITH THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	250.000	1	250.000	6.217	0.017
LD	250.000	1	250.000	6.217	0.017
Explained	250.000	1	250.000	6.217	0.017
Residual	1527.998	38	40.210		
Total	1777.998	39	45.590		

*Significant at greater than the .100 level

TABLE # 3

THE SIGNIFICANT DIFFERENCE OF
SSW TEST SCORES FOR THE LEFT EAR
BY COMPARING THE LD GROUP WITH THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	543.906	1	543.906	8.257	0.007
LD	543.906	1	543.906	8.257	0.007
Explained	543.906	1	543.906	8.257	0.007
Residual	2503.083	38	65.871		
Total	3046.989	39	78.128		

*Signficant at greater than the .100 level scores for the right ear attributed to sex as measured by the Staggered Spondaic Word Test between children labeled as being learning disabled and those of a control group.

Table #4 illustrates the need to retain the null hypothesis by virtue of a significance level of F=.146.

5) H_o There is no significant difference of test scores for the left ear attributed to sex as measured by the Staggered Spondaic Word Test between children labeled as being learning disabled and those of a control group.

Table #5 illustrates the need to retain the null hypothesis by virtue of a significance level of F=.357 (not significant at the .100 level of confidence)

6) H_o There is no significant difference of test scores obtained for the right ear and those obtained of the left ear as measured by the Staggered Spondaic Word Test between children labled as being learning disabled and those of a control group.

Table #6 illustrates the need to reject the null hypothesis by virtue of a significance level of at least F=.001 by 2-Tail Probability.

Therefore, the alternate hypothesis must be

TABLE # 4

THE SIGNIFICANT DIFFERENCE OF SSW TEST SCORES FOR SEX BY COMPARING THE RIGHT EAR BETWEEN THE LD GROUP AND THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	97.200	1	97.200	2.198	0.146
Sex	97.200	1	97.200	2.198	0.146
Explained	97.200	1	97.200	2.198	0.146
Residual	1680.798	38	44.232		
Total	1777.998	39	45.590		

*Not significant at .100 level

TABLE # 5

THE SIGNIFICANT DIFFERENCE OF SSW TEST SCORES FOR SEX BY COMPARING THE LEFT EAR BETWEEN THE LD GROUP AND THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	68.252	1	68.252	0.871	0.357
Sex	68.252	1	68.252	0.871	0.357
Explained	68.252	1	68.252	0.871	0.357
Residual	2978.736	38	78.388		
Total	3046.989	39	78.128		

*Not significant at the .100 level

TABLE # 6

THE SIGNIFICANT DIFFERENCE OF SSW TEST SCORES OBTAINED BETWEEN EARS WHEN COMPARING THE LD GROUP WITH THE CONTROL GROUP

		Mean Score	Mean Difference	Degress of Freedom	2-Tail Problem
L.D. Group	SSW/Right	96.000	4.55	19	.000
	SSW/Left	91.450			
Control Group	SSW/Right	91.000	6.925	19	.0000*
	SSW/Left	84.075			

*(Found to be statistically significant)

retained.

H_a There is a significant difference of test scores obtained for the right ear, and those obtained of the left ear as measured by the Staggered Spondaic Word Test between children labeled as being learning disabled and those of a control group.

<u>Goldman-Fristoe-Woodcock Selective Attention Test:</u>

7) H_o There is no significant difference of test scores obtained on the "fan" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

Table #7 illustrates the need to retain the null hypothesis by virtue of a significance level of F=.384 (not significant at the .100 level of confidence)

8) H_o There is no significant difference of test scores obtained on the "cafeteria" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

Table #8 illustrates the need to reject the null hypothesis by virtue of a significance level of F=.060

Therefore, the alternate must be retained:

TABLE # 7

THE SIGNIFICANT DIFFERENCE OF G-F-W SELECTIVE ATTENTION, "FAN" SUBTEST SCORES BY COMPARING THE LD GROUP WITH THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	3.600	1	3.600	0.776	0.384
LD	3.600	1	3.600	0.776	0.384
Explained	3.600	1	3.600	0.776	0.384
Residual	176.400	38	4.642		
Total	180.00	39	4.615		

*Not Significant at .100 level

TABLE # 8

THE SIGNIFICANT DIFFERENCE OF G-F-W SELECTIVE ATTENTION, "CAFETERIA" SUBTEST SCORES BY COMPARING THE LD GROUP WITH THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	12.100	1	12.100	3.760	.060
LD	12.100	1	12.100	3.760	.060
Explained	12.100	1	12.100	3.760	.060
Residual	122.300	38	3.218		
Total	134.400	39	3.446		

*Significant at greater than the .100 level

H_a There is a significant difference of test scores obtained on the "cafeteria" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

9) H_o There is no significant difference of test scores obtained on the "voice" sub-test of the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

Table #9 illustrates the need to retain the null hypothesis. It should be noted that the level of significance is F=.105, and therefore is a marginal decision. (our criterion was .100 for a significant level of confidence)

10) H_o There is no significant difference of total test scores as measured by the Goldman-Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of a control group.

Table #10 illustrates the need to reject the null hypothesis by virtue of a significance level of F=.040. Therefore, we must retain the alternate hypothesis.

H_a There is a significant difference of total test scores as measured by the Goldman-

TABLE # 9

THE SIGNIFICANT DIFFERENCE OF G-F-W SELECTIVE ATTENTION "VOICE" SUBTEST SCORES BY COMPARING THE LD GROUP WITH THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	21.025	1	21.025	2.757	0.105
LD	21.025	1	21.025	2.757	0.105
Explained	21.025	1	21.025	2.757	0.105
Residual	289.749	38	7.625		
Total	310.774	39	7.969		

*Not Significant At the .100 level

TABLE # 10

THE SIGNIFICANT DIFFERENCE OF G-F-W SELECTIVE ATTENTION TOTAL TEST SCORES BY COMPARING THE LD GROUP WITH THE CONTROL GROUP

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F *
Main Effects	108.900	1	108.900	4.530	0.040
LD	108.900	1	108.900	4.530	0.040
Explained	108.900	1	108.900	4.530	0.040
Residual	913.499	38	24.039		
Total	1022.399	39	26.215		

*Significant at greater than the .100 level

Fristoe-Woodcock Selective Attention Test between children labeled as being learning disabled and those of control group.

Brainstem Auditory Evoked Potentials:

The data generated by the Brainstem Auditory Evoked Potentials (B.A.E.P.) technique resulted in a graphic record, representative of the evoked potential responses as the auditory stimuli was transported to the brain. From the graphic record, measurements were made to answer the hypothetical questions that follow. These questions were answered by either "yes" or "no" resulting in a two (2) item forced choice, which was subjected to a standard test for Difference in Proportions. This yields a t-test, by defining the number of "yes" answers and employing the following formula

$$t = \frac{\bar{P}_{LD} - \bar{P}_{controls}}{\sqrt{\frac{\bar{P} - (1 - \bar{P})}{n}}}$$

By using the above formula, the scores resulting in numbers greater than +2.0 or, less than -2. would be considered statistically significant.

11) H_o There is no significant difference in latency values between those children labeled as being learning disabled and those

of a control group for the occurrence of Waves I, III, and V, for the right ear or left ear as measured by the Brainstem Auditory Evoked Potential.

Measurement of latency values are usually measured against the norm values presented by Starr and Achor (1975) Table #11-A represents the latency values of this investigation with those of Starr and Achor.

Because Starr and Achor's values represent normal latencies of a predominantly adult population, and because this investigation dealt with children under twelve (12) years of age, new "normal" values were developed for children under twelve (12).

Table #11-B represents the comparison of latency values of this investigation with normative values from a peer group.

Both Tables #11-A and #11-B illustrate the need to retain the null hypothesis (t-test values are between 2.0 and -2.0, therefore, they are not significant)

12) H_o There is no significant difference in central conduction times of two (2) administrations to the same ear between those children labeled as learning disabled and those of a control group, when comparing Waves I-III, I-V, and III-V, for the right ear.

TABLE # 11-a

THE SIGNIFICANT DIFFERENCE OF LATENCY VALUES FOR
WAVES I, III, V,
BETWEEN THE LD GROUP AND THE CONTROL GROUP
(USING THE PREDOMINANTLY ADULT NORMS
OF STARR AND ACHOR 1975)

	Wave	P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
	1	0.800	0.600	0.700	1.380
RT	3	0.750	0.700	0.725	0.354
	5	0.650	0.700	0.675	0.338
	1	0.750	0.600	0.675	1.013
LT	3	0.750	0.700	0.725	0.354
	5	0.600	0.650	0.625	-0.327

TABLE # 11-b

THE SIGNIFICANT DIFFERENCE OF LATENCY VALUES
FOR WAVES I, III, V,
BETWEEN THE LD GROUP AND THE CONTROL GROUP
(USING NORMS ESTABLISHED FROM A PEER GROUP)

Wave	P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
1	0.500	0.550	0.525	-0.317
RT 3	0.250	0.250	0.250	0.000
5	0.250	0.450	0.350	-1.326
1	0.350	0.550	0.450	-1.271
LT 3	0.250	0.250	0.250	0.000
5	0.450	0.500	0.475	-0.317

(Note: There were no latency values found to be statistically significant in either Table 11 A or Table 11 B)

TABLE # 12

THE SIGNIFICANT DIFFERENCE OF CENTRAL CONDUCTION TIME OF TWO (2) ADMINISTRATIONS TO THE SAME EAR (RIGHT) BETWEEN THE LD GROUP AND THE CONTROL GROUP WHEN COMPARING WAVES I-III, I-V, AND III-V

(RIGHT EAR)

Waves	P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
1-3	0.800	0.900	0.850	-0.886
1-5	0.650	0.900	0.775	-1.893
3-5	0.700	0.900	0.800	-1.581

(No values were found to be statistically significant)

Table #12 illustrates the need to retain the null hypothesis. (t-test values are between 2.0 and -2.0; therefore, they are not significant)

13) H_o There is no significant difference in central conduction times of two (2) administrations to the same ear between those children labeled as being learning disabled and those of a control group, when comparing Waves I-III, I-V, and III-V, for the left ear.

Table #13 illustrates the need to retain the null hypothesis. (t-test values are between 2.0 and -2.0, therefore, they are not significant)

14) H_o There is no significant difference in latency values for the occurrence of Wave V between ears at the same sensation level. when comparing those children labeled as being learning disabled and those of a control group.

Table #14 illustrates the need to reject the null hypothesis.

Therefore, the alternate hypothesis must be retained:

H_a There is a significant difference in latency values for the occurrence of Wave V between ears at the same sensation level, when comparing those children labeled as

TABLE # 13

THE SIGNIFICANT DIFFERENCE OF
CENTRAL CONDUCTION TIME OF
TWO (2) ADMINISTRATIONS TO THE SAME EAR
(LEFT) BETWEEN THE LD GROUP AND THE CONTROL GROUP
WHEN COMPARING WAVES I-III, I-V, AND III-V.

(LEFT EAR)

Waves	P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
1-3	0.800	0.850	0.825	-0.416
1-5	0.700	0.900	0.800	-1.581
3-5	0.800	0.900	0.850	-0.886

(No values were found to be
statistically significant)

TABLE # 14

THE SIGNIFICANT DIFFERENCE
IN LATENCY VALUES FOR THE OCCURRENCE OF WAVE V
BETWEEN EARS AT THE SAME SENSATION LEVEL
WHEN COMPARING THE LD GROUP WITH THE CONTROL GROUP

P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
0.700	0.950	0.825	-2.081*

*(Found to be significant by virtue of being smaller than a -2.0)

being learning disabled and those of a control group.

15) H_o There is no significant difference in the superimposability of two (2) successive stimulus runs for the right ear between those children labeled as being learning disabled and those from a control group.

Table #15 illustrates the need to retain the null hypothesis. (t-test values are between 2.0 and -2.0, therefore, they are not significant)

16) H_o There is no significant difference in the superimposability of two (2) successive stimulus runs for the left ear between those children labeled as being learning disabled and those from a control group.

Table #16 illustrates the need to retain the null hypothesis. (t-test values are between 2.0 and -2.0, therefore, they are not significant)

17) H_o There is no significant difference in amplitude reduction at any one of the peaks, (I, III, V) when comparing the results of both ears, between those children labeled as being learning disabled and those from a control group.

Table #17 illustrates the need to retain the null hypothesis for all entries except Peak V for the left ear

TABLE # 15

THE SIGNIFICANT DIFFERENCE OF "SUPERIMPOSABILITY" OF TWO (2) SUCCESSIVE STIMULUS RUNS FOR THE RIGHT EAR BETWEEN THE LD GROUP AND THE CONTROL GROUP

P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
0.650	0.800	0.725	-1.062

(Value found not to be statis-ically significant)

TABLE # 16

THE SIGNIFICANT DIFFERENCE OF "SUPERIMPOSABILITY"
OF TWO (2) SUCCESSIVE STIMULUS RUNS
FOR THE LEFT EAR BETWEEN
THE LD GROUP AND THE CONTROL GROUP

P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
0.550	0.650	0.600	-0.646

(value found not to be statistically significant)

TABLE # 17

THE SIGNIFICANT DIFFERENCE IN AMPLITUDE REDUCTION AT ANY ONE OF THE PEAK, (I, III, V,) WHEN COMPARING RESULTS OF BOTH EARS BETWEEN THE LD GROUP AND THE CONTROL GROUP

Waves	P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
Right				
1	0.300	0.150	0.225	1.136
3	0.250	0.100	0.175	1.248
5	0.150	0.150	0.150	0.000
Left				
1	0.350	0.150	0.250	1.461
3	0.250	0.050	0.150	1.771
5	0.250	0.000	0.125	2.390*

*(only value found statistically significant, as it exceeds 2.0)

(t-test values were between 2.0 and -2.0 therefore, they are not significant)

Table #17 illustrates the need to reject the null hypothesis for Peak V for the left ear.

Therefore, the alternate hypothesis must be retained for the entry. (a significance level of 2.39 was achieved)

H_a There is a significant difference in amplitude reduction for the left ear at Peak V, when comparing the results of both ears, between those children labeled as being learning disabled and those from a control group.

18) H_o There is no significant difference in wave shape abnormalities of Peaks I, III, V, of either ear between those children labeled as being learning disabled and those from a control group.

Table #18 illustrates the need to retain the null hypothesis for all entries except Peak I for the right ear. (t-test scores were between 2.0 and -2.0, therefore, they are not significant).

Table #18 illustrates the need to reject the null hypothesis for Peak I, for the right ear. Therefore the alternate hypothesis must be retained for this entry. (a significant level of 2.191 was achieved)

H_a There is a significant difference in wave

TABLE # 18

THE SIGNIFICANT DIFFERENCE IN WAVE SHAPE ABNORMALITIES OF PEAKS I, III, V, OF EITHER EAR BETWEEN THE LD GROUP AND THE CONTROL GROUP

Waves	P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
Right				
1	0.400	0.100	0.250	2.191*
3	0.200	0.200	0.200	0.000
5	0.350	0.200	0.275	1.062
Left				
1	0.400	0.300	0.350	0.662
3	0.250	0.200	0.225	0.379
5	0.300	0.150	0.225	1.136

*(Only value found statistically significant as it exceeds 2.0)

shape abnormalities of Peak I for the right ear, between those children labeled as being learning disabled and those from a control group.

19) H_o There is no significant difference as to peak presence or absence, of the first five (5) of the Jewett Seven (7) Peaks when comparing those children labeled as being learning disabled and those from a control group.

Table #19 illustrates the need to retain the null hypothesis. (t-test scores were between 2.0 and -2.0 therefore, they are not significant)

20) H_o There is no significant difference in latency values for the occurrence of Wave V between ears at the same sensation level, by age groups, when comparing those children labeled as being learning disabled and those of a control group.

Tabel #20 illustrates the need to reject the null hypothesis.

Therefore, the alternate hypothesis must be retained:

H_a There is a significant difference in latency values for the occurrence of Wave V between ears at the same sensation level, by age groups, when comparing those child-

TABLE # 19

THE SIGNIFICANT DIFFERENCE AS TO PEAK PRESENCE OF THE FIRST FIVE (5) OF THE JEWETT SEVEN (7) PEAKS WHEN COMPARING THE LD GROUP WITH THE CONTROL GROUP

Waves	P LD Yes	P Control Yes	P Overall Average Yes	T-Test Statistic
Right				
1	0.950	0.950	0.950	0.000
2	0.550	0.350	0.450	1.271
3	0.950	1.000	0.975	-1.013
4	0.200	0.200	0.200	0.000
5	1.000	1.000	1.000	0.000
Left				
1	0.850	1.000	0.925	1.801
2	0.550	0.550	0.550	0.000
3	1.000	1.000	1.000	0.000
4	0.150	0.100	0.125	0.478
5	1.000	1.000	1.000	1.000

(No values were found to be statistically significant)

TABLE # 20

THE SIGNIFICANT DIFFERENCE IN LATENCY VALUES
FOR THE OCCURRENCE OF WAVE V
BETWEEN EARS AT THE SAME SENSATION LEVEL
BY AGE GROUPS

	Age Grouping (Year-Month)		
	6.6-8.8	8.9-10.0	10.1-11.6
Percent of Control's Exceeding Acceptable Latency Values for Wave V. by Age	0.0%	0.0%	0.0%
Percent of Learning Disabled Exceeding Acceptable Latency Values for Wave V. by Age	55.6%	33.3%	0.0%

ren labeled as being learning disabled and those of a control group.

Summary:

The results of this investigation indicate that the Staggered Spondaic Word (SSW) Test was able to distinguish between children identified as having a learning disability from those of a control group in at least two (2) statistically significant ways.

The labeled learning disabled group had lower overall test scores than did the control group, as measured by the Staggered Spondaic Word Test.

There is a greater inter-ear discrepancy of test scores for the control group, than was evident with the labeled learning disabled group, as measured by the Staggered Spondaic Word Test.

The Goldman-Fristoe-Woodcock Selective Attention Test was found to be discriminatory between the control group and the labeled learning disabled group.

As expected, the total test score was more discriminating than any of its component sub-tests individually. The "fan-like" noise, sub-test was less effective than the "voice" sub-test which was less effective than the "cafeteria" sub-test in their ability to separate the two (2) groups of children.

The Brainstem Auditory Evoked Potentials (B.A.E.P.) instrument demonstrated an ability to distinguish between those children belonging to the control group from those labeled learning disabled as a function of age. This instrument was most effective when differentiating younger children. The latency values and aberrant Wave V tracings were more abnormal, more often, for younger children in the learning disabled group than for older children of the same group.

The frequency of abnormalities surrounding Wave V, decrease with an increase in age for those children in the learning disabled group. The children in the control group demonstrated no statistically significant abnormalities.

These findings strongly suggest that the neurologic events measured electrophysiologically may be developmentally or maturationally linked.

SUMMARY, CONCLUSIONS, IMPLICATIONS

CHAPTER V

The Problem Restated

The problem was to ascertain if two (2) central auditory processing tests, and an electrophysiologic assessment would prove to be discriminating between children labeled "normal" and those labeled as being learning disabled.

Specifically, would the Goldman-Fristoe-Woodcock "Selective Attention Test", Katz's "Staggered Spondaic Word Test" (SSW), and Brainstem Auditory Evoked Potentials (BAEP), demonstrate significantly different scores between a control group and children identified as having learning disabilities?

Summary Of Procedures:

A total of forty (40) children were evaluated with twenty (20) randomly selected from those labeled as being learning disabled, and the remainder comprising a control group.

Using a "double-blind" paradigm, each child was administered the Goldman-Fristoe-Woodcock Selective Attention Test, the Staggered Spondaic Word Test, and Brainstem Auditory Evoked Potentials procedures.

Information was kept in individual folders until the completion of all data gathering procedures.

Standard test administration procedures were followed during all phases of the investigation with anonymity of the group placement maintained throughout the duration of the study.

Data was analyzed using the standard Statistical Package For The Social Sciences (SPSS) and Fortran Programs For Differences In Proportions.

Summary Of Findings:

The results of this investigation suggest that the Staggered Spondaic Word Test was able to differentiate between individual members of the control group and those of the labeled learning disabled group. The Staggered Spondaic Word Test further demonstrated an inter-ear difference, strongly favoring the right ear. The inter-ear difference for the control population averaged seven (7) points better in favor of the right side. The right ear was favored in the learning disabilities group, but not to the same degree.

The learning disabilities group demonstrated a right ear preference by virtue of a 4.5 averaged discrepancy between ears. This would support the concept that the normal state favors a right ear dominance to a wider degree than appears evident in the labeled learning disabled population.

Selective attention as measured by the Goldman-Fristoe-Woodcock instrument was also effective in discriminating the learning disabled population from the control group. Interestingly, the "voice" sub-test did not prove to be as effective as the "cafeteria" sub-test in separating the groups. It should also be noted that the overall or total test score, comprised of all the sub-tests, were more effective than any one of the sub-tests individually.

These two (2) central auditory tests offer strong supportive evidence that children at risk for learning disabilities may be identified from a general population through the use of either of these behavioral instruments.

Physiologic assessments of the auditory pathway synchronicity were made possible by employing the Brainstem Auditory Evoked Potentials Technique.

The results of the electrophysiologic assessment provides at least two (2) major concepts.

1) Learning disabled children demonstrated a high incidence of inter-ear discrepancies at Wave V. The control group did not.

2) The number of aberrant patterns observed at Wave V varied inversely with increasing age.

The above findings are consistent with the idea that learning disabilities has a neurologic component, and that the neurologic component is developmental or maturationally linked.

Perhaps it is not important to argue whether or not learning disabilities are behavioral or neurological except that both components appear to exist.

Conclusions:

The problem began in an attempt to ascertain if two (2) central auditory processing tests, and an electrophysiologic measurement would be effective in discriminating children that had been labeled as learning disabled from a control group. The instruments used in this investigation did. Specifically, the Goldman-Fristoe-Woodcock Selective Attention Test, Katz's Staggered Spondaic Word Test, along with the Brainstem Auditory Evoked Potential Techniques demonstrated statistically significant differences between groups.

Not only did these instruments differentiate between the learning disabled group and the control group, but they have provided additional insight as to not the cause, but the composition of the condition defined as learning disabilities.

The evidence from this investigation supports the following conclusions:

1. The condition "learning disabled" has at least two (2) components, one being displayed and measureable behaviorally, the other being

displayed and measureable electrophysiologically.

2. The condition "learning disabled" now has convincing evidence that at least the physiologic component, as measured by the Brainstem Auditory Evoked Potentials Technique, is developmentally or maturationally linked.

3. The condition "learning disabled" may in fact be describing a condition of variance in the rate of normal development, thereby not being a disability at all.

It appears that progress in the remediation of learning disabilities is coincident in time, or closely follows in time, changes in physiologic function. Specifically, there is a change in the patterns of synchronicity in the neural firings along the auditory pathway prior to behavioral changes manifested in the learning setting. This would support the argument that behavioral changes may result from a combination of both therapeutic application and maturational changes in physiology.

Implications:

The implications of this research are many and varied. They range from possible changes in the learning disabilities definition and expectations of the learning disabled child, to therapeutic applications.

The evidence is in, to support the need to incorporate a term or phrase depicting the physiologic component found in many children with learning disabilities. That is not to say that all learning disabled children have a physiologic component. Not all learning disabled children have been evaluated. However, in those children evaluated in this investigation, the labeled learning disabled children demonstrated a physiologic factor while the control group did not.

Since the three (3) instruments employed here were successful in differentiating the labeled learning disabled population from the control, it seems apparent that earlier identification of these children is possible. If earlier identification of children at risk for learning disabilities could be accomplished, it would provide the necessary lead time for special education planning and intervention.

Perhaps more importantly, are the implications for our expectations of the learning disabled child. We assume a child of nine (9) years of age to possess the physiologic development of most children nine (9) years of age. What if the child at age nine (9) has the physiologic development of a normal six (6) year old child? We could be demanding too much from a sensory modality that at its best is destined to failure.

Perhaps the label "disabled" is a misnomer. We could be observing children that are in a condition of variation in the rate of normal physiologic development.

If this is true, then we need to view our traditional therapeutic approach with a great deal of objective criticism.

Our primary learning modalities are visual and auditory. Both of these depend upon the integrity of the neural pathway to transport the stimulus information to the brain for processing. If that transportation system is not mature, or developed, the information arriving at the cortical centers for processing will be in less than optimum condition.

If we are presented with a primary pathway that has demonstrated deficiencies, it makes little sense to force feed the information through the poor system. This is especially true if the system is physiologically delayed, as it appears to be with learning disabilities.

Instead, the therapeutic approach should be one of a language enrichment and/or language saturation program(s), that tend to align themselves with an experimental approach. The utilization of this approach coupled with the ability to identify learning disabled "at risk" children earlier would allow for an intervention program that could prevent, or remarkably reduce the severity of the disability prior to entry into the traditional education system.

Suggestions For Further Study:

There remain a multitude of unanswered questions. Questions that permeate each of several disciplines. The educator, the physician and the audiologist, to name but a few, each view the learning disabled child from a different perspective. Each has a responsibility, albeit a moral obligation to apply their expertise in search of answers to learning and learning disabilities.

To the educator:

How can we stimulate physiologic development in those demonstrating delay?

If children are physiologically or neurologically delayed, what should we realistically expect of them in terms of academia, behavior, and social growth?

Can we find a better way of generating federal funds than asking administrators to be "bounty-hunters" with labels?

To the medical community:

Do we fully understand normal and abnormal physiologic development?

What factors may influence physiologic development?

How do physiologic factors affect laterality?

Can conditions of physiologic or neurological delay be treated medically?

Can we develop electrophysiologic measurements to a level of sophistication whereby we can understand the processes of "learning"?

Can we reduce the need for physicians to be required to label children?

Can we develop diagnostic measures to a level of differential diagnosis rather than the label being assigned through a process of elimination?

To the Audiologist:

Can we develop identification instruments capable of differentiating "at risk" children somewhere near thirty (30) to thirty-six (36) months of age?

Can we establish the audiologist in the educational setting as an integral part of the identification team?

Can we provide a program for the identification, monitoring and treatment of the subclinically ill children with middle ear-effusion during the language acquisition years?

Can we assist with an objective measure that could be used for an "entrance-exit" criteria that would more effectively return children to a label of "normal" than now exists?

There are many other areas in need of investigation, for example, the diet, socio-economic background, and the opportunity to learn.

The specific suggestions for further study as they apply to this investigation are along three (3) main fronts.

To pursue the earlier identification of "at risk" children, our current behavioral assessment materials need to be redesigned. They will need to be designed at an acceptable level for a child of thirty (30) to thirty-six (36) months, yet maintain their current ability to detect subtle differences.

The Brainstem Auditory Evoked Potentials procedure is currently utilized on neonates. However, it needs to be expanded in terms of our understanding the events occurring after Wave V. This would require the observation of neurological events occurring from about 5 milliseconds to 35 milliseconds post onset of stimulation.

The item that seems most critical at this point is how do we go about stimulating increased physiologic development?

It seems clear that with improved behavioral assesment instruments, and a better understanding of the physiologic development in children, we could direct the efforts on their behalf more intelligently and more efficiently.

BIBLIOGRAPHY

Ayres, A., Sensory Integration and Learning Disabilities. Los Angeles, California: Western Psychological Services, 1972.

Bashore, S.R., The Use Of Tympanometry For Screening Developmentally Disabled Children. Audiology and Hearing Education, October/November, 1976.

Bess, F. H., and McConnell, F.E., Audiology, Education And The Hearing Impaired Child. St. Louis: The C.V. Mosby Company, 1981.

Bocca, E., and Calearo, C., Central Hearing Processes. In Jerger, J., (Ed.), Modern Developments In Audiology. New York: Academic Press, 1963.

Brooks, D.N., Impedance Measurement In Screening For Auditory Disorders In Children. Hearing Instruments (February) 20-21, 36, 1974.

Brotsky, Suellen, Auditory Figure-Ground Perception In Neurologically Impaired Children. Journal Of Auditory Research, 10, 1970.

Carhart, R., Special Hearing Tests For Otoneurologic Diagnosis. Arch. Otolaryngol., 89, 64-67, 1969.

Carpenter, M., Core Text Of Neuroanatomy. Baltimore: Williams and Wilkins, 1972.

Cone, Barbara K., Auditory Evoked Potentials For Pediatric Evaluations, Audiology and Hearing Education, 6, 3, Fall, 1980.

DeHirsch, K., Learning Disabilities: An Overview. Bull, N.Y. Acad. Med. 1974.

Dublin, Wm. M.D., "Cytoarchitecture Of The Cochlear Nuclei", Arch. Otolaryngol., Nov. 1974.

Everett, N., Sundsten, J., and Lund, R., Functional Neuroanatomy, Ed. 6. Philadelphia: Lea and Febiger, 1971.

Fernandes, D., Gupta, S., Sly, R.M., and Fracer, M., Tympanometry In Children With Allergic Respiratory Disease. Annals Of Allergy, 40, 3, March, 1978.

Flowers, A., Costello, M., and Small, V., Flowers, Costello Tests Of Central Auditory Abilities. Dearborn, Mich.: Perceptual Learning Systems, 1973.

Foster, G.F., Schmidt, C.R., Sabatino, D., Teacher Expectancies And The Label "Learning Disabilities". J. Learn. Disabil., 9; 1976.

French, J., The Reticular Formation. Sci. Am., 196, 54-60, 1957.

Fria, T.J., and Sabo, D.L., The Use Of Brainstem Auditory Electric Responses In Children: Practical Considerations. Hearing Aid Journal, March, 1979.

Galambos, R., Schwartzkopff, J., and Rupert, A., Microelectrode Study Of Superior Olivary Nuclei. Am. J. Physiol., 197, 527-536, 1959.

Gerber, S.E., and Mencher, G.T., Auditory Dysfunction. Houston: College-Hill Press, 1980.

Gillespie, P., Miller, T., and Fielder, V. Legislative Definitions Of Learning Disabilities: Roadblock To Effective Service, Journal Of Learning Disabilities, 1975, 8(10), 659-666.

Goldman, R., Fristoe, M., Woodcock, R., G-F-W Auditory Selective Attention Test. American Guidance Service, Inc., 1974.

Goldstein, R., Paper Presented At The University Of Oklahoma Symposium entitled "Hearing Disorders In Children", January, 1967.

Gottesman, R., Belmont, I., Kaminar, R., Admission And Follow-Up Status Of Reading Disabled Children Referred To A Medical Clinic. J. Learn. Disabil., 8, 1975.

Hecox, K., and Galambos, R., Brainstem Auditory Evoked Responses In Human Infants And Adults. Arch. Otolaryngol., 99, 30-33, 1974.

Hewett, F.M., and Wilderson, F.B. Jr., Developmentally Backward And Emotionally Distrubed Children, in J. Gallagher (Ed), Windows On Russia, Washington, D.C.: U.S. Government Printing OFfice, 1974.

Hobbs, N., The Future Of Children: Categories, Labels and Their Consequences. San Francisco: Jossey-Bass, 1975.

Jerger, J., Audiological Manifestations Of Lesions In The Auditory Nervous System. Laryngoscope, 70, 417-425, 1960.

Jerger, J., Auditory Tests For Disorders Of The Central Auditory Mechanism. In Fields, W., and Alford, B. (Eds.), Neurological Aspects Of Auditory And Vestibular Disorders. Springfield, Ill.: Charles C. Thomas, 1964.

________, (Ed.), Modern Developments In Audiology, Ed. 2, New York: Academic Press, 1973.

Jerger, J., Maudlin, L., and Anthony, L., Brainstem Evoked Response Audiometry. Audiology and Hearing Education, June/July, 1978.

Jerger, J., and Jerger, S., Clinical Validity Of Central Auditory Tests. Scand. Audiology, 4, 147-163, 1975.

Jerger, S., and Jerger, J., Extra-And Intra-axial Brainstem Auditory Disorders. Audiology, 14, 92-117, 1975a.

Jerger, S., and Jerger, J., Recovery Of Crossed Acoustic Reflexes In Brainstem Auditory Disorder. Arch. Otolaryngol., 101, 329-332, 1975c.

Jewett, D., and Williston, J., Auditory-Evoked Far Fields Averaged From The Scalp Of Humans. Brain, 94, 681-696, 1971.

Johnson, D.W., and Sherman, R.F., The New SSW Test (List EE) And The CES Test. Audiology And Hearing Education, Spring, 1980.

Katz, J., Audiologic Diagnosis; Cochlea To Cortex, Menorah Med. J., 1, 25-38, 1970b.

________, Differential Diagnosis Of Auditory Impairments In Fulton, R.T., and Lloyd, L.L. (Ed), Audiometry For The Retarded: With Implications For The Difficult To Test. Baltimore: Williams and Wilkins, Co. 1970.

________, The SSW Test - An Interim Report. J. Speech Hear. Disord., 33, 132-146, 1968.

________, The SSW Test Manual. Brentwood, Mo.: Auditec Of St. Louis, 1973.

________, The Use Of Staggered Spondaic Words For Assessing The Integrity Of The Central Auditory Nervous System. Journal Of Auditory Research, 2, 327-337, 1962.

Katz, J., Besil, R.A., and Smith, J.M., A Staggered Spondaic Word Test For Detecting Central Auditory Lesions Ann. Otol. Rhinol. Laryngol., 72, 908-918, 1963.

Katz, J., and Fishman, P., The Use Of The Staggered Spondaic Word Test As a Means Of Detecting Differences Between Age Groups. Unpublished Study, 1964.

Katz, J., Myrick, D.K., and Winn, B., Central Auditory Dysfunction In Cerebral Palsy. Paper presented at American Speech and Hearing Association Convention, Washington, D.C., 1966.

Katz, J., and Myrick, D.K., A Normative Study To Assess Performance Of A Group Of Children, Aged Seven Through Eleven On The Staggered Spondaic Word (SSW) Test. Unpublished Study, 1965.

Katz, J., and Pack, G., New Developments In Differential Diagnosis Using The SSW Test. In, Sullivan, M. (Ed.) Central Auditory Processing Disorders, Omaha: University of Nebraska Press, 1975.

Keith, R.W.(Ed.), Central Auditory and Language Disorders In Children. Houston: College-Hill Press, 1981.

Kirk, S., and Kirk, W., Psycholinguistic Learning Disabilities: Diagnosis and Remediation. Urbana, Ill: University Of Illinois Press, 1971.

Kirk, S.A., McCarthy, J.P., and Kirk, W.D.: The Illinois Test Of Psycholinguistic Abilities, Urbana, University Of Illinois Press, Rev. Ed. 1968.

Koppitz, E., Special Class Pupils With Learning Disabilities, Acad. Ther., 8, 1972.

Koppitz, E., The Bender Gestalt Test For Young Children. Grune and Stratton Co. Inc., 1963.

Lamb, L.E., Acoustic Impedance In Screening For Hearing Loss And Ear Disease. Pamphlet Supplied By Teledyne Avionics, Charlottesville, Virginia.

Lasky, E.Z., and Tobin, H., Linguistic And Nonlinguistic Competing Message Effects. J. of Learning Disabil., 6, 4, April, 1973.

Lynn, G., and Gilroy, J., Effects Of Brain Lesions On The Perception Of Monotic And Dichotic Speech Stimuli. Proceedings Of A Symposium On Central Auditory Processing Disorders, University of Nebraska Medical Center, January, 1975.

Lynn, G., and Gilroy, J., Neuro Audiological Abnormalities In Patients With Temporal Lobe Tumors. J. Neurol. Sci., 17, 167-184, 1972.

Magoun, H., The Walking Brain, 2nd Ed., Springfield, Ill.: Charles C. Thomas, 1963.

Martin, F.N. (Ed.), Pediatric Audiology. New Jersey: Prentice-Hall, Inc., 1978.

Masters, L., and Marsh, G.E., Middle Ear Pathology As A Factor In Learning Disabilities. Journal Of Learning Disabilities, 11, 2, February, 1978.

Matzke, H., and Foltz, F., Synopsis Of Neuroanatomy, Ed. 2 New York: Oxford University Press, 1972.

Matzkor, J., Two Methods For The Assessment Of Central Auditory Functions In Cases Of Brain Disease. Ann. Otol. Rhinol. Laryngol., 68, 1185-1197, 1959.

Moore, E.J., and Devgan, B.K., Questions And Answers About Electrochochleography And Brain-Stem Evoked Responses. Audiology And Hearing Education, Oct/ Nov. 1976.

Needleman, H.: Effects Of Hearing Loss From Early Recurrent Otitis Media On Speech and Language Development. In Hearing Loss In Children, Ch. 44, edited by B. Jaffe, Baltimore University Park Press, 1977.

Nodar, R.H., Hahn, J., and Levine, H.L., Brainstem Auditory Evoked Potentials In Determining Site Of Lesion Of Brainstem Gliomas In Chidlren. Laryngoscope, XC, 2, February, 1980.

Nodar, R.H., and Kinney, S.E., The Contralateral Effects Of Large Tumors On Brainstem Auditory Evoked Potentials. Laryngoscope, SC, 11, November, 1980.

Nodar, R.H., Orlowski, J.P., and Lonsdale, D., The Effects Of Thiamine On Abnormal Brainstem Auditory Evoked Potentials. Cleveland Clinic Quarterly, 46, 5, Fall, 1979.

Northern, J., and Downs, M., Hearing In Children. Baltimore: Williams and Wilins, Co., 1978.

Orchik, D.J., Dunn, J.W., and McNutt, L., Tympanometry As A Predictor In Middle Ear Effusion, Arch Otolaryngol, 104, January, 1975.

Orlowski, J.P., Nodar, R.H. and Lonsdale, D., Abnormal Brainstem Auditory Evoked Potentials In Infants With Threatened Sudden Infant Death Syndrome. Cleveland Clinic Quarterly, 46, f, Fall, 1979.

Peters, N.A., Stephenson, W.T., Parents As Partners In A Program For Children With Oral Language And Reading Disabilities, Exceptional Child, Winter, 1979.

Rees, N.S., Auditory Processing Factors In Language Disorders: The View From Procrustes Bed. J. Speech Hearing Dis., 38, 1973.

Reger, R., A Case Study Of The Effects Of Labeling. J. Learn. Disabil., 7, 1974.

Roeser, R.J. and Downs, M.P., Auditory Disorders In School Children. New York: Thieme-Stratton, Inc., 1981.

Rosenblum, S., Arick, Joel, Krug, David., et al. "Brainstem Dysfunction As A Possible Cause Of Autism". Oregon State Department of Education Publication, fall, 1980.

Sabatino, David A., Identifying Neurologically Impaired Children Through A Test Of Auditory Perception. J. Consulting and Clinical Psychology, 33, 2, 1969.

Schow, R.L., and Nerbonne, M.A. Introduction To Aural Rehabilitation. Baltimore: University Park Press, 1980.

Smith, B.B., and Resnick, D.M., An Auditory Test For Assessing Brainstem Integrity; preliminary report. Laryngoscope, 82, 414-424, 1972.

Sparks, R., Goodglass, H., and Nickel, B., Ipsilateral Versus Contralateral Extinction In Dichotic Listening Resulting From Hemispheric Lesions. Cortex, 6, 249-260, 1970.

Special Education For Handicapped Children: First Annual Report Of The National Advisory Committee On Handicapped Children, Washington, D.C., 1968, Office of Education, Department of Health, Education and Welfare.

Starr, A., and Achor, L.J., Auditory Brainstem Responses In Neurological Disease. Archives Of Neurology, 32, November, 1975.

Starr, A., Amlie, R.N., Martin, W.H., and Sanders, S., Development Of Auditory Function In Newborn Infants Revealed By Auditory Brainstem Potentials. Pediatrics, 60, 831-839, 1977.

Starr, A., and Hamilton, A.E., Correlation Between Confirmed Sites Of Neurological Lesions And Abnormalities Of Far-Field Auditory Brainstem Responses. Electroencephalography And Clinical Neurophysiology, 41, 1976.

Walsh, E., An Investigation Of Sound Localization In Patients With Neurologic Abnormalities. Brain, 80, 222-250, 1957.

Webster, D.B., and Webster, J.: Brainstem Auditory Nuclei After Sound Deprivation. Paper Presented To The 91st Acoustical Society Of American Meeting, Washington D.C.: April 5-9, 1976. Accepted For Publication, Archives Of Otolaryng., 1977.

Whitfield, I., The Auditory Pathway. Baltimore: Williams And Wilkins, 1967.

Wiig, E.H., Semel, E.M., Comprehension Of Linguistic Concepts Requiring Logical Operations By Learning Disabled Children. J. Speech Hearing Res., 16, 1973.

Willeford, J., Central Auditory Function In Children With Learning Disabilities. J. Audiol. Hear. Educ. 2, 12-20, 1976a.

Williford, J., Central Auditory Function. In Donnelly K(Ed.), Communicative Disorders: Learning Disabilities Boston: Little, Brown & Company, 1976b.

Willeford, J., Competing Sentences For Diagnostic Purposes Unpublished Material, Colorado State University, Fort Collins, Co., 1968.

Young, E., and Tracy, J.M., An Experimental Short Form Of The Staggered Spondaic Word List For Learning Disabled Children. Audiology and Hearing Education, 3, 1, Dec/Jan. 1977.

APPENDICES

APPENDIX A

Approval Of The Human Subjects Board

OREGON STATE UNIVERSITY

APPLICATION FOR APPROVAL OF THE HUMAN SUBJECTS BOARD

Principal Investigator* Frank Cross, Ph. D.

Department Education Phone 754-3648

Project Title An Assessment of Electrophysiological and Auditory Processing Instruments in Relation to Learning Disabilities.

Present or Proposed Source of Funding Self

Type of Project ________ Faculty Research Project

X Graduate Student Thesis Project*
(Student's name Evan L. Evans)

The following information should be attached to this form. All material, including this cover sheet, should be submitted IN DUPLICATE to the Office of the Dean of Research, AdS A312. Feel free to call extension 3437 if you have questions.

1. A brief description of the methods and procedures to be used during this research project.

2. A list of the risks and/or benefits (if any) to the subjects involved in this research.

3. A copy of the informed consent document and a description of the methods by which informed consent will be obtained. (Information concerning the "Basic Elements of Informed Consent" is reproduced for your information on the back of this form.)

4. A description of the method by which anonymity of the subjects will be maintained.

5. A copy of any questionnaire, survey, testing instrument, etc. (if any) to be used in this project.

6. If this is part of a proposal to an outside funding agency, attach a copy of the proposal.

Signed ______________________ Date 3/3/81
Principal Investigator

*Note: Graduate Student Thesis projects should be submitted by the major professor as Principal Investigator.

OREGON STATE UNIVERSITY

Committee for Protection of Human Subjects

Summary of Review

TITLE: An Assessment of Electrophysiological and Auditory Processing Instruments in Relation to Learning Disabilities

PROGRAM DIRECTOR: Frank Cross (Evan L. Evans)

RECOMMENDATION:

XX Approval

____ Provisional Approval

____ Disapproval

____ No Action

REMARKS:

Date: 3/6/81 Signature

cc: Committee Chairman

mep

Rod. V. Frakes
Associate Dean of Research
Phone: 754-3439

APPENDIX B

Informed Consent

Informed Consent

Dear Parents,

The purpose of sending you this form is to ask for your signed permission allowing your child to participate in a study which is to be done within the Jefferson School District in March and April of this year. This project has been approved by the Jefferson School Board, and will be conducted completely on the school grounds.

The purpose of the study is to try to find those children that need special assistance earlier in their school career, and therefore provide them with better, more appropriate, perhaps more timely help if they demonstrate the need for such help.

In order to do the study it is necessary to have children who have already been identified as needing assistance, and at least an equal number of children who do not appear to need help in school in the area of auditory perceptual abilities (listening and processing skills.)

We would like to have your child participate in this study. Your signed consent is necessary. Unfortunately, without your signing the form on the last page, we will not be able to allow your child to participate in this study.

We will not be able to begin the study until a sufficient number of these forms have been returned with the parents signature. We ask your earliest consideration and reply.

There will be three (3) separate test instruments used during this study. The first evaluation will require about 30 minutes to complete. It consists of your child listening to a tape recorder, and pointing to one (1) of four (4) possible pictures per page.

The next evaluation will again involve your child listening to a tape recorder. This time, s/he will be asked to repeat, out loud, the words that s/he heard on the tape. This evaluation will also require about 30 minutes to complete.

The final evaluation requires about 1 hour for completion. During this time, three tiny electrodes will be taped to his/her head. They will listen to a "Click" sound. The electrodes allow us to measure the brain's electrical activity as a result of listening to the "clicks."

This procedure is absolutely safe. (It has been used on babies just days old when physicians were assessing hearing acuity of infants.) There are no noxious stimuli, and your child will be in absolutely no danger.

It is our intent to insure as complete a level of confidentiality of information as possible. That is, every effort will be made to protect the identity of each participant. Any report, or discussion of our findings will provide for total anonymity for all involved.

You must understand that your signed consent is required before any testing can be done. You are free to withdraw your consent at any time, for any reason.

You are invited to attend any of the sessions involving your child. Further, I will meet with you at any time to discuss any aspect of this study, or its procedures.

At the end of the study, I will offer to meet with you regarding the results of your child's evaluation.

I would appreciate your support in this study, and will make every effort to keep you informed. Should you have any questions, please call one of the numbers listed below.

Thank you for your consideration in this matter.

Sincerely,

327-2960
838-3001

Evan L. Evans, M.S.

I have read the above, and agree to give my permission for my child, ________________________________ to participate as described above. I understand that I am free to withdraw my permission at any time, (for any reason,) by written notice.

Signed ______________________________

Relationship ______________________________

Date: ______________________________

APPENDIX C

G.F.W. Selective Attention Response Form

Goldman-Fristoe-Woodcock Auditory Skills Test Battery

G-F-W AUDITORY SELECTIVE ATTENTION TEST

Quiet
Fan-like Noise
Cafeteria Noise
Voice

by Ronald Goldman, Ph.D.
Macalyne Fristoe, Ph.D.
Richard W. Woodcock, Ed.D.

Examiner ____________________ Testing Date __________

NAME ____________________ SEX: M ☐ F ☐ BIRTHDATE __________

GRADE __________ SCHOOL/AGENCY ____________________

CITY ____________________ STATE __________

	Year	Month
Testing Date	____	____
Birthdate	–____	____
Age	____	____

Calculation of Subject's Age: Record the year and month of the testing date and birthdate in number form (disregard days). Subtract the birthdate from the testing date to obtain the subject's age in years and months.

Equipment: (Make and model)

Tape Player ____________________

Earphones ____________________

RECORDING RESPONSES: Record correct responses by placing a "1" (one) in the appropriate space. Record incorrect responses, or failures to respond, by placing a "0" (zero) in the appropriate space.

Published by

AGS **American Guidance Service, Inc.,** Publishers' Building, Circle Pines, Minnesota 55014

TRAINING SECTION

Training Item	Words	Trials 1	Trials 2	Trials 3
1	Sue			
	cat			
2	shack			
	key			
3	patch			
	rock			
4	wing			
	chair			
5	sack			
	wig			
6	two			
	bag			
7	tack			
	sip			
8	pat			
	shoe			
9	pass			
	lock			
10	bang			
	rake			
11	fair			
	chip			
12	back			
	tear			
13	pea			
	pear			
14	sang			
	lake			
15	fat			
	Sue			

TEST SECTION

Quiet

Test Item	Target Word	Score (1 or 0)
Q-1	shoe	
Q-2	rock	
Q-3	pear	
Q-4	pea	
Q-5	bang	
Q-6	rake	
Q-7	pat	
Q-8	sack	
Q-9	wig	
Q-10	back	
Q-11	fair	

QUIET NUMBER CORRECT [ ]

Fan-like Noise

Test Item	Target Word	Score (1 or 0)
F-12	lake	
F-13	bag	
F-14	shack	
F-15	sang	
F-16	cat	
F-17	tear	
F-18	chip	
F-19	two	
F-20	lock	
F-21	sack	
F-22	sip	
F-23	wing	
F-24	chair	
F-25	key	
F-26	patch	
F-27	Sue	
F-28	tack	
F-29	fat	
F-30	pass	
F-31	lake	
F-32	pear	
F-33	pat	
F-34	tack	
F-35	wing	
F-36	chair	
F-37	sang	
F-38	pat	
F-39	rake	
F-40	Sue	
F-41	sack	
F-42	bang	
F-43	patch	
F-44	back	

AN-LIKE NOISE
UMBER CORRECT [ ]

Cafeteria Noise

Test Item	Target Word	Score (1 or 0)
C-45	key	
C-46	fair	
C-47	shoe	
C-48	tear	
C-49	bang	
C-50	sack	
C-51	cat	
C-52	shack	
C-53	chip	
C-54	pat	
C-55	rock	
C-56	sack	
C-57	bag	
C-58	pat	
C-59	patch	
C-60	lock	
C-61	pass	
C-62	Sue	
C-63	bang	
C-64	fat	
C-65	chair	
C-66	sip	
C-67	two	
C-68	pear	
C-69	wig	
C-70	patch	
C-71	pea	
C-72	sip	
C-73	sack	
C-74	pat	
C-75	bang	
C-76	fat	
C-77	pass	

CAFETERIA NOISE
NUMBER CORRECT [ ]

Voice

Test Item	Target Word	Score (1 or 0)
V-78	Sue	
V-79	back	
V-80	shoe	
V-81	wing	
V-82	tear	
V-83	cat	
V-84	sack	
V-85	wig	
V-86	sang	
V-87	chip	
V-88	pat	
V-89	rock	
V-90	Sue	
V-91	shoe	
V-92	patch	
V-93	sack	
V-94	lake	
V-95	fair	
V-96	bang	
V-97	pat	
V-98	two	
V-99	pea	
V-100	Sue	
V-101	fair	
V-102	patch	
V-103	sack	
V-104	tack	
V-105	key	
V-106	lock	
V-107	bag	
V-108	shack	
V-109	pat	
V-110	rake	

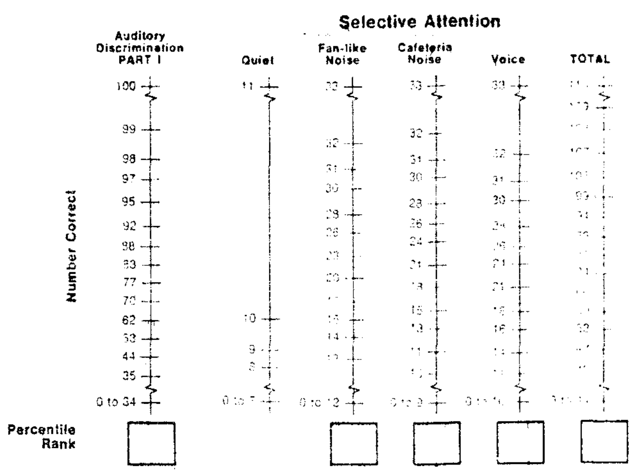
VOICE
NUMBER CORRECT [ ]

SUMMARY OF SCORES

Subject's Age ____ ____ (from front page)
years months

	Number Correct	Percentile Rank	OPTIONAL SCORES Age Equivalent	Standard Score	Stanine
AUDITORY DISCRIMINATION (Part I of the G-F-W Diagnostic Auditory Discrimination Test)		☐	____	____	____
Quiet . . . . ____ (11)					
Fan-like Noise . . . . ____ (33)		☐ TABLE			
Cafeteria Noise . . . . ____ (33)		☐ TABLE 3			
Voice . . . . ____ (33)		☐ TABLE 4			
TOTAL . . . . ____ (110)		☐ TABLE	____ TABLE	____ TABLE C	____ TABLE C

PERFORMANCE PROFILE



Instructions for completing the "Performance Profile":

1. Place a large dot representing the number correct, on the vertical line for each test. Note that a dot may need to be positioned between two scores printed on the vertical line.
2. Connect the dots by straight lines to produce the Profile.
3. Record the subject's percentile rank for each test in the box beneath the vertical line.

APPENDIX D

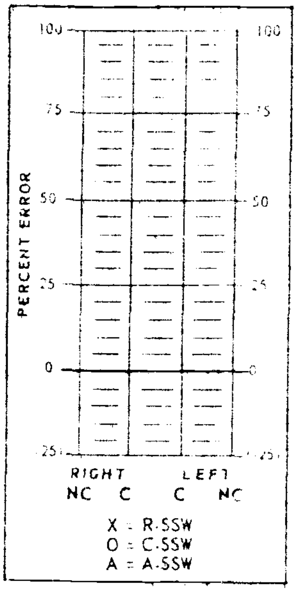
Staggered Spondaic Word Test Form

SSW TEST LIST EC

Name ______________________ Date ____________ S* ____________

Age ____________ Sex: M F Tester ______________________ 1st Ear: REF LEF

1. R-SSW Enter totals from page 3				
CONDITION	RNC	RC	LC	LNC
Total Errors				
Multiplier	x	x	x	x
R-SSW % Error				
EAR	RE		LE	
R-SSW % Error				
TOTAL		T		
R-SSW % Error				



2. C-SSW Enter R-SSW % error				
CONDITION	RNC	RC	LC	LNC
R-SSW % Error				
- WDS % Error	-	-	-	-
C-SSW % Error				
EAR	RE		LE	
C-SSW % Error				
TOTAL		T		
C-SSW % Error				

3. A-SSW Enter appropriate errors from page 3				
Condition	RNC	RC	LC	LNC
Errors				
Multiplier	x	x	x	x
New % Error				
- WDS % Error	-	-	-	-
A-SSW % Error				
EAR	RE		LE	
A-SSW % Error				
TOTAL		T		
A-SSW % Error				

RESPONSE BIAS

Effects

Ear ________ ________

Order ________ ________

Pattern A

Reversals

True ________

Probable ________

Questionable ________

MAX ____

MULTIPLIERS		
# Items	R-SSW	A-SSW
20	5	10
25	4	8
30	3.3	6.6
40	2.5	5
If other:		
( )	____	____

COMMENTS: ______________________

*CATEGORY

PURE TONE AND SPEECH SUMMARY						
RE						
LE						

AUDITEC of St. Louis
402 Pasadena Ave.
St. Louis, MO 63119

PRACTICE ITEMS

a.	air	plane	wet	paint
c.	north	west	stair	way

b.	cow	boy	white	bread
d.	oat	meal	flash	light

Left First / Right First	L-NC (A) R-NC	L-C (B) R-C	R-C (C) L-C	R-NC (D) L-NC	Rev	WRONG
1.	up	stairs	down	town	T P Q	
3.	day	light	lunch	time	T P Q	
5.	corn	bread	oat	meal	T P Q	
7.	flood	gate	flash	light	T P Q	
9.	meat	sauce	base	ball	T P Q	
11.	house	fly	wood	work	T P Q	
13.	sun	day	shoe	shine	T P Q	
15.	back	door	play	ground	T P Q	
17.	snow	white	foot	ball	T P Q	
19.	blue	jay	black	bird	T P Q	
SUM						

	R-NC E L-NC	R-C F L-C	L-C G R-C	L-NC H R-NC	Rev	WRONG
2.	out	side	in	law	T P Q	
4.	wash	tub	black	board	T P Q	
6.	bed	spread	mush	room	T P Q	
8.	sea	shore	out	side	T P Q	
10	black	board	air	mail	T P Q	
12.	green	bean	home	land	T P Q	
14	white	walls	dog	house	T P Q	
16	school	boy	church	bell	T P Q	
18	band	saw	first	aid	T P Q	
20.	ice	land	sweet	cream	T P Q	
SUM						

COMMENTS:

	A	B	C	D	Rev	WRONG
21.	hair	net	tooth	brush	T P Q	
23.	ash	tray	tin	can	T P Q	
25.	key	chain	suit	case	T P Q	
27.	corn	starch	soap	flakes	T P Q	
29.	day	break	lamp	light	T P Q	
31.	bird	cage	crow's	nest	T P Q	
33.	book	shelf	drug	store	T P Q	
35.	hand	ball	milk	shake	T P Q	
37.	for	give	milk	man	T P Q	
39.	race	horse	street	car	T P Q	
SUM Page 3						
SUM Page 2						
TOTAL						
Left First / Right First	L-NC (A) R-NC	L-C (B) R-C	R-C (C) L-C	R-NC (D) L-NC		

	E	F	G	H	Rev	WRONG
22	fruit	juice	cup	cake	T P Q	
24.	nite	light	yard	stick	T P Q	
26.	play	ground	bat	boy	T P Q	
28	birth	day	first	place	T P Q	
30	door	knob	cow	bell	T P Q	
32.	week	end	work	day	T P Q	
34.	wood	work	beach	craft	T P Q	
36.	fish	net	sky	line	T P Q	
38.	sheep	skin	bull	dog	T P Q	
40.	green	house	string	bean	T P Q	
SUM Page 3						
SUM Page 2						
TOTAL						
	R-NC E L-NC	R-C F L-C	L-C G R-C	L-NC H R-NC		

EAR EFFECT		
Total Errors	RE First	LE First
☐ Sig. ☐ N. Sig.		

REVERSALS		
True	Prob.	Quest.
MAX =		

ORDER EFFECT			
1	2	3	4
FIRST SPONDEE		SECOND SPONDEE	
Sig		N. Sig	

COMBINED TOTALS	RNC	RC	LC	LNC
A D or E H				
H E or D A				

Enter these figures on Page 1

APPENDIX E

B.A.E.P. Response Form

BAEP Study

Name______________________

Check off as completed:

Date:____________

_____2048 _____less than 5K ohms _____ .2uv _____Left Ear Phone for Test
_____1024 _____20 per sec. _____ .5uv _____White lead to Test
_____ _____10 msec. _____ 1.uv _____Changed to Opposite side
_____ Test wave generated _____ EEG Signal O.K.'d

1.) Are the peaks within .2msec of the norms?*

Right			Left		
W-1	W-3	W-5	W-1	W-3	W-5
Y N	Y N.	Y N	Y N	Y N	Y N

2.) Are the central conduction times within .2msec of being equal between administrations of the same ear?

Right			Left		
W 1-3	W 1-5	W 3-5	W 1-3	W 1-5	W 3-5
Y N	Y N	Y N	Y N	Y N	Y N

3.) Is the latency of the occurrence of the 5 within .2 msec between ears at the same SL.

Y N

4.) Are the results of two successive stimulus runs superimposable within the same ear?

Y N (right ear) Y N (left ear)

5.) When comparing the results of both ears, at any one of the peaks, [I III V] is the amplitude of that wave reduced by 50%?

right			left		
W-1	W-3	W-5	W-1	W-3	W-5
Y N	Y N	Y N	Y N	Y N	Y N

6.) Is there any abnormality in the shape of the waves? [flattening, broad based peak, additional peaks]

right			left		
W-1	W-3	W-5	W-1	W-3	W-5
Y N	Y N	Y N	Y N	Y N	Y N

7.) Are the first 5 of the Jewett seven peaks present?

W-1	W-2	W-3	W-4	W-5	
Y N	Y N	Y N	Y N	Y N	[right]
Y N	Y N	Y N	Y N	Y N	[left]

---

* Monaural Starr & Achor Wave	75	65	55	45 (dB SL)	Tele-Dyne Wave	75	65	55	45
1	1.4	1.6	1.8	2.2	1	1.4	1.6	1.8	2.2
2	2.6	2.8	3.0	3.3	2	2.6	2.8	3.0	3.3
3	3.7	3.8	3.9	4,3	3	3.7	3.8	3.9	4.3
4	4.6	4.8	5.0	5.4	4	4.6	4.8	5.0	5.4
4-5	5.2	5.2	5.6	5.9	4-5	5.2	5.2	5.6	5.9
5	5.4	5.5	5.8	6.0	5	5.4	5.5	5.8	6.0
6	6.9	7.1	7.5	7.8	6	6.9	7.1	7.5	7.8
7	8.7	9,0	9.0	9.6	7	8.7	9.0	9.0	9.6

APPENDIX F

TEST BATTERY USED BY JEFFERSON SCHOOL DISTRICT FOR ENTRANCE INTO LEARNING DISABLED PROGRAM

Instruments used by Jefferson School District

Mann-Suiter _Handbook in Diagnostic Teaching_

Peabody Individual Achievement Test

Wechsler Intelligence Scale for Children--Revised

Wide Range Achievement Test--Revised