A Review of the Auditory Processing Skills of Fifty Children And Recommendations For Educational Management

Ralph R. Rupp, Ph.D.
Professor of Education and Audiology
The School of Education
The University of Michigan
Ann Arbor, Michigan
and
Coordinator, Audiological Services
Department of Otorhinolaryngology
St. Joseph Mercy Hospital
Ann Arbor, Michigan

OUTLINE

I. UNDERSTANDING THE CHALLENGE

Early elementary-age school children in academic distress constitute a special challenge — to themselves, to their parents, and to their teachers.

The following report, based on assessment findings from the University of Michigan protocol for measuring auditory perceptual and processing skills, reviews trends from fifty such children in obvious listening and learning distress in the early elementary grades.

The majority of these children were referred to our center for auditory processing assessment by local otologists who saw these children with the following classical expression of concern by the parents: "The teacher says he must have a hearing loss, for he just doesn't seem to be able to hear or listen in the classroom. He is never quite with the group in classroom discussions, and he doesn't seem to be able to follow directions. He is not making appropriate programs in his academic skills. Interestingly, the teacher finds that on a one-to-one interaction, he does much better."

According to Wepman (1975), "Society expects each child to learn his communication skills during kindergarten through the third grade." Some children do not seem to do this. We ought to wonder **why?** Who are these children who do not learn their language communication skills? Katz and Illmer (1972) discussed these kinds of children in their chapter, "Auditory perception in children with learning disabilities." They quoted the national definition that learning disability refers to deficits in one or more of the specific intellectual processes. They reported that "children with learning disabilities demonstrate a discrepancy between the expected and actual achievement." Communication skills generally include the following types, in order of frequency of occurance (in the adult) according to Butler (1975): **listening** at a forty-five percent incidence, **speaking** at a thirty percent occurrence, **reading** at a sixteen percent incidence and **writing** at approximately a nine percent distribution. Clearly, listening — together with its associated adequacy or deficit — accounts for the majority of the communicative effort of the individual.

In what areas do learning discrepancies occur? Deviations from the norms may exist in the areas of heard, spoken, read or written language, mathematics, and other associated school subjects. The learning difficulty may show up as inabilities in understanding, integrating, or manipulating information.

INCIDENCE FIGURES

What is the prevalence of auditory and perceptual processing disabilities in school-aged children? Katz and Illmer suggested that as many as twenty percent of school-age children may have some kind of lag in terms of learning through language routing system. This means that in a representative classroom of thirty children, perhaps six of them may have difficulties in using language effectively, either in a straightforward or in a complicated manner. Further, it is anticipated that the prevalence of visual or auditory processing problems with these children may increase as multidisciplinary teams enter the diagnostic picture in the school setting. In an interesting discussion entitled, "Whose child is he — yours, mine, or ours?" Maitland (1976) suggested the respective roles of the variety of specialists who may interact with elementary school children. He proposed that each specialty has a cooperative and complimentary role of interaction with the other specialists, with the goal as the betterment of the child under observation. The identification of such children considered to be at risk is the first step in the intervention process, but it is the one that may be absent for many children with subtle auditory perceptual and processing difficulties.

It has been suggested that children with auditory problems relating to learning acquisition may, indeed, number about seventy-five percent of the learning-delayed group. Stated alternately, of the twenty percent of school children with language acquisition and manipulation deficit, three-fourths may be in distress because of auditory perceptual and processing difficulties.

EDUCATIONAL SIGNIFICANCE

The fifty children in this study have subtle listening problems. And since the problems are subtle, these children were not detected on routine screening or diagnostic audiological workups. The basic procedures in most audiology centers include assessment of air-conduction, pure-tone thresholds; bone conduction, pure-tone thresholds; spondee thresholds, and an estimate of understanding ability in a quiet background. The majority of children with auditory perceptual and processing difficulties will pass these four standard diagnostic measurements with ease. These tasks are not demanding enough; or conversely, the listening or processing difficulties are too subtle for the low demands of these basic audiologic procedures.

These fifty children also have essentially normal intelligence when their visual problem-solving abilities are assessed by tests that do not put a large emphasis on language use. To clarify: when nonlanguage performance is assessed, most of these children perform well, intellectually. In summary, most children with stable listening difficulties will have essentially "normal" hearing when measured on basic audiologic tests, and they will show normal intelligence when examined with performance-type assessments.

The problem remains, however, that they run into listening difficulties when they attempt to interact, auditorily, in school or at home. Most of the children seen for diagnostic workup in our clinical facility because of suspected listening problems come from first, second, and third grade classrooms. It is in these classroom environments that the children evidence problems in maintaining effective auditory contact with their teachers. It is at this time, also, that more heavy demands are placed on listening skills related to the language arts curriculum. The most common concern stated by the parents, as cited earlier, is that the child must have a hearing loss for he or she just does not seem to be succeeding in the classroom.

DEFINITION

Let us now move to a definition of auditory perception. In a 1976 short course at the ASHA annual meeting, Rupp proposed the following definitions: "Auditory perception is the receiving, processing, and classifying of aural sensory information for coding into familiar symbols so that the individual understands the symbols and is then free to concentrate and consider the abstract information so symbolized." The key phrases include the terms: receiving, processing, and classifying. Why? For coding into familiar symbols. Following this perception portion, the individual then understands the symbols and can concentrate on the abstract information in the groups of symbols being presented.

Witkin (1971) proposed the crucial triad of sensation, perception, and cognition. Sensation refers to the conscious arrival of an auditory stimulus at the cortex, perception refers to the coding of the stimulus into a unique symbol, and cognition refers to the child's ability to use the familiar symbols creatively and abstractly for both receptive and expressive language use. Gould, cited by Witkin, suggests that perception is a sensory experience that has gained meaning or significance. English and English, also cited by Whitkin, proposed that perception is an event in the person's experience created by the excitation of sensory receptors to which a uniqueness has been attached. Perception is the attachment of a consistent uniqueness to an auditory experience.

Cognition, the third segment of Witkin's triad, has to do with the comprehension and retention of spoken language and the performance of language related tasks, which includes recognizing the main ideas, analyzing and recalling details, and associating ideas. In order to effectively master the cognition levels, however, the child also must have mastered the perceptual and processing functions. Witkin suggested that "Auditory perception involves focusing, attention, tracking, sorting, scanning, comparing, retrieving, and sequencing of spoken messages at the moment of utterance, at the time of the sensation." To interact effectively, the child must be able to attend to the message, he must be able to track it over time, to discriminate among sounds and syllables, he must have a measurable auditory memory, and finally, he must be able to use the input cognitively in order to react appropriate to teachers, parents, friends, or siblings.

A definition of auditory perception and processing: the ascribing of a consistent uniqueness to an auditory signal. The child is not yet at the point of **meaning**, as such, but rather, only that the individual can identify a unique nonlinguistic sound or is able to repeat a multisyllabic oral utterance correctly. At this point, meaning and cognition has not taken place, but the child is able to imitate or reproduce it accurately. Following the ascribing of the consistent uniqueness to the signal comes the assignment of **meaning** to it. To review: we **hear**, we **perceive**, and we **understand** in that order.

THE CHARGE TO THE AUDIOLOGIST

Why are audiologists cited as the appropriate professional group to conduct the assessments on children with suspect auditory processing difficulties? Consider the following five documents in the public records. First, the "Dictionary of Occupational Titles," published by the United States Department of Labor in 1964, identifies the professional role of the audiologist. Second, the 1975 Career Brochure, "Hearing Impairment and the Audiologist," published by the American Speech and Hearing Association, describes audiologists as "The professionals who are concerned with normal and defective hearing and language development." Third, the ASHA position statement on learning disabilities, which appeared in 1976, charged the audiologist with the evaluation and remedication of communicative input and output difficulties. Fourth, the 1974 ASHA position statement on the responsibilities of the audiologist in the habitation of the auditorily handicapped, which stated "the initial step in the audiologic habilitation process is an audiologic assessment, which must be restricted to differential evaluation of auditory function for the purpose of medical diagnosis only, but should include: (one) assessment of auditory sensitivity and dynamic range; (two) assessment of listening behavior, including descriptions of auditory attention, auditory awareness, perception of connected speech, determination of the temporal capacities for speech comprehension, auditory closure, sequencing, memory span and retrieval, and definition of receptive distance for auditory reception; (three) evaluation of phonologic, morphologic, syntactic, and semantic language abilities, and (four) gathering of functional evidence related to the anatomic site of pathology." Fifth, Wepman (1975) wrote that the goal of the speech and hearing profession is "to provide the expertise in auditory perceptual development needed in naormal as well as in pathologically abnormal communication skills. As a profession most clearly identified with auditory development and function, ... we are amiss if we do not ... begin to function as the recognized experts in auditory process development and mal-development." Clearly, if the five citations are appropriate, the audiologist can be considered an appropriate responsibility professional who is well qualified to evaluate hearing ability and auditory processing proficiency.

II. A MODEL OF AUDITORY PROCESSING

A number of authors have proposed models of auditory processing (Butler, 1975; Carhart, 1960; Fairbanks, 1954; O'Neill, 1964; Pollack, 1970; Rupp, 1976, 1978; Semel, 1970; Weener, 1976; Wepman, et al., 1960; and Witkin, 1971). The common thread among the various models includes a sequence beginning with an awareness of the signal, then an integration of the signal, and finally, an understanding of the meaning of the signal.

Rupp's (1976, 1978) cortical model for auditory processing included four sequences: first, sensation as the conscious awareness of the arrival of the auditory signal; secovd, perception and processing as the decoding and classifying aspect where a consistent uniqueness is ascribed to the linguistic or nonlinguistic signal; third, cognition as the attachment of meaning to the linguistic or nonlinguistic experience so that interpretation, understanding, and reasoning may follow; and fourth, an appropriate response as a mental, motor, and/or verbal act in reaction to the interpretation of the input signal.

III. A PROFILE OF AUDITORY PROCESSING

The actual assessment of such a dynamic process is not one that can be accomplished as a single task because the process, itself, is complex. To assess a child's abilities to process auditorily, at the University of Michigan, we have developed a six-part battery in which we look at attention, memory, sequencing, discrimination, categorization, and performance. A battery of specialized audiologic tests also may be employed for assessing hearing and central auditory processing. The complete list of potential tests in each area is presented in Table One.

Two or more assessments in each of the six measurement areas are run. The audiologic tests in the seventh area are adjunctive and may be used with children presenting the most complex problems. It has been our expectation that the findings within an area measured with slightly different tasks will be reinforcing of each other. If such measures within an area are not corraborative of each other, we attempt to study that specific area in greater depth.

The child's test scores, plotted on the form shown in Figure One, provide a grphic profile of his functioning in auditory perception and processing. The profile was designed so that it could be used with any age child to reflect, graphically, both performance strengths and weaknesses. For continuity, the data are reported in the following way (left to right): Nonlanguage performance results in order to establish a problem solving potential; then, categorization where screening assessment of language useage is reported; then, discrimination memory, and sequencing, and, at the far right, selective attention, and data from the associated audiologic battery.

Along the left ordinate are the age equivalents. The child's chronological age is entered at the center of the ordinate and serves as the base against which all subsequent age-equated scores are compared. Moving up and down from the base age, a linear spread of six years is possible, with a plus or minus three-year range on each side of the chronological age. Since the audiologic data are generally not reportable in age equivalents, departures from the norms are noted only in downward citations from the line labeled audiologic norms. When the profile is presented in its totality, as shown later in Figures Two, Three, and Four, strengths and weaknesses as reflected in the profile are readily observed. It is from observations on this diagnostic profile that the intervention and management plan will be developed.

As suggested earlier, the goal of this assessment procedure is to identify those children whose specific auditory processing abilities fall below the age-expected norms in one or more of the measurement areas. As reviewed earlier, the assignment of the audiologist will be to measure and analyze this dynamic activity called auditory processing.

Table One: A Listing of Potential Procedures for Assessing Auditory Processing Skills.

I. Attention
- *A. Pure tone, air and bone conduction thresholds (not age related)
- *B. Auditory Selective Attention Test, 3-80 yr. (G-F-W Auditory Test Battery, Section 1, 1974)
- *C. Speech Discrimination in Noise (adult norms)
- D. Localization in space (not age scored)

II. Memory
- *A. Auditory Closure, 2-10 yr. (ITPA, 1968)
- *B. Sound Blending. 2-4 to 8-7 yr. (ITPA, 1968)
- C. Auditory Conceptualization Test, 5-11 yr. (Lindamood, Lindamood, 1971)
- D. Spondaic Threshold and Phonetically-Balanced Kindergarten Lists (not age normed; age equated)
- E. Diagnostic Auditory Discrimination Test (Part I, II, III) 3-80 yr. (G-F-W, 1974)
- F. Recognition Memory (Test 1, Auditory Memory Tests) (G-F-W, 1974)
- G. Sound Mimicry (Test 1, Sound-Symbol tests) 3-80 yr. (G-F-W, 1974)
- H. Sound Recognition (Test 2, Sound-Symbol Tests) 3-80 years (G-F-W, 1974)
- I. Sound Analysis (Test 3, Sound-Symbol Tests) 3-80 years (G-F-W, 1974)
- J. Sound Blending (Test 4, Sound-Synbol Tests) 3-80 years (G-F-W, 1974)

III. Sequencing
- *A. Memory for related and unrelated sentences, 4-8 yr. (Bloomer, 1970)
- *B. Immediate and delayed sentence recognition, below 7 yr.; above 7 yr. (Kirby, 1970)
- C. Auditory Attention Span for Unrelated Words, 3-19 yr. (Baker, Leland, 1967)
- D. Oral Commissions (Test 7), 3-8.3 yr. (Baker, Leland, 1967)
- E. Memory for Digits, 2-14 yr. (Arthur, 1947)
- F. Auditory Sequential Memory, 2-10.3 yr. (ITPA, 1968)
- G. Sentences, 4-9.6 yr. (Spencer, 1958; McGrady, 1964)
- H. Memory for Content (Test 2, Auditory Memory Tests) 3-80 yr. (G-F-W, 1974)
- I. Memory for Sequence (Test 3, Auditory Memory Tests) 3-80 yr. (G-F-W, 1974)

IV. Discrimination
- *A. Auditory Discrimination Test, 5-8 yr. (Wepman, 1958)
- *B. Goldman-Fristoe-Woodcock Test of Auditory Discrimination, 3.8-70+ years (1970)
- C. Sound-Symbol Association (Test 5, Sound-Symbol Tests) 3-80 yr. (G-F-W, 1974)
- D. Reading of Symbols (Test 6, Sound-Symbol Tests) 3-80 yr. (G-F-W, 1974)
- E. Spelling of Sounds (Test 7, Sound-Symbol Tests) 3-80 yr. (G-F-W, 1974)

V. Categorization
- *A. Peabody Picture Vocabulary Test, 3.5-17.6 yr. (Dun. 1959)
- *B. Extended Action-Agent Test, 5-15 yr. (Bloomer, Herman, 1956)
- C. Test for Auditory Comprehension of Language, 3-6 yr. (Carrow-Woolfolk, 1973)
- D. Verbal Opposites (Test 4), 5.3-19 yr. (Baker, Leland, 1967)
- E. Auditory Reception, 2.1-16.2 yr. (ITPA, 1968)
- F. Auditory Association, 2.4-10.11 yr. (ITPA, 1968)
- G. Word Intelligibility by Picture Identification, not age normed, but appropriate to children 3 yr. and older (Ross, Lerman, 1971)
- H. Michigan Picture Language Inventory, 4-6 yr. (Lerea, 1958)

VI. Performance
- *A. Progressive Matrices (Colored) 5.6-11 yr.; (Standard) 8-65 yr. (Raven's, 1956, 1968)
- *B. Symbol-Digit Modalities Test, 8-17 yr. (Smith, 1973)
- *C. Hiskey Cubes, 3-8 yr. (Hiskey, 1966)
- D. Knox cubes. 5.6-10.6 yr. (McNemar, 1942)
- E. Vineland Social Maturity Scale, 0-25+ yr. (Doll, 1936)

VII. Audiologic Procedures
- *A. Pure-tone, air and bone conductions thresholds
- *B. Spndaic Thresholds
- *C. Discrimination in Quiet (30 dB SL): monaural, sound field
- *D. Discrimination in Noise (30 or 50 dB SL): monaural, sound field (speech and noise separated), sound field (speech and noise combined)
- *E. Impedance Testing (Otoadmittance): tympanometry, stapedius acoustic reflex, acoustic reflex decay
- F. Synthetic Sentence Identification: ipsilateral competing message, contralateral competing message (Jerger, 1973)
- G. Staggered Spondee Word Test (Katz, 1972)
- H. Percentage versus Intelligibility for PB Words
- I. Rapidly alternating speech perception
- J. Binaural integration or alternating spondaic syllables
- K. Accelerated Word Intelligibility by Picture Identification (Ross, Lerman, 1971)

* Tests used to assess auditory perception and processing with those tests that may be employed for abbreviated examinations.

The protocol assess six general areas of auditory processing. They include the following:

A. Selective attention — 'listening' for tonal and speech stimuli in both quiet and noise contaminating environments.
B. Memory — analytic processing of a linguistic or nonsense unit; processing the pieces that make up a word or unit; phonemic synthesis.
C. Sequencing — the ability to handle a 'train' or series of word units or numerals in a progression.
D. Discrimination — hearing and then judging "same" or "different" with pairs of words that may be only minimally different.
E. Categorization — using language units meaningfully; vocabulary identification; subject-verb interaction; verbal opposites, and
F. Performance — a screening approach to assess visual abstract problem-solving skills with a low language demand.

The twenty-three common measurements made in the above six cited processing areas are reviewed in Table Two. These same twenty-three measurements will be included in the summary discussion for the fifty children under study.

IV. THREE CLINICAL PROFILES

To bring this discussion back to a practical level, three profiles of children evaluated in our clinic will be summarized to illustrate the diagnostic effectiveness of our procedure.

Figure Two reflects the auditory performances of P.P., age 6.8 years, who was referred to our facility by his classroom teacher who suspected that he had a hearing loss even though the boy's mother was unaware of any problem with her son's hearing. He was described by his teacher as "a nonattender." Baseline audiological information recorded on the profile to the right on the heavy vertical line reinforces normal sensitivity for pure tones. His spondee thresholds were well within normal at three and eight decibels for right and left ears, and discrimination scores in quiet were one hundred percent, bilaterally. On the Word Intelligibility by Picture Identification test, performed in one-to-one noise via monaural headphone and sound field conditions, he scored at eighty-four and eighty-eight percent, respectively, which were also within normal limits for this test, as interpolated from adult norms. In addition, on the noise subtest of the Goldman-Fistoe-Woodcock Auditory Discrimination test, he scored at the ninety-

Table Two: Auditory Tasks, Cited According to Areas Under Study.

1. Selective Attention	
Air conduction pure tone thresholds	
Spondee thresholds	
Right Ear/Discrimination in Quiet	
Left Ear/Discrimination in Quiet	
Right Ear/Discrimination in Noise	
Left Ear/Discrimination in Noise	
Soundfield/Discrimination/Speech-noise Combined	
Soundfield/Discrimination/Speech-noise Separated	
G-F-W Auditory Discrimination/Quiet Subtest	
G-F-W Auditory Discrimination/Noise Subtest	T-10
2. Memory (units)	
ITPA Blending Subtest	
ITPA Closure Subtest	
Lindamood Auditory Conceptualization	T-3
3. Sequencing ('train' of units)	
Memory for Related Sentences	
Memory for Unrelated Sentences	
Memory for Digits	T-3
4. Discrimination (same/different)	
Wepman Auditory Discrimination Test	T-1
5. Categorization (language screen)	
Peabody Picture Vocabulary Test	
Verbal — Opposites Test	
Full Range Action Agent	T-3
6. Performance (problem solving)	
Raven's Progressive Matrices	
Hiskey Cubes	
Knox Cubes	T-3
GRAND TOTAL 23	

sixth percentile, which was well within normal. On the age-equated measures, his performance scores were within normal limits with a fiftieth percentile on the Raven's and a 6.5 year score on the Knox Cubes. In the categorization tasks on language screening, normalcy was again observed as he achieved a 7.3 year level on the Peabody, and a six year level on the Action-Agent test. On the memory tasks, as reflected in his scores on the ITPA Closure and Blending tests and the Lindamood test, he achieved scores of seven years, 7.4 years, and mid-first grade, respectively. His sequencing scores were only slightly below age level, as he achieved age equivalents of six and 6.5 years on the sentence tests. He topped out on the Wepman Auditory Discrimination test at eight years. From our observations gathered over three appointments, none of the findings suggested any unusual deficits in P.P.'s auditory processing. Since the boy was performing poorly in school, however, we initiated further contact with the school personnel as to possible causation. The end of the story was that P.P. and his teacher had developed an irresolvable incompatibility and were totally unable to communicate with each other. Since there were two other first grades in the school, the principal moved P.P. into another classroom. From subsequent feedback from the home, P.P. was getting along well in his modified environment. P.P.'s profile is quite different from the findings in Figures Three and Four.

Figure One

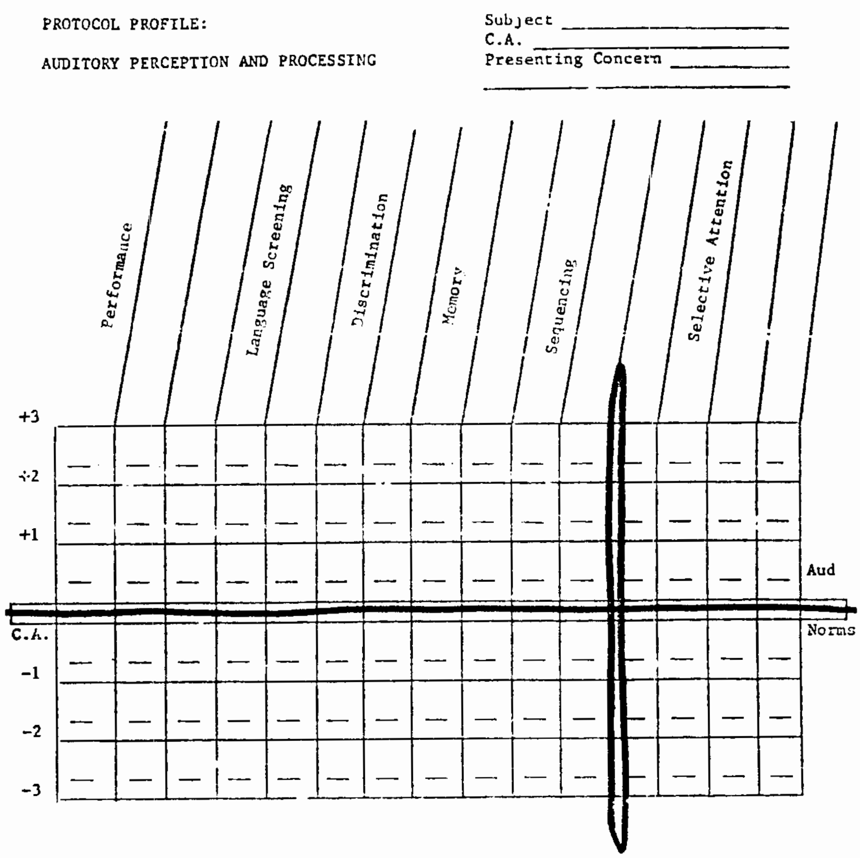
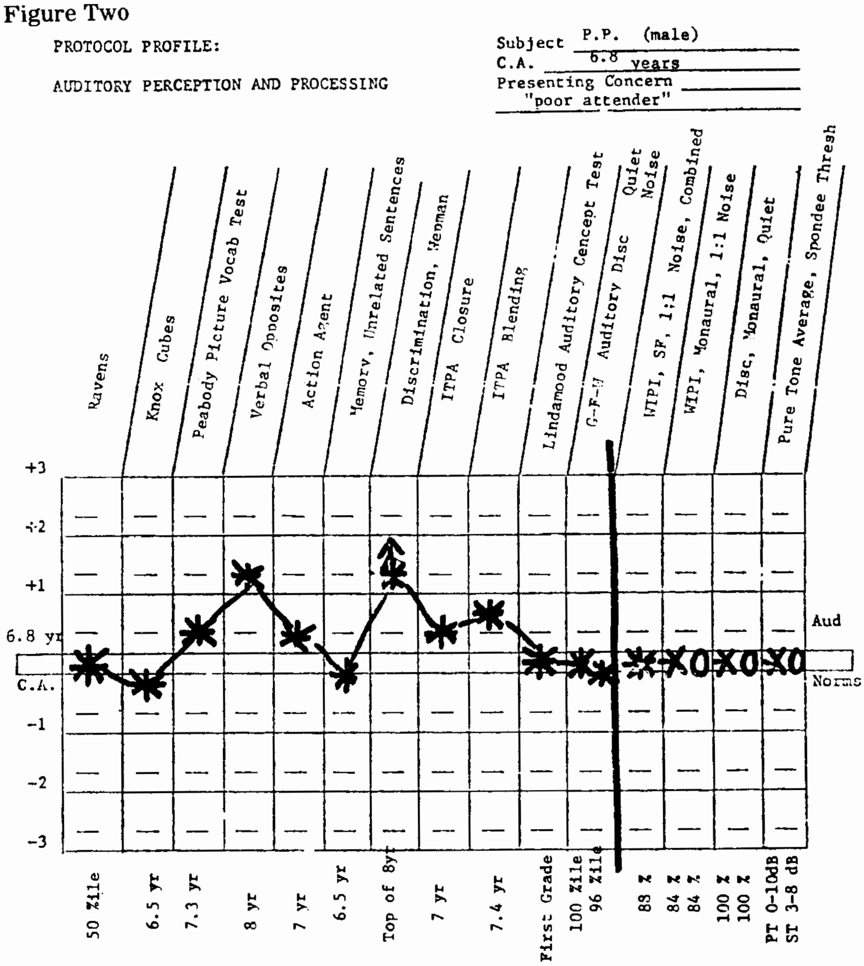


Figure Three shows the findings, graphically, for a second child. C.P., age 7.3 years at the time of the study and completing the first grade. Base line audiologic information suggests good sensitivity for pure-tone and spondee thresholds, with understanding at a 30 dBSL to be at ninety-two percent for each ear. Similar-

Figure Two



ly, his visual problem solving skills were at the normally anticipated levels as long as he could keep the stimulus in front of him (for both the Raven's and Hiskey Cubes). When C.P. was required to sequence a visual task, ala the Knox Cubes, his performance dropped with a two years delay. Interestingly, C.P.'s auditory sequencing skills show a comparably two year lag. His abilikty to retain 'trains' of units, either visually or auditorily is suppressed. On the one screening task assessing language competence, C.P. achieved an age equivalent of 9.5 years on the vocabulary identification task from the Peabody test. Beyond this positive observation, the remainder of the findings show lag. The one exception to this generalized delay is in the area of memory (or unit manipulation) where C.P. achieved at the top of the 8.7 year level on the Blending subtest of the ITPA. His other scores in the memory area show ITPA Closure at a year delay and abstract phonemic analysis on the Lindamood Auditory Conceptualization Test at this same one year lag level.

He also does not easily hear the subtle differences between very similar **but** different words. His ability to **judge** these differences (as in /fin-thin/ or /thimble-symbol/) is approximately a year delayed according to the Wepman Discrimination Task.

Reported earlier, C.P.'s auditory sequencing ability was one to two years delayed.

The final major deficit factor is C.P.'s inability to function in environments containing noise. For all four of the audiologic studies in noise where he attempted to repeat children's phonemically balanced words (PBK's), his performances ranged from twenty-six to forty percent (against norms of seventy - ninety percent). Further, he was unable to take advantage of the spatial separation of speech and noise in the soundfield environment when the two signals came from different loudspeakers. In corraboration, his vocabulary identification task on the Goldman-Fristoe-Woodcock Auditory Discrimination Task, noise subtest, placed him at the twenty-second percentile. Clearly, most children his age perform more optimally on the audiometric speech-in noise task (seventy-eight percent). C.P. was the child who left his own birthday party "because it was too noisy."

C.P. reflects the central tendency findings of our fifty sample children, and then he shows some additional lag areas. The common deficit measures include: inability to understand in noisy situations, delay auditory sequential ability, and lag in phonemic synthesis. His more individualized deficits include: inability to judge same-different aspects for very similar words and a shortened visual sequential memory.

Appropriate environmental monitorying and remedial programs were suggested to the family. Many of them will be reviewed in the subsequent section on Program Planning.

In the final case presentation, B.B. was 8.6 years of age at the time of the evaluation and in the second grade in a self-contained room (see Figure Four). He repeated kindergarten. His father described his son as a "beaver" in school, "he works very hard" but "he becomes frustrated and moody over his low success in the classroom."

As with the other children, baseline audiologic information suggests no obvious sensitivity deficit nor understanding problem in quiet. Similarly, from the three screening tasks for problem solving, B.B. performs at-age-level up to two years above age expectation. Unlike C.P. cited earlier, B.B. has excellent visual sequential memory skills.

On the two language screen tasks, B.B. performed at age level on the Verbal-Opposites Task, but was suppressed by approximately a year and a half on the Action-Agent Task.

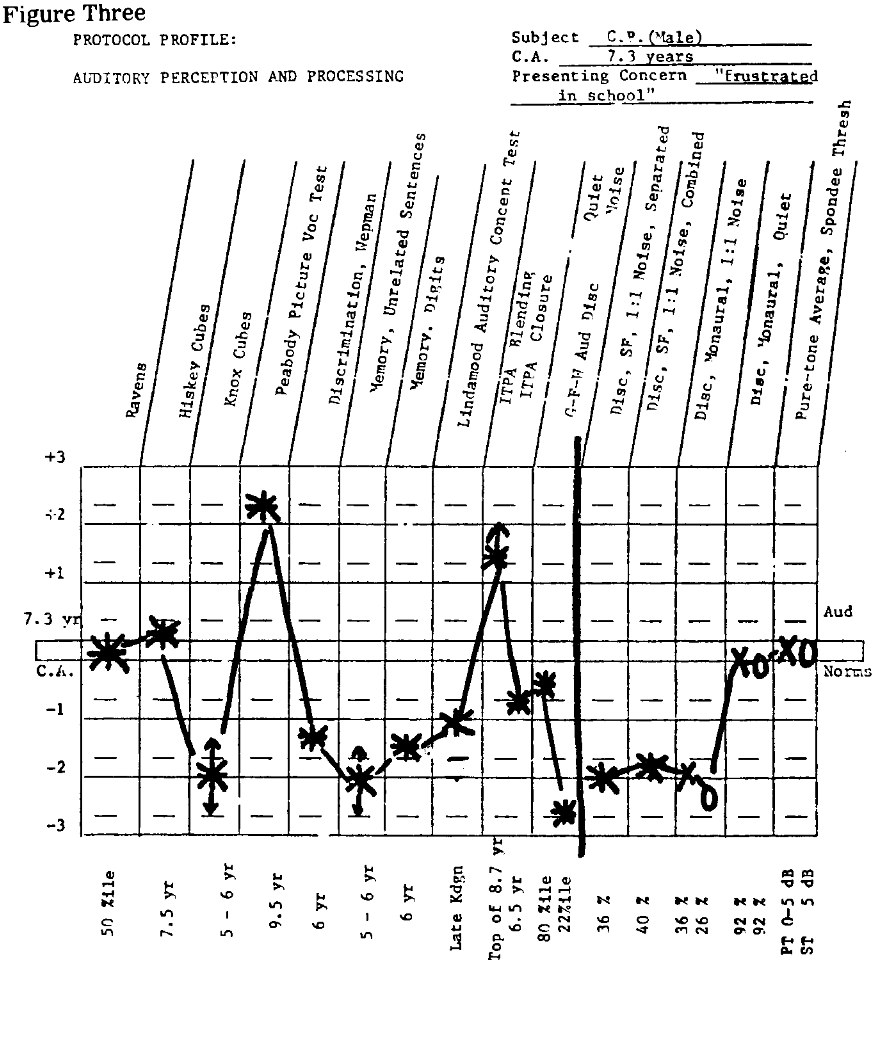
Like C.P., B.B. also showed marked delay in judging the sameness or different between similar sounding but different words. Interestingly, he could imitate the pairs correctly, but he could not evaluate them.

His auditory sequential memory skills for both measures show marked delay, with performance at four to six year levels.

On the memory (or unit analysis) tasks, he achieved at age level for the Blending Test but was suppressed for both Closure and the abstract and analytic Lindamood Test.

On the effects of noise in the listening environment, B.B. func-

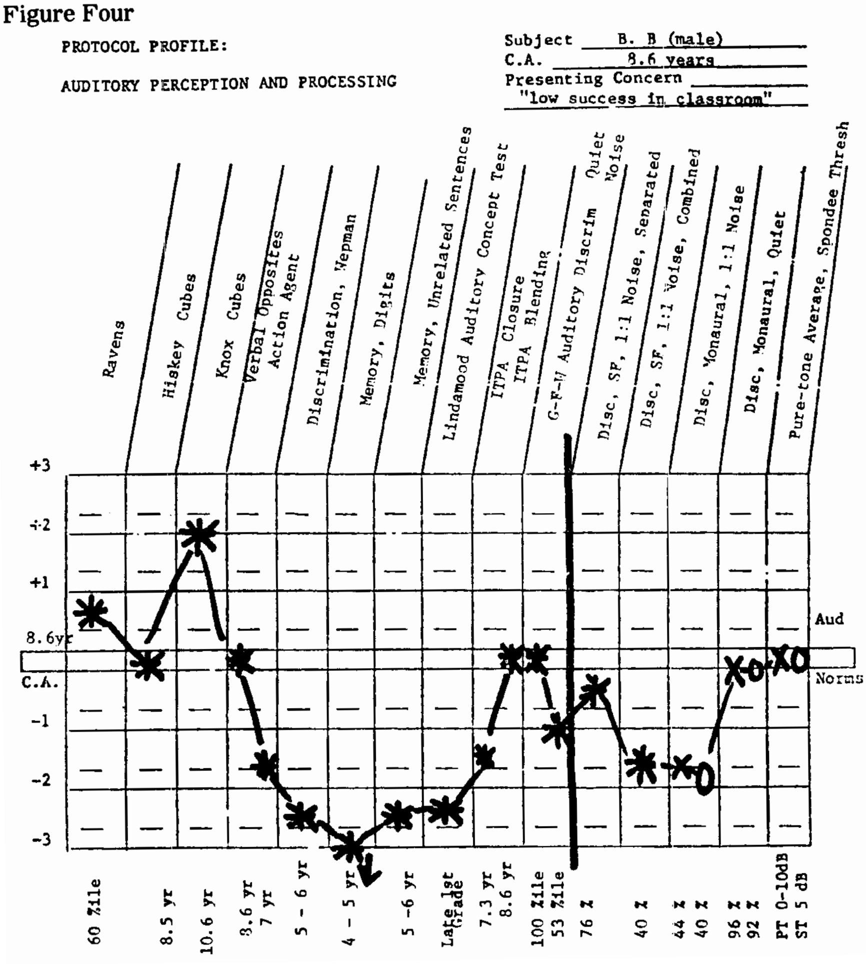
Figure Three



tions in a different manner from C.P. While his scores for monaural listening and for soundfield with speech and noise from the same loud speaker were similar to those of C.P., and forty to forty-four percent, he showed marked improvement in understanding by reproduction of the PBK words in the soundfield with spatial separation of the two signals (at a level of seventy-six percent and only slightly below the norms of eighty to ninety percent). Similarly, on the noise subtest of the Goldman-Ristoe-Woodcock Auditory Discrimination Test, he achieved a score at the fifty-third percentile level (an unexpected finding). It may be that when he can pick from only four choices in the cafeteria-type noise, he is able to use the "phonemic windows" in the noise to help with identification.

Appropriate environmental stage setting as well as specific

Figure Four



suggestions regarding training were reviewed for the family.

As C.P. and B.B. illustrate, these children are frequently quite different in the ways they handle auditory information. Each child is unique.

V. TRENDS OBSERVED ON FIFTY CHILDREN

And now, the central tendency findings in our group population. The present report reviews the evaluative findings on fifty children who satisfy the three requirements for inclusion in the target population: normal hearing sensitivity, normal problem-solving skills, and academic distress in the early elementary grades.

As stated earlier, the data were collected for twenty-three different, measurable, and coadable 'listening' and performance behaviors. The median age of the population was nine years with a range of 5.6 to thirteen years. It consisted of ten girls and forty boys.

The central tendency "statistical" **child** is seen on Figure Five, Auditory Perceptual and Processing Skills: Composite Findings. These central tendencies of the population, reported in **medium** values, show clear areas of superior and deficient performance. They are reviewed below in terms of rankings from most superior to most inferior skills:

1/2/3 (tie	Selective Attention in a Quiet Environment: Not Age Equated a. Pure tone thresholds, 0-15 dB HL. b. Spondee thresholds, 0-15 dB HL. c. Discrimination scores, AS, AD, 90-100 percent and age equated. d. Goldman-Fristoe-Woodcock-Quiet Subtest, 100th percentile	
1/2/3 (tie)	Categorization — language use An average of three measurements	plus .5 year
1/2/3 (tie)	Problem-solving Performance An average of three measurements.	plus .5 year
4	Auditory Discrimination on "same"/"different" One observation	0 year
5	Memory as in phonemic synthesis An average of three measurements	minus .75 year
6/7 (tie)	Sequencing a 'train' of units An average of three measurements	minus 2.25 years
6/7 (tie)	Selective Attention in Noisy Environments — Not Age Equated	

Word Discrimination Scores measured at a signal noise ratio of 1:1 at 50 dB HL.

(a. Speech and noise separated, soundfield, 4-6 percent suppression)

b. Speech and noise combined, soundfield, 22 percent suppression

c. Speech and noise combined, left ear, 22 percent suppression

d. Speech and noise combined, right ear, 22 percent suppression

e. Goldman-Fristoe-Woodcock Auditory Discrimination Test — Noise Subtest — 30th percentile

As a group, these children show three major lag or deficit areas; and reported in increasing degree of severity, they include: memory or phonemic synthesis, sequencing a 'train' of units, and marked inability to listen effectively in noise when they **cannot selectively tune toward** the speech and away from the noise.

VI. PROGRAM PLANNING

These children who came to our clinical facility for evaluation of auditory perceptual abilities need to be assessed clinically and then approached educationally as unique learners. As two example profiles suggest, and as our other profiles corroborate, each child is different, and each one needs a plan tailored to his or her strengths and weaknesses. The findings on the profile will point the way to the remedial focus for each child.

PLANNING PROGRAMS FOR HOME AND SCHOOL

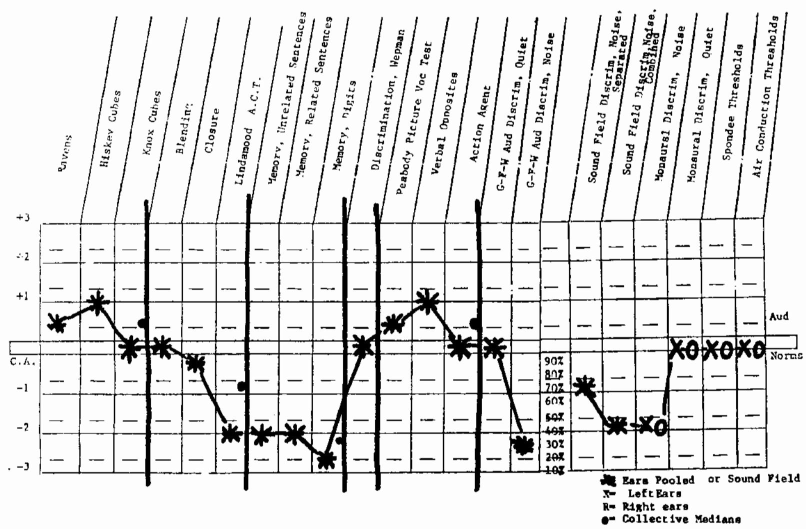
The management of such listening-deficient children falls into two main areas: modifications where possible in the various and important listening environments in order to allow the child to 'hear' the desired oral communication more easily, and specific training in the areas identified as deficient in order to improve, if possible, the specific areas of auditory processing lag.

Perhaps the greatest benefit deriving to the specific child under assessment for possible auditory perceptual deficit is in the identification of such possible 'listening' difficulties so that the family and school can approach the resolution of the challenge with a more objective attitude. Once the family and school staff is aware of specific areas of deficit for the child under observation, then together with the child, a management-intervention program can be initiated.

For the child who cannot listen effectively in noisy environments, there are a series of monitor and modification approaches which can be employed:

1. Preferential or roving seating can be instituted within the present classroom so that a more favorable signal-to-noise ratio can be established with the child in closer proximity to the teacher. Additionally, such an arrangement also places the ambient classroom noises behind the child, and if our findings support that performance improves with separation of noise spatially from the desired speech signal, then this child will be doubly benefited for he gets a stronger speech signal and he is able to "tune out" the background noise more easily.
2. Realistically, the family should realize that stereos, television, and noisy siblings also have a negative effect on ease of

Figure Five Auditory Processing Skills: Composite Findings on 50 Children, Expressed in Median Values for Each Measure.



attending in the home environment. Therefore, when it is important that this child listen at home most easily, the other noises in the home environment should be suppressed or turned off. Important listening would be at mealtime, when discussing family issues involving the participation of the child, and when one parent may be helping the child with necessary (and catch-up) homework. In these instances, unnecessary "noise" should be abolished for meal and discussion times. Homework discussions should be done in the child's quiet room as far as possible from the hustling activity of the home.

3. Recognition should be given that this child may not respond appropriately if mother calls to him from another room as he listens to a favorite television show. Important conversations need to come during a commercial or after the set has been turned off.
4. Annual principal-parent conferences should be scheduled prior to the assignment of the child to the next grade. Ideally, such children function optimally in a quiet classroom with an articulate teacher. If there are three possible teachers available for the next year's classroom assignment (and all are assumed to be equally effective), then the student will perform best in the ideally, most quiet classroom.
5. There will be times when the family and school cannot control the noise levels which interfere with easy listening. When these occur, the expectations on the child should be modified and reduced because of the adversive environment.
6. A summary suggestion is to maximize the desirable speech signal and to suppress the noise.

For the child with shortened sequential auditory memory, the family and teacher should consider the following modifications or suggestions:

1. Directions or instructions to the child should be reduced in length, and this length should be in keeping with the upper limit of the child's syllable recall ability.
2. Ideally, if the child can read, detailed work assignments should be written out, so the child can visually double check his auditory input. Saturday work assignments at home could be aurally given and then supplemented with a written list (which could be marked off by the child as he/she completes each item). Similarly, the teacher may wish to write crucial room assignments on the board so that our special child can visually check on himself.
3. As a support process, the teacher may quietly assign a "friend" to help the child on directions, if written or special aid cannot be given.
4. If the child cannot read, then home and school directions can be modified by lists of key drawings or sketches to help the child keep the outline in correct order.
5. In discussions at home and at school, silent intervals in a conversation may help this child to "catch up" with the topic.
6. When the parent or teacher is not sure the child has understood the process, a request for a verbal review may clarify whether the youngster is ready to follow through on the assignment appropriately.

7. There are commercially available programs to help the child strengthen his sequential memory skills as well as other auditory processing abilities. These have been reviewed by Rupp, et. al. (1978). These "packaged" programs are available to assist the teacher, the audiologist, the speech and language pathologist or the resource teacher to expedite the therapeutic programs for children with specific auditory processing problems. Three such representative programs that are available to help the clinician work through a habilitative process are the Lindamood and Lindamood's Auditory Discrimination in Depth, the Semel Auditory Processing Program, published in 1970, and the Auditory Perceptual Training Program published by Witkin and her colleagues in 1976. Obviously, the skilled clinician will not simply run one of these programs with a child but will design a therapeutic program and use the portions of available programs as they fit the needs of the specific child. In the present discussion, the intervention goal would be to lengthen the child's auditory sequential memory.

The third most significant central tendency deficit noted for our conglomerate child was that of analytic and abstract phonemic synthesis in the general area of memory for a unit. Many of the children in our observation group had reading lags in addition to or related to their listening problems. As shown on the Lindamood Auditory Conceptualization Test in Figure Five, the composite score on this task was 2.75 years below the norm. When a specific skill appears as deficit, then the remediational approach may be to train, if possible, for the enhancement of the specific skill.

1. When the child has difficulty with analytic phonemic synthesis, or a delayed ability to hear the components in the unit and when and where they are changed, specific trial training in the unit-memory area are changed, specific trail training in the unit-memory area should be attempted. The Auditory Discrimination in Depth (ADD) Program by the Lindamood team (1969), and described above as representative 'commercial' program, is specifically designed to help the child 'hear' and 'manipulate' the specific components in a word unit. It incorporates an analytic and abstract approach to the general phonemic synthesis task.
2. Similarly, the other two representative commercial programs cited earlier also include segments on phonetic analysis.
3. Further, the instructional and resource staffs in the elementary schools can also supply the classroom and/or resource

teacher with a variety of phonics or phonetics training programs available through educational catalogs. For example, Milliken Publishing Company[1] and Modern Curriculum Press[2] publish a wide variety of phonics workbooks at several academic levels which could be used for training and intervention.

Each child seen for auditory processing assessment has a unique profile on the assessment protocol. As Figures Three and Four show, not all children fit these central trends. As deviations or lags appear in the findings, specific training to these areas should be attempted.

FACING REALITIES

Parents, teachers and audiologists must remain realistic, however, about the potential for children with auditory perceptual difficulties as remedial and management programs are developed. It may not be possible to bring the child up to normal levels in the various deficit areas. Katz and Illmer (1972) suggested that while children do seem to profit from training in terms of phonetic synthesis and analysis by work on closure and blending tasks, they do not appear to be able to make significant progress in improving their listening skills in noisy environments. Ideally, therefore, we will train these children to be as effective as possible, and we will work to make their listening environments less contaminating by modifying them as much as possible.

VII. SUMMARY

Our collective goal is to make these children functionally adequate. We want to improve their communicative efficiency at school and at home. Society expects each child to learn his communication skills. Society also expects that we should be able to identify those children who may not be succeeding in learning communications skills. As important, society also anticipates that we will be able to help these children whom we have found to have problems in processing auditory signals. As audiologists, we now have the diagnostic and remediational technology. As educationally oriented communicologists, we have an important service to provide to our school-age children who hear but who have lags in their auditory processing abilities.

[1] Milliken Publishing Company, 1100 Research Boulevard, St. Louis, MO 63132

[2] Modern Curriculum Press, 13900 Prospect, Cleveland OH 44136

REFERENCES

Arthur G: A point scale of performance tests (Clinical Manual, Knox Cub Test, Revised Form II). New York: The Psychological Corporation (1947)

Baker G, Leland G: **Detroit Tests of Learning Aptitude.** Indianapolis, Bobbs-Merrill (1967)

Bloomer HH: **Memory for Related Sentences Test,** and Memory for Unrelated Sentences Test. Ann Arbor, Michigan, Speech and Hearing Sciences (1970)

Bloomer HH, Herman G: Extended Action Agent Test. Ann Arbor, Michigan, Speech and Hearing Sciences. (1956)

Butler K: Auditory perceptual skills: Their measurement and remediation with preschool and school-age children. A short course presentation at the annual meeting of ASHA in Washington, D.C. (1975)

Carhart R: Auditory training, in Davis H, Silverman SR (eds): **Hearing and Deafness.** New York, Holt, Rinehart and Winston (1960)

Carrow-Woolfolk E: **Test of Auditory Comprehension of Language.** Austin, Texas, Learning Concepts (1973)

Dictionary of Occupational Titles U.S. Department of Labor: Washington, D.C., U.S. Printing Office (1965)

Doll EA: **The Vineland Social Maturity Scale.** Circle Pines, MN, American Guidance Corporation (1936)

Dunn LM: **Peabody Picture Vocabulary Test.** Circle Pines, MN, American Guidance Corporation (1965)

Fairbanks G: A theory of the speech mechanism as a servo system. **J Speech Hear Disord** 19:133-139 (1954)

Goldman-Fristoe-Woodcock: **Test of Auditory Discrimination.** Circle Pines, MN, American Guidance Service (1970)

Goldman-Fristoe-Woodcock: **Auditory Skills Test Battery.** Circle Pines, MN, American Guidance Service (1974)

Hearing Impairment and the Audiologist: Washington, D.C., American Speech and Hearing Association (1976)

Hiskey M: **Hiskey-Nebraska Test of Learning Aptitude.** Los Angeles, Western Psychological Corporation (1966)

Jerger J: Diagnostic audiometry, in Jerger J (ed): **Modern Developments in Audiology**, 2nd edition. New York, Academic Press, pp 75-115 (1973)

Katz J: The staggered spondaic word (SSW) test, in Katz J (ed): **Handbook of Clinical Audiology.** Baltimore, Williams & Wilkins, pp 334-356 (1972)

Katz J, Illmer R: Auditory perception in children with learning disabilities, in Katz J (ed): **Handbook of Clinical**

Audiology. Baltimore, Williams and Wilkins, pp 540-563 (Quotation, p 540) (1972)

Kirby AM: Sentence Repetition Task Assession Immediate and Delayed Recall. Randolph, MA, Boston School for the Deaf (1970)

Kirk SA, McCarthy JJ, Kirk WD: **Illinois Test of Psycholinguistic Abilities.** Los Angeles, Western Psychological Services (1968)

Lerea L: **The Michigan Picture Language Inventory.** Ann Arbor, The University of Michigan Press (1958)

Lindamood CH, Lindamood PC: The A.D.D. Program — Auditory Discrimination in Dept. Boston, Teaching Resources Corporation (1969)

Lindamond CH, Lindamond PC: **Auditory Conceptualization Test.** Boston, Teaching Resources Corporation (1971)

Maitland G: Whose child is he — yours, mine or ours? **J Childhood Communication Disorders,** VIII:15-26 (1976)

McGrady HJ: Verbal and nonverbal functions in school children with speech and language disorders. Unpublished doctoral dissertation, Northwestern University. (1964)

McNemar Q: **The Revision of the Stanford-Binet Scale.** Boston, Houghton-Mifflin, pp 89-98 (1942)

O'Neill JJ: **The Hard of Hearing.** Englewood Cliffs, NJ, Prentice-Hall (1964)

Pollack D: **Educational Audiology for the Limited Hearing Infant.** Springfield, IL, C C Thomas (1970)

Position Statement of the American Speech and Hearing Association on Learning Disabilities: **Asha** 18:282-290 (1976)

Raven JC: **Progressive Matrices (Standard)** New York, The Psychological Corporation (1956)

Ravens JC: **Progressive Matrices (Colored).** New York, The Psychological Corporation (1962)

Rampp DL (ed): Proceedings of the Memphis State University's First Annual Symposium on Auditory Processing and Learning Disabilities. Memphis, University Press (1972)

Rupp RR: The audiologist's role in the evaluation of auditory perceptual and processing abilities in young school-age children. A short course presentation at the annual meeting of the American Speech and Hearing Association, Washington, D.C. (1976)

Rupp RR: The Audiologist's Role in the evaluation of auditory perceptual and processing abilities in young school-aged children. **Audiology, An Audio Journal for Continuing Education,** New York, Grune and Stratton, Inc. (1978)

Rupp RR, Olsen D, Saxman S, Shapiro E, Doyle EJ: A Catalog of "Commercially Available Materials on Auditory Processing Abilities: Assessment Approaches and Programs for Remediation." Ann Arbour, University of Michigan Program in Special Education and Speech and Hearing Sciences (1978)

Ross M, Lerman J: **Word Intelligibility by Picture Identification Test.** Pittsburg, Stanwix House (1971)

Semel E: **Semel Auditory Processing Program.** Chicago, Follett Publishing Co. (1976)

Smith A: **Symbol-Digit Modalities Test.** Los Angeles, Western Psychological Corporation (1973)

Spencer EM: Investigation of the maturation of various factors of auditory perception in pre-school. Unpublished doctoral dissertation, Northwestern University (1958)

Task Force on Learning Disabilities, Position Statement of the American Speech and Hearing Association, **Asha,** 18 (12), 282-290 (1976)

The Audiologist: Responsibilities in the Habilitation of the Auditorily Handicapped: **Asha** 16:68-70 (Quotation, p 69) (1974)

Weener P: Toward a developmental model of auditory processing. **J Childhood Communication Disorders** 1:152-169 (1976)

Wepman J: **Auditory Discrimination Test.** Los Angeles, Western Psychological Corporation (1958)

Wepman J: New and wider horizons for speech and hearing specialists. **Asha** 17:9-10 (Quotations, p 10) (1975)

Wepman J, Jones EV, Bock RD, Van Pelt D: Studies in Aphasia: Background and theoretical formulations. **J Speech Hear Disord** 25:323-332. (1960)

Witkin BR: Auditory perception — implications for language development. Lang Speech Hear Services Schools 4:31-52; also in J Res Devel Education (1971) 3:31-52 (Quotation, p 32) (1971)

Witkin BR, Butler KG, Hedrick DL, Manning C: Auditory perceptual training program. Hayward, CA, Alameda County School Department. (1976)