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A COMPARISON OF AUDITORY DISCRIMINATION ABILITIES IN THREE YEAR OLDS WITH HIGH RISK AND NORMAL PRENATAL AND PERINATAL HISTORIES

By

Susan Arnold Lane

B.A., Western Washington State College, 1973

Presented in partial fulfillment of
the requirements for the degree of

Master of Arts
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Approved by:

Richard M. Boehmler
Chairman, Board of Examiners

John B. Stewart
Dean, Graduate School

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Title: A Comparison of Auditory Discrimination Abilities in Three Year Olds With High Risk and Normal Prenatal and Perinatal Histories (49 pages)

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The purpose of this study was to compare the auditory discrimination skills of high risk children and children with normal birth histories under conditions of quiet and noise. Eight high risk children matched for sex and age with eight children with normal birth histories participated in this study. The independent variables were: (1) Risk Status: High Risk and Normal, (2) Noise Condition: Quiet and Noise, and (3) Order of Presentation: First and Second.

Two separate lists from the Word Identification Picture Index (WIPI) were presented to all subjects, one being presented in quiet and one in noise. The normal and high risk subjects did not differ significantly under quiet conditions whereas they did differ significantly under the noise condition. The performance of both groups was significantly better on the second presentation than on the first presentation order. Both groups functioned better under conditions of quiet than in noise. This study has implications for early identification of children with specific learning disorders.

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CHAPTER I

INTRODUCTION

Background

Much research has been available describing the risks of certain newborn conditions in relation to disorders such as blindness, cardiovascular malfunction, mental retardation, cerebral palsy, and deafness. This research has been the major impetus for the development of At Risk Screening Programs as a first step in detecting problems needing intervention. High Risk screening programs have been used to select specific groups of infants in whom the prevalence of hearing disorders is expected to be significantly higher than in the general population and for whom audiological evaluations are given. In the absence of early infant hearing screening programs, the foregoing identification programs have reportedly increased the number of children who are identified as hearing impaired at an early age as much as ten fold (AAOO, AAP, and ASHA, 1974).

There is some evidence which suggests that many of the high risk factors associated with congenital deafness are also related, in the absence of deafness, to later learning and communication difficulties. Erlich, Shapiro, Kimball, and Huttner (1973) evaluated the speech, language, auditory, and intellectual development of 81 five-year olds who were

high risk on one or more of the following factors: low birth weight, prematurity, Rh or ABO blood incompatibility, respiratory distress and hyperbilirubinemia. Their results indicated that significant dysfunctions occurred primarily in children with histories of respiratory distress and abnormal birth weight/gestational age. Auditory discrimination in noise or in quiet was the most frequently impaired function. Other significant difficulties were found in visual- figure-ground discrimination, expressive vocabulary, block design, word finding, articulation, memory for sentences, mazes, sound blending, geometric design, and short attention span.

Shideler (1970), recognizing that there may be a possible relationship between high risk factors and various dysfunctions, advised that data obtained from High Risk Hearing Screening Programs should be made available not only to audiologists but to other professional personnel who are concerned with identifying children who may later suffer from various learning problems other than deafness. Prematurity and perinatal anoxia have been frequently found to be related to learning problems. The effects of prematurity have long been a major concern of researchers, pediatricians, and educators. There appears to be a higher proportion of children with speech disorders and reading difficulties among prematurely born children as compared to normals (Sheridan, 1973).

De Hirsh, Jansky, and Langford (1954) compared the performances of normal children and prematurely born children (birth weights of premature children ranged from 1,000 to 2239 grams) on various psycholinguistic tasks. The mean age of both groups was 5.8 years. The prematurely born children were found to be significantly inferior to normal children in 7 of 15 areas tested: tapped patterns, language comprehension, word finding, number of words used, mean of five longest sentences, sentence elaboration and definitions. These authors believed that the inferior performance in the area of oral language of premature children may be related to "lingering neuro-physiological immaturity." De Hirsh et. al. stated that many researchers believe that premature children are known to be slow in starting, but are assumed to "catch-up before the age of five as long as their intelligence is normal and neurological sequelae are absent." De Hirsh et al. cited Knoblich and others as believing that these prematurely-born children tend to encounter difficulties when they enter school and have to deal with tasks requiring a high degree of integration and differentiation. The research by De Hirsh et. al. suggests that the prematurely-born children they studied at age five had yet to "catch-up" with their normal counterparts in various language skills. Their research is supported by the conclusion of others that low

birth weight appears to be associated with an increased chance of intellectual handicaps (Dann and New, 1964; Hardy, 1973).

Another high risk factor, perinatal anoxia, may also be a prime cause for subsequent neurologic learning and behavior disorders (Kappleman, 1971). Three-year old children who had experienced perinatal anoxia were found to score significantly lower on several tests of cognitive function (Graham, Ernhart, Thurston, and Craft, 1962).

The various high risk factors cited above seem to be related to several specific learning problems. The research by Erlich et. al. suggests a deficit in auditory discrimination abilities may be present in children with normal peripheral hearing who are high risk on the aforementioned prenatal and perinatal factors. The presence of an auditory discrimination deficit in high risk populations would support the inclusion of speech discrimination testing in the battery of audiometric tests used in high risk hearing screening programs. However, speech discrimination testing does not appear to be routinely included in the battery of audiological tests used in current high risk screening programs except in the case of children identified as hearing impaired. (These tests are not usually administered to children who are judged to have normal hearing acuity levels. Shideler, 1970; Northern and Downs, 1974.)

There has been much research which has looked at the relationship between auditory discrimination skills and other

communication skills such as articulation, language and reading. Several researchers have found that children with functional articulation disorders perform significantly more poorly on auditory discrimination tasks than do normals (Kronvall and Diehl, 1954; Cohen and Diehl, 1963; Marquardt and Saxman, 1972). Wepman believes that poor auditory discrimination accounts for approximately 80% of articulatory defects in children. However he reports no data to support this conviction. Prins (1963) found no significant differences in auditory discrimination ability between speech defective and normal children. Sherman and Geith (1967) proposed an explanation for the negative results of some studies of the relation of articulation and speech discrimination. They stated that most of this research had chosen experimental groups on the basis of speech deviation: these experimental groups, then, were heterogeneous with respect to etiology of speech disorders. Sherman and Geith selected subjects who were high or low scorers on the Templin Speech Discrimination Tests. Articulation scores were then obtained for the two groups. The group receiving low scores on the speech discrimination tests received significantly poorer scroes on the articulation test than the high scorers. Sherman and Geith concluded that low speech sound discrimination ability is "in general causally related to poor articulation." Other researchers have reported findings which suggest that subjects

with articulation defects do not have a general deficiency in auditory discrimination, but a deficiency only for those sounds which they misarticulate (Monnin and Huntington, 1974). After an extensive search of the literature dealing with the relationship of auditory discrimination to articulation, Winitz concluded that "the evidence overwhelmingly supports the point of view that articulatory defective children score below non-articulatory defective children on tests of speech sound discrimination." Perkins (1971) stated that auditory discrimination and articulation abilities are interconnected but "it is unclear whether this is a causal relationship." Whatever the specific nature of the relationship one cannot ignore the importance of auditory discrimination to articulation.

Auditory discrimination has also been suggested to be correlated to general language skills. Marquardt and Saxman (1972) compared the performances of speech defective children and normal children on Carrow's Language Comprehension Test and Wepman's Auditory Discrimination Test. A high correlation was found between scores obtained on the language test and the auditory discrimination test in the group of children with a high number of misarticulations. This correlation was absent in the group of normal children. These researchers suggest that:

> ...normal language development involves a set of skills developing somewhat in parallel, with each related to some general language ability that becomes more proficient

> with age. The development of a given skill can lag behind others without impeding their development so long as the skill remains within the normal range.

Several researchers have found high correlations between performance on the ITPA and auditory discrimination tests (Perozzi and Kunze, 1971; Rechner and Wilson, 1967). Upon close examination of their results, Perozzi and Kunze found significant correlations were obtained between the auditory discrimination tests and the two ITPA subtests measuring expressive language skills, whereas nonsignificant correlations were obtained between auditory discrimination and the subtests assessing receptive and associative language skills. Auditory discrimination has also been found to be related to performances on the Peabody Picture Vocabulary Test (Sherman and Geith, 1967). These researchers speculated that a child with poor auditory discrimination ability who finds it difficult to hear the differences between such words as "mouth and mouse" may be delayed in his rate of vocabulary learning. Auditory discrimination ability, then, appears to be related to various expressive and receptive language skills.

Like much of the research involving auditory discrimination, the data concerning the relationship between auditory discrimination and reading performance is somewhat inconclusive. Wepman (1960) reports a "definite" relationship between poor reading scores and poor discrimination scores. Some researchers have suggested that a child's difficulty in

discriminating the temporal sequence of sounds may retard his acquisition of word attack skills (Golden and Steiner, 1969). Marion Blank (1968) suggests that this relationship may be merely an artifact of the assessment tool (Wepman's auditory discrimination test) utilized to measure auditory discrimination skills. The Wepman test requires the subject to make a judgement of same/different when hearing two words. Poor readers may not be disabled in auditory discrimination, but may instead have more difficulty in dealing with paired comparison discrimination type tasks or in dealing with the concepts of same and different. One study which used the Goldman-Fristoe-Woodcock test of Auditory Discrimination found no significant correlation between reading ability and auditory discrimination ability (Finkenbinder, 1973). Hammill and Larsen (1974) reviewed over 280 different correlation co-efficients which depicted the relationship between tests of auditory perception and reading. They concluded that no practical relationship exists between auditory perceptual skills and reading comprehension. Certainly, the relationship between reading and auditory discrimination has not been identified.

The results of research relating auditory discrimination skills to various oral and written communication skills appear to be inconclusive in terms of whether the relationships are causal or merely correlational. The data appears to indicate

a relationship, but the quality and extent of this relationship remains unclear. It may be that these language skills are all dependent on some as yet unidentified skill.

Recently, researchers have begun evaluating the specific skills of children who have been labeled learning disabled. Estes and Huizinga (1974) studied learning disabled children and compared their performance on learning tasks when presented with auditory and visual materials. These children had been diagnosed as being learning disabled according to the definition set by the National Advisory Committee on Handicapped Children (1968). These children were presented paired-associate lists which had been prepared for both auditory and visual presentations. The learning disabled children learned a greater amount from visually presented material than they learned auditorally. Estes and Huizinga contrasted this to the restuls from the Otto (1961) and Burdoff and Quinlan (1964) studies which indicated that a normal population of the same age children learned a greater amount from the auditory material than from the visual presentations. This suggests a possible auditory deficit in learning disabled children. Eaves, Kendall and Chricton (1972) attempted to determine variables which could be used to identify learning disabled children at an early age. A group of kindergarten children received psychological and neurological examinations as well as the ten tests of the Hirsch Predictive Index, the Draw-A-

Person Test, and Name Printing. In addition, a kindergarten teacher completed a checklist for each child. The children were classified by the psychologist and neurologist as being Minimally Brain Damaged, immature or normal. The researchers completed a discriminant analysis of 196 variables (including all tests given and clinical impressions) that separated the three groups perfectly, i.e., each child was classified in agreement with the clinical diagnoser on the basis of these. The Wepman Auditory Discrimination Test was one of eight variables (selected out of a possible 196 variables) which were determined to be the most sensitive to distinguishing learning disabled children. This research suggests that an auditory discrimination test may be a senstive tool to help identify learning disabled children.

Since auditory discrimination difficulties appear to be closely associated with various learning problems including speech and language disorders, it seems desirable to identify children with auditory discrimination difficulties at an early age. These children who are identified as having auditory discrimination problems could then be closely observed so that learning problems could be detected at an early age and appropriate intervention programs could be instigated. However, there are several issues that need to be considered when testing the auditory discrimination abilities of young children: the paucity of appropriate test materials, the

signal/noise ratio used, the presentation of speech stimuli live voice versus recorded voice, and the application of conditioning procedures.

One major difficulty encountered when attempting to assess the auditory discrimination skills of young children is the lack of appropriate test materials. Currently available material have varying limitations. Haskins PB-K lists appear to be one of the most commonly used speech stimuli for discrimination testing. However, these lists have never been standardized on children. One difficulty with Wepman's Auditory Discrimination Test is that for younger children the concept of same or different may be too abstract (Elenbogen and Thompson, 1972). In addition, a major problem with any paired-comparison test such as the Wepman is that the presentation of stimulus items in pairs may involve a memory factor which might confound any affects (Swartz and Goldman, 1974).

Recently two auditory discrimination tests have been devised for use with young children. Discrimination by Identification of Pictures (DIP), a test developed by Siegenthaler and Haspiel (1966), was standardized on children as young as three years. When the child is presented with a word he selects the correct picture from a choice of two. One major difficulty in the use of this test is that chance selections would produce a 50% score since only two choices are involved in any one matrix (Ross and Lerman, 1970).

Ross and Lerman developed an auditory discrimination test, the Word Identification Picture Index Test (WIPI) to be used with hearing impaired children four years of age and older. A major advantage of this test is that the vocabulary is appropriate for most very young children. Recognizing that most hearing impaired children have limited vocabularies, the authors of this test were careful to select words which would be present in the recognition vocabulary of most young hearing impaired children. Like the DIP test, the WIPI is a closed-set discrimination task; chance selections on the WIPI would produce an 18% score, while conventional tests are open-ended with chance scores being closer to 0%. For this reason Ross and Lerman suggest that their test is too easy for most children with normal hearing acuity or with conductive or minimal sensorineural hearing loss. These children will obtain scores close to or at 100%. They recommend the use of open-set tasks with normal or near normal hearing acuity children. However, the audiologist may encounter difficulties using an open-set task with children as young as three. In an open-set test the child must repeat the word he was presented. Since the articulation abilities of the three year old are often less developed than that of the four year old, the three year old may often misarticulate the speech stimuli. The audiologist may then have a difficult time determining if the child auditorally discriminated the word

correctly. Ross and Lerman did not standardize the WIPI on children younger than age four. Therefore, the WIPI may be adequately difficult to use with children younger than four. There is much research which suggests that measurements of speech discrimination are probably more valid when presented in the presence of noise because this involves a figure-ground discrimination task more similar to normal communication stiuations (Kreul et. al., 1969; Berry, 1969). The results of a pilot study done by the present author indicated that the WIPI was adequately difficult, in the presence of noise, for three year olds.

Much of the research involving speech testing with adults recommends the use of recorded stimuli. However, several researchers have reported that speech stimuli are commonly presented live voice in a pediatric setting (Erlich and Tartaglia, 1973; Shepherd, 1971). In order that research data concerning the auditory discrimination abilities of children may be utilized in clinical practice, the research procedure may need to approximate that which is commonly practiced in clinics. For this reason, the use of auditory discrimination testing with live voice stimuli may be justified in research. One major advantage to live-voice testing is its flexibility; this flexibility is often needed with young children. When developing the WIPI, Ross and Lerman used live-voice stimuli. Upon retest of these, again using live

voice, test-retest reliability was found to be high (test-retest reliability coefficients ranged from .87 to .94).

Some researchers have recommended the use of motivational techniques in discrimination testing with young children (Hodgson, 1972). Hodgson (1972) suggested that a major factor contributing to the difficulties encountered by audiologists attempting to obtain speech discrimination scores for young children has been a failure to implement systematic reinforcement. Hodgson cites an unpublished doctoral dissertation by Smith which reported consistent improvement in discrimination scores of both normal and hearing-impaired children when correct responses were systematically reinforced using an operant conditioning approach. St. James-Roberts (1972) and Lloyd (1966) suggest starting the operant procedure with a 1-to-1 fixed reinforcement schedule and then using a partial reinforcement schedule for every attempt at the task. Lloyd states that partial reinforcement is more efficient and tends to result in a response more resistent to extinction. He concludes that partial reinforcement is "one of the best safeguards against a child failing to respond because of satiation." Lloyd (1966) has reported the use of tangibles to be effective reinforcers in pediatric audiometry.

It appears that speech discrimination testing with young children would be possible and beneficial if appropriate test materials and procedures were utilized. That is, auditory

discrimination testing with young children may be more valid when a test similar to the WIPI is presented in the presence of noise and operant procedures with partial reinforcement are applied. The addition of such testing to High Risk Follow-Up Programs might lead to the early identification of children who have a likelihood of being learning disabled such that preventative intervention programs could be initiated.

Statement of the Problem

The primary purpose of this study was to investigate the auditory discrimination skills in high risk children when presenting speech stimuli via live voice and using appropriate materials and reinforcements. The hypothesis tested was that there would be a significant difference in auditory discrimination scores obtained by high risk three year olds and normal three year olds, especially in noise.

CHAPTER II

PROCEDURE

Subjects

Eight high risk children (age range: 2-10 to 3-3) and eight children (age range 2-10 to 3-3) with normal birth histories participated in this study. The high risk three year olds were identified by the University of Montana Infant and Early Childhood At Risk Programs to have a positive history on one of these factors: (1) Rh or ABO incompatibility, (2) gestational age under 36 weeks, (3) respiratory distress syndrome, and (4) jaundice-hyperbilirubinemia: 15 mg/100 cc and over.

The At Risk case files from three years previous were combed to select children meeting these criteria. Subjects were sought from among twenty such children; attrition by death, unwillingness to participate, and moving without available contact reduced the number to eight. These subjects' pediatricians were contacted by phone and the purpose of this study was explained to them. Letters were then sent to each pediatrician with an explanation of the research and the list of their patients who would be involved. (See Appendix A.) The experimenter contacted the parents of these high risk children and in each case the explanation in Appendix B was

given to them. An explanation of the test results for each high risk child were sent to their pediatricians at the conclusion of the study (see Appendix C).

The normal subjects were identified by the Infant and Early Childhood At Risk Program to have a negative history on the same four factors listed above. The names of parents of numerous normal subjects were checked against the current telephone directory. Those that had not moved were contacted by phone and given an explanation as outlined by Appendix D. Many of these subjects had moved, six refused to participate, and four agreed to participate but did not show up for their appointments and refused to reschedule for another time. Eight acceptable subjects who matched with High Risk subjects by sex and age (±one month) were thus obtained. Both the normal subjects and the high risk subjects had normal hearing in at least one ear, according to a puretone screening test in sound field at 15 dB for the frequencies 500 Hz., 1,000 Hz., and 4,000 Hz. The results of the puretone screening test were explained to the parents of the subjects.

Materials

The Word Identification Picture Index (WIPI) was used to assess auditory discrimination skills of the subjects (see Appendix E). Ross and Lerman (1970) suggested their test, WIPI, was too easy for children with normal hearing acuity or

with conductive or minimal sensorineural hearing loss. However, Ross and Lerman standardized their test on normal and hearing impaired children only as young as four years and under quiet conditions. In a pilot study, the present author administered the WIPI to seven subjects age 2-9 to 3-3. These words were presented in a background of white noise. The fact that the mean scores of this group did not approach the ceiling score suggested that the WIPI is appropriate for three year olds with normal hearing. In order to faciliate comparisons between the study by Erlich et. al. and the present study, the same signal/noise ratio of 0 was used in the noise condition.

Procedures

All speech stimuli were presented in a sound field at a Hearing Level (HL) of 55 dB. The child was seated in one room of a two room audiometric suite at a distance of five feet from the speakers. Experimenter I was present in this room to help condition the subject. Experimenter II, seated in the control room and blind to the subject's status, presented the stimuli.

Prior to testing, each subject was familiarized with the testing environment. The child was first taken into the control room and was told that this was where Experimenter II would be. The room where the child, his parent, and Experimenter I would be was pointed out through the one-way mirror.

The child was told that he would not be able to see Experimenter II, but that Experimenter II would be able to see him. This author believes this procedure was important in reducing possible anxiety concerning the testing environment.

The practice set of the WIPI consisting of six words were used during the conditioning stage. Edible reinforcers (soda pop) were administered by Experimenter I on a 100% reinforcement schedule during conditioning. Edible reinforcers were then administered on a fixed ratio reinforcement schedule of every four responses. Social reinforcement, administered by Experimenter II accompanied these edible rewards. This social reinforcement consistently varied between "that's good" and "nice job." The child responded by pointing to the picture corresponding to the word presented to him. Experimenter II uttered each word after saying the child's name and the carrier phrase "Show me the _____." Emphasis was placed upon typical, rather exaggerated articulation. The final score was the percentage of correct responses.

Each subject received two separate lists. One list was presented in quiet and one was presented in noise. First order and second order were counterbalanced across noise and no noise and experimental and control groups. Lists were counterbalanced across noise/no noise and experimental/control with the exception of one experimental subject for whom the lists were mistakedly reversed, resulting in a 7/9 and 9/7

list 1 versus list 2 ratio across noise versus no noise, thus the variance due to list was predominantly confounded with the error variance except for one subject wherein it was confounded with noise/no noise variance.

Testing Conditions

All testing was conducted in an Industrial Acoustics Corporation Testing Suite, model 1204 A-CTR. A Grason-Stadler Audiometer, model 1701 was used for amplifying speech and for generating white noise. The speech and noise were both presented sound-field simultaneously through two speakers. To insure that experimental conditions were consistent throughout the experimental period the sound source for both speech and noise were calibrated with a Bruel and Kjaer Sound Level Meter 2203 just prior to the experimental period and again at the end of the entire experimental period after all subjects had been tested. The experimenter read a short passage when calibrating the sound source for speech. The VU meter on the audiometer was adjusted to peak approximately at 0 when the Hearing Level (HL) dial on Channel I of the audiometer was set at 55 dB. The sound was calibrated for each speaker separately by taking individual measurements with the Bruel and Kjaer Sound Level Meter 2203 at a distance of approximately six inches from each speaker. When calibrating the sound source for white noise, the VU meter on the audiometer was adjusted

to peak approximately at 0 when white noise was presented through Channel II at a HL of 55 dB. The placement of the Sound Level Meter was the same as when calibrating for speech. The sound source for speech and noise was calibrated before testing each subject in the following manner. The VU meter on the audiometer was adjusted to peak approximately at 0 when the HL dial on Channel I was set at 55 dB as the experimenter presented five list words. The VU meter on the audiometer was then again adjusted to peak approximately at 0 when the white noise was presented through Channel II at a HL of 55 dB.

CHAPTER III

RESULTS

The primary purpose of this study was to evaluate the relationship between high risk prenatal and perinatal history and auditory figure-ground discrimination in three year olds. The data analyzed in this study consisted of a score (percent correct) for every subject for each of two word lists from the WIPI presented in quiet and in noise. The factors under consideration included: (1) Risk Status: High Risk and Normal, (2) Noise Condition: Quiet and Noise, and (3) Order of Presentation: First and Second.

The hypothesis was that normal three year olds would perform better on an auditory dsicrimination task than high risk three year olds, especially with background noise. The means for each of the Risk Status and Noise conditions are presented in Table 1 and illustrated in Figure 1. The scores for all of the statistical analyses presented here were obtained from the data presented in Appendix E. The results were evaluated by a complex Latin Square Design, and a test for the Simple Effects. All results were tested at the .05 coefficient of risk. The summary of the analysis of variance of the data is presented in Table 2.

All interactions involving order were nonsignificant. The mean score for the first order condition was 70.50 and

TABLE 1

MEAN SCORES FOR RISK STATUS AND NOISE CONDITIONS

	Quiet	Noise	Total
High Risk	82.50 (6.74)	57.50 (10.46)	70.0
Normal	85.00 (13.14)	69.50 (12.08)	77.25
Total	83.75	63.50	73.63

( ) = Standard Deviation

Figure 2

MEAN SCORES FOR RISK STATUS AND NOISE CONDITIONS

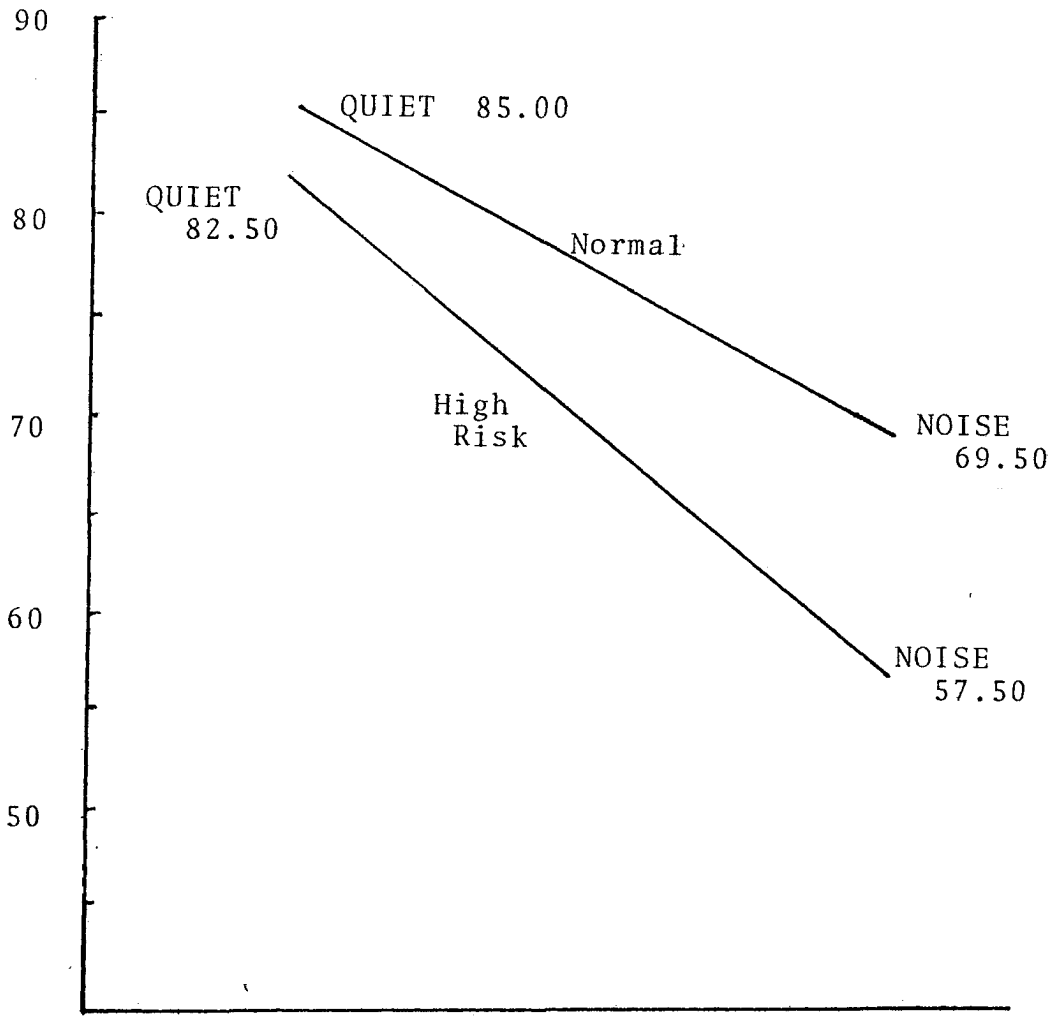

TABLE 2

SUMMARY OF ANALYSIS OF VARIANCE

Source	SS	df	ms	F	P*
Between Subjects	2963.50	15	--		
Risk	420.50	1	420.50	2.21	
Noise X $Order_b$	220.50	1	220.50	1.16	n.s.
Noise X Order X $Risk_b$	40.50	1	40.50	.213	n.s.
Error	2282	12	190.17	--	
Within Subjects	4232	16	--	--	
Noise	3280.50	1	3280.50	78.79	
Order	312.50	1	312.50	7.50	.025
Noise X Risk	180.50	1	180.50	4.335	.10
Order X Risk	.50	1	.50	.012	n.s.
$Error_w$	458	12	41.64	0	
Total	7195.30	31			

*.05 coefficient of risk was used

the mean score for the second order condition was 76.75. This difference was significant ($p<.05$, $F=7.50$, $df=1$). The performance of three year olds was significantly better on the second presentation than on the first presentation order as expected.

The interaction between risk and noise was nonsignificant ($p<.10$, $F=4$, $df=1$). Since this interaction approached significance (.10) and was predicted, it seemed more appropriate to evaluate the noise and risk as simple rather than main effects.

The normal and high risk children did not differ significantly under quiet conditions (mean difference = 2.50, $t=.64$, $df=7$) whereas they differed significantly under the noise condition (mean difference = 12, $p<.05$, $t=3.09$, $df=7$). These results support the predicted interaction effect between high risk and noise and suggest the high risk children have greater discrimination difficulty under noise than do normals. Although the obtained difference between normals and high risk in quiet was in the same direction, the difference was relatively small and not statistically significant.

Both groups functioned significantly better under conditions of quiet than in noise (Normal mean difference = 15.5, $p<.05$, $t=4.81$, $df=7$)(High Risk mean difference = 25.00, $p<.05$, $t=7.61$, $df=7$). This suggests that both high risk and normal

subjects performed better on the auditory discrimination task in quiet than in noise as would be predicted.

CHAPTER IV

DISCUSSION

The central question of this study was whether three year olds with high risk histories would differ from normal three year olds in their performance on an auditory figure-ground discrimination task. It was expected that the normal three year olds would perform better on the auditory discrimination task than high risk three year olds, especially with background noise.

Although order was not of particular interest to the present study, the results may be of interest for future research. The performance of three year olds improved from the first to the second presentation of the stimulus items, regardless of risk status and noise conditions. The experimenter was initially concerned that a fatigue effect might create poorer discrimination scores on the second presentation particularly under the condition in which white noise (an aversive stimulus) was presented first. It appeared to the experimenter that, as many of the children who received this condition (noise first, quiet second) began the second list, they seemed more nervous and fidgety than those children who received quiet first and noise second. This observed behavior suggested to the experimenter that an interaction between

noise and order would be significant. However, all interactions involving order were nonsignificant. Fatigue effects, if any were operative, were offset by the apparent practice effect that took place from the first to the second presentation.

The difference in the performance of three year olds in noise and quiet was not a central issue to this study, and the results were as expected. Both high risk and normal subjects performed better on the auditory discrimination task in quiet. The significant differences obtained within the noise conditions (noise versus quiet) and the order conditions (first versus second) serve to validate the test and procedures selected as appropriate means for assessing the discrimination acuity of high risk and normal three year olds.

The performance of the normal and high risk children did not differ significantly on the auditory discrimination task under the quiet condition, but did differ significantly under the noise condition. These results supported the predicted hypothesis that normal children would perform better on an auditory figure-ground discrimination task than high risk children. Erlich et. al. found this difference both in quiet and in noise. Erlich et. al. presented word lists to five year olds in conditions of quiet and noise. On these tests, fialure in auditory discrimination was a quiet score below 88% or a noise score below 70%. A significant number of failures was obtained by the high risk five

year olds in both the quiet and noise conditions. Erlich et. al. did not report the percentage of failures within each condition, therefore it is not known to the present author if a significantly greater number of failures were obtained in the noise condition than in the quiet condition. If that did occur, it would be consistent with the present study. In the present study, the difference between normals and high risk in quiet was in the same direction as in noise, but this difference was not statistically significant.

The results of the present study indicate that high risk children are likely to be deficient in auditory discrimination under conditions of noise and that it is possible to detect this deficiency in high risk children at age three. As evidenced by the introductory section, there has been considerable research on the relationship of auditory discrimination abilities to articulation, reading and language disorders. The research appears to indicate a relationship between auditory discrimination skills and various oral and written communication skills. However, it appears to be unknown if this relationship is causal.

Recently much literature has appeared in the learning disabilities journals concerning the establishment of screening methods to identify learning problems at an early age. Most of these screening tests are administered to children in kindergarten (Keogh, Tchir, and Windeguth, 1974;

Eaves, Kendall, and Chricton, 1972; and Ferinden, Jacobsen, and Linden, 1970). At this age a major part of language learning should have occurred. For some children, remediation at age five may not be as effective as intervention during the preschool years.

There is a need for screening tests which will identify learning disabled children earlier than kindergarten age. The results of the present study as well as the research by Erlich et. al. suggests that high risk children demonstrate a poorer performance on auditory discrimination tests in noise than do normal children. The present study demonstrated that it is possible to find this difference with children who are as young as three years. The research by Eaves et. al. also indicates that an auditory discrimination test may be a sensitive tool to help identify learning disabled children. The use of an auditory discrimination test in noise appears to be a promising means of identifying, at an early age, many learning disabled children. The type of materials and procedures used in this study are often used in the clinical setting. The administration of the WIPI under noise conditions, using operant procedures can be done efficiently by a trained audiologist in any audiological suite containing an audiometer that can amplify speech and generate white noise.

High Risk Registers are currently being used as a means of identifying hearing loss as early as possible in young children so that early intervention can occur. Most of the high risk programs discussed in the literature involve the early identification of peripheral hearing loss. At the present no program has reported including tests of auditory discrimination for those children who have normal peripheral hearing. Yet the results of the present study suggest that many of these high risk children may have normal peripheral hearing with deficits in auditory discrimination which may relate to later learning disabilities. Most of these learning disabled children would not be identified by the high risk register screening program follow-up tests as they now exist.

Recommendations

1. On the basis of this study this author recommends that High Risk Screening Programs extend their testing to include the administration of auditory discrimination test under noise conditions to both high risk children identified as having a hearing loss as well as high risk children with normal peripheral hearing. Data should then be collected from these programs to evaluate the effectiveness of such early screening programs for identifying learning disabled children.

2. Presently there is no data which designates a specific WIPI score under noise conditions as being pass or fail. Further studies need to be conducted to determine the criteria for a pass and failure on the WIPI test for various ages under noise conditions. This test would then appear to be an appropriate test to use in early identification programs for learning disabled children.

3. The results of this study indicated that three year old children performed better on the second presentation than on the first presentation of words. Apparently, practice improved their performance on the task. The audiologist should consider this practice effect when training the young child to take an auditory discrimination test. In the present study, six practice words were used in the training session, yet the children's performance continued to improve after the training session, as they became more familiar with the task. To maximize scores in auditory discrimination testing with children as young as three, it may be advisable to increase the number of words used in the training session.

Although the fields of audiology, speech pathology, learning disabilities, medicine, and psychology often study children with similar disorders, the researchers and clinicians of these fields too infrequently join forces to discuss these children.

The problems of learning disabled children are multivaried and the methods for prevention, identification, and treatments of these problems are still in the initial theoretical and experimental stages. Unfortunately, the above-mentioned fields have too often studied these children within their own disciplines without sharing their research with other specialists. The results of the present study suggest that auditory discrimination problems may be in some way related to prenatal and perinatal histories of children. These same children may later experience learning problems. This type of information would be most useful if its implications were discussed among the fields of pediatricians, audiologists, speech pathologists, education, and psychology.

An effective and efficient screening, diagnostic, and treatment program for learning disabled children may only come about after these specialists combine their efforts and share their knowledge.

CHAPTER V

SUMMARY AND CONCLUSIONS

An investigation was made to determine if three year olds with high risk histories would differ from normal three year olds in their performance on an auditory figure-ground discrimination task.

Eight high risk three year olds and eight normal three year olds, who evidenced normal peripheral hearing, took part in this study. Two word lists (monosyllabic CVC words selected from the WIPI) were presented under quiet and noise (Signal/Noise=0) conditions to these children. In order to avoid the possibility of confounding the results with either fatigue or practice effects, the order of presentation was counterbalanced.

The results were evaluated by a Complex Latin Square Design, and a Test for Simple Effects. The .05 level of confidence was chosen. The main effects of order was statistically significant. All interactions involving order were nonsignificant.

Since the obtained results showed risk-noise interaction in the predicted manner, and because this interaction approached significance (.10), noise and risk were evaluated as simple rather than main effects. The normal and high risk

children did not differ significantly under quiet conditions, whereas they differed significantly under the noise condition. These results suggest that high risk children have greater discrimination difficulty under noise than do normal children. Both normal and high risk children performed significantly better under quiet than noise conditions as predicted.

The major implications of the study were that: (1) auditory discrimination testing under noise should be implemented as part of high risk follow-up test for both high risk children identified as having a hearing loss as well as high risk children with normal peripheral hearing; and (2) the use of auditory discrimination testing in noise may be potentially valuable as a screening tool to identify learning disabled children as young as age three.

Recommendations were made for further studies related to auditory discrimination testing with young children.

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APPENDIX A

TEST SCORE SHEET

Name _____ Pretone Screening _____

WIPI LIST ONE		WIPI LIST TWO	
broom	_____	spoon	_____
ball	_____	bowl	_____
coke	_____	coat	_____
door	_____	corn	_____
blocks	_____	box	_____
hat	_____	bag	_____
pan	_____	man	_____
bread	_____	bed	_____
dress	_____	desk	_____
bear	_____	chair	_____
eye	_____	pie	_____
bee	_____	key	_____
meat	_____	feet	_____
ring	_____	string	_____
mouse	_____	clown	_____
skirt	_____	shirt	_____
gun	_____	sun	_____
bus	_____	cup	_____
cake	_____	plane	_____
star	_____	car	_____
fish	_____	dish	_____
bib	_____	crib	_____
wheel	_____	seal	_____

TEST SCORE SHEET (continued)

frog _____ dog _____

tail _____ pail _____

SCORE _____ SCORE _____

APPENDIX B

Dear Dr. _____:

As we discussed on the phone, we are conducting a follow-up study of the hearing and auditory discrimination abilities of three year olds with high risk neonatal histories who were identified by the University of Montana Infant and Early Childhood At Risk Program. The children we are specifically interested in are high risk on at least one of the four following factors: (1) Rh or ABO incompatibility, (2) gestational age under 36 weeks, (3) respiratory distress-syndrome, and (4) jaundice-hyperbilirubinemia; 15 mg/100cc and over.

At study by Erlich et. al. at Denver Children's Hospital found that approximately 80% of the children who were high risk on one or more of the above factors and who did not have a conventional pure tone hearing loss were functioning below normal in several areas; the most frequently impaired function was auditory discrimination.

When completing the initial Hearing Loss High Risk Check List, you did not consider all of your patients who had one or more of the above factors to be an "at risk" infant. However, primarily because of the Erlich data, we would like to follow-up on these children to further investigate their auditory discrimination skills. We would like to do this without using the term "at risk" or "high risk" when corresponding with the parents. Therefore, we would like merely to inform the parents of these children that we are conducting a study of the hearing and auditory discrimination abilities of young children and that you, their physician, recommend their participation. If we found any of these children to be performing at levels below normal, we would share these results with you and follow your recommendations in discussing this with the parents.

Our other option is to inform the parents of these children that their children are "high risk" according to certain of the data they made available in an earlier University of Montana study and that we are conducting a program to identify high risk with hearing or auditory discrimination problems. Again, if any of these children were found to be performing at levels below normal, we would share our results with you.

We prefer the first option; that of working solely through the child's physician. The children whose parents listed you as the physician are noted below. As agreed upon by phone, we will be proceeding by referring to you as the recommending physician. We appreciate your cooperation and if you have any questions or concerns, please contact us.

Sincerely,

APPENDIX C

This is Ms. _____ calling from the University of Montana Speech and Hearing Clinic. We are conducting a study of the hearing abilities of young children, and your pediatrician, Dr. _____, recommended that your child, _____, participate in this study as the information will be useful to him also as part of your child's health records. Your child's hearing for both speech and non-speech sounds will be tested. This free test will take approximately one-half hour. The results will be sent to your child's physician.

APPENDIX D

LETTER TO PHYSICIANS: EXPLANATION OF RESULTS

Dear Dr. _____:

In May 1975 we contacted you concerning our follow-up study of the auditory discrimination abilities of three year olds who had been identified by the University of Montana Infant and Early Childhood At Risk Programs to have a positive hisotry on one or more of these factors: (1) Rh or ABO incompatibility, (2) gestational age under 36 weeks, (3) respiratory distress syndrome, and (4) jaundice-hyperbilirubinemia; 15 mg/100 cc and over. As we stated in our previous letter, a study by Erlich et. al. at Denver Children's Hospital found that approximately 80% of the children who were high risk on one or more of the above factors and who did not have a conventional puretone hearing loss were functioning below normal in several areas; the most frequently impaired function was auditory discrimination under both quiet and noise conditions.

The results of our study support Erlich's study, in part. The high risk and normal children in our study did not perform significantly differently on an auditory discrimination task in quiet but their performance did differ significantly under the noise condition. The high risk children performed significantly poorer on the auditory discrimination task under noise conditions than the normal children. Six our of eight high risk children performed more poorly than all but one normal child on the auditory discrimination task in noise.

With your permission, we contacted your patients, _____ and _____, and informed them that you recommended their participation in this study. A summary of each child's test restuls follows.

1. (Name of High Risk Child): His score was within the variation found with the control subjects. This suggests that he is probably functioning adequately in auditory discrimination abilities.

2. (Name of High Risk Child): His score was below all of the control subjects. This suggests a possible auditory discrimination problem which may lead to language disabilities. If

there are any other indications of possible speech or language problems, you may feel it adviseable to have this patient receive an in depth language disorder evaluation.

Thank you for your cooperation. If you have any questions, please call us.

Sincerely,

APPENDIX E

This is Ms. _____ calling from the University of Montana Speech and Hearing Clinic. We are conducting a study of the hearing abilities of young children. I found, in a hospital survey, that you have a child named _____ who is about three years old. Would you be interested in having your child participate in this study? Your child's hearing for both tones and speech will be tested. This free test will take approximately one-half hour.

APPENDIX F

RAW SCORES

High Risk

Group 1 (Order: Quiet 1st; S/N=0 2nd)					Group 2 (Order: S/N=0 1st; Quiet 2nd)				
Subject	Quiet	List	Noise	List	Subject	Quiet	List	Noise	List
1	72	2	48	1	5	88	1	68	2
2	76	2	56	1	6	88	1	52	2
3	80	1	56	2	7	92	2	60	1
4	84	2	76	1	8	80	2	44	1

Normal

Group 3 (Order: Quiet 1st; S/N=0 2nd)					Group 4 (Order: S/N=0 1st; Quiet 2nd)				
Subject	Quiet	List	Noise	List	Subject	Quiet	List	Noise	List
9	56	2	52	1	13	92	1	64	2
10	76	2	72	1	14	96	1	72	2
11	88	1	64	2	15	88	2	60	1
12	92	1	88	2	16	92	2	84	1