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Performance of language delayed preschool children on an auditory figure-ground task

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Performance of language delayed preschool children
on an auditory figure-ground task

by

John William Millsapps

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INTRODUCTION

The development of language is a significant problem for many children. It is estimated (Irwin and Marge 1972) that approximately six children in one hundred have problems of delayed language development. The lack of psychosocial and academic development that may result from this type of delay can present a real difficulty for those children, for their parents, and for significant others in their lives. It appears that adequate development of language is crucial to more than just learning to talk; it also appears necessary for the subsequent development of social and academic skills. This is attested to by the fact that delayed language development is reported in the case histories of many children experiencing severe reading difficulties (Mordock 1975). Such reports suggest that it is highly desirable for many children to receive early language training. Before training is provided, however, it seems necessary to identify problem areas of inadequate language development as early as possible.

One problem area may be that of deficient auditory perception. It has been widely assumed that auditory processing skills are fundamental to language development and academic learning. A dysfunction of auditory perception is often cited as a direct or indirect cause of language and learning disorders in children; e.g. defects in articulation, reading dif-

ficulty, dysphasia, learning disability, and language delay. Rees (1973) has indicated that there is a dearth of reliable data to show a connection between specific auditory deficits and language disorders. Clinical tests of auditory perception skills probably do not specifically and fully assess children's abilities to process such complex auditory information as that in speech. For instance, difficulties in speech-signal processing that are specifically linked to rate of speech are not directly assessed by traditional testing; yet Tallal and Piercy (1973, 1974) found rate-specific deficits for verbal and nonverbal stimuli among a group of language delayed dysphasic children. Results of a study by Shankweiler and Liberman (1976) indicate a lack of "phonemic awareness" among poor readers, suggesting that children who are poor readers may have difficulty relating letters in written words to phonemes in speech, as a result of not having established adequate phonetic representation of speech elements. This is another specific deficit that is not directly assessed by traditional clinical testing instruments but has been indicated in research findings. A recent book of psycholinguistic teaching aids (Bush and Giles 1977) offers activities for remediation of specific language deficits, but the activities suggested for the auditory modality are restricted to the areas of auditory reception, association, closure, and memory

which are all ostensibly assessable with traditional clinical tests. No activities are suggested for auditory figure-ground (selective attention), though, and this function is not ordinarily tested by traditional clinical instruments. It is a possibility that auditory selective attention problems exist in children with language delay and, even though we have recognized and dealt with visual attention problems over the years (visual distractibility is the symptom we react to) (Hallahan and Cruickshank 1973), we have yet to approach in auditory attention research what has been done in the visual attention sphere.

Just as the visual sense is exposed to innumerable stimuli, the auditory environment of the child is a myriad of sounds--verbal and nonverbal, relevant and irrelevant--that have to be "sorted out" and dealt with. Coleman (1976) says that "the normal individual--by means of complex processes of 'filtering'--can selectively attend to and cope with the great mass of incoming sensory information to which he is exposed," p. 293. The process of sorting or filtering is normally carried out with little conscious effort. The child with a problem in auditory selective attention, however, will experience difficulty in handling even moderately noisy communication situations. This fact can become increasingly evident to us through a simple experiment such as tape-recording the con-

versation at a family reunion dinner. One will find that the tape recorder is not selective but actually records every sound within its range. There will be difficulty in following any one conversation on the tape because so many different conversations are going on simultaneously--not to mention the various noises made by knives and forks clinking together, chairs being scraped on the floor, etc. Another example is an outdoor cocktail party: if one walks approximately 25-50 feet away from the party area when a large number of guests are having conversations in small groups, there will be great difficulty in understanding anything that is being said; whereas while one is among the party guests, it is relatively easy to follow a conversation while ignoring others that are going on at the same time.

Simple experiments such as these can serve to illustrate the normal and abnormal functions of selective attention and allow one to get a brief insight into what a child with an auditory figure-ground attention deficit may be experiencing.

It has been advocated by Delacato (1974) that in the special case of autism the child finds his auditory environment so intense, diffuse, and so impossible to organize that he soon learns to ignore auditory stimuli because he can make no sense of them. Perhaps the child, like the tape recorder, finds it impossible to filter the relevant from the irrelevant

auditory stimuli, i.e. he cannot selectively attend. Seeming to confirm this supposition is the fact that there has been very little success in teaching auditory language to autistic children. A special school in Chicago, however, is reportedly successful at teaching autistic children the sign language of the deaf for use in communication with one another and with their teachers and parents (Offir 1976). The fact that the children are learning to communicate through the visual modality when they could not learn through the auditory modality seems to corroborate the notion that an auditory figure-ground attention deficit may exist in autistic children.

This Chicago school program and programs for the deaf utilize the visual modality as the primary channel for language learning. The reason for prime importance of the visual channel for the deaf is obvious; for the autistic the reason is less apparent, but begins to make sense when one considers the confusion that may be present in the "normal primary channel" (i.e. auditory) of language learning.

Perhaps the understanding of the auditory behavior of autistic children will give some insight into the auditory behavior of other language disordered children. For instance, in a study of auditory reception in preschoolers, Putzer and Friedlander (1970) found that as an auditory (verbal) stimulus was progressively degraded by white noise, normal

children responded differentially and gradually lost interest in a story being told on a video-tape monitor. The language disordered children, however, did not make a significant change in their attending behavior in spite of the degradation and subsequent obliteration (total masking) of the auditory message. One could infer from such a report that these language disordered children had poor hearing; yet the auditory sensitivity levels of the children in the Putzer and Friedlander study were reported to be within normal limits.

In light of the foregoing discussion, it seems quite feasible that a child might tend to rebel against auditory cues for language learning because he has difficulty bringing order to his auditory world. As a result he may learn to ignore or pay less attention to auditory stimuli in favor of visual stimuli since he can make more sense of the latter.

The present study was designed to investigate the effects of noise as a distractor on the auditory figure-ground (selective attention) abilities of preschool children with language comprehension deficits. It was hypothesized that children with language delay might have that delay because of an inability to filter out or inhibit irrelevant auditory stimuli. The study posed the following questions:

- 1) Is there any significant problem with auditory selective attention among preschoolers with delay in language development?

- 2) Is there any significant difference between the left ear and right ear in performance on auditory selective attention tasks among normal preschoolers or among those with delay in language development; i.e. can a right ear advantage for verbal material be demonstrated in monaural presentation with these groups?
- 3) Is binaural listening significantly better (or worse) than monaural listening as reflected in performance scores on the auditory selective attention task?

Organization of the Study

This report is composed of six chapters. The first is an introduction to the problem presenting background, purpose of the study, questions to be answered and definitions of terms. Chapter two contains a survey of related literature, including a section on auditory perception, one section on attention theory, one on developmental considerations, and another on assessment and remediation. Methodology and procedures are discussed in chapter three, including instrumentation and statistical analysis. Chapter four discusses findings of the investigation. In chapter five there is a discussion of observations, limitations, and recommendations for further investigation. Chapter six summarizes the study.

Definition of Terms

autism - Generally accepted definition involves the following characteristics proposed by Kanner in 1943: 1) the inability to relate to and to interact with people, 2) the inability to communicate with others through language, 3) the obsession with maintaining sameness and resisting change, 4) the preoccupation with objects rather than people, and 5) the occasional evidence of good potential for intelligence (Delacato 1974).

binaural - Listening with both ears (Martin 1975).

bleat - Isolated second or third formant (resonance energy region) of a phoneme (Whittacker and Porter 1976).

consonant-vowel syllable (CV) - A syllable made up of a vowel preceded by a consonant; e.g. /ba/.

dichotic listening - Listening to two different stimuli simultaneously presented--one to one ear, one to the other.

diotic - Two different messages presented to both ears in some form of competition (Berlin and McNeil 1976).

lingua-alveolar - Formed by the articulation of the tongue and the alveolar ridge (upper gum ridge); e.g. /t, d, l, n/ (Tiffany and Carrell 1977).

lingua-velar - Formed by the articulation of the tongue and the soft palate; e.g. /k, g/ (Tiffany and Carrell 1977).

low-pass filtered speech - Speech in which all frequencies below 1000 Hz are allowed to pass through the filter or peak intensity but frequencies above 1000Hz are rejected (Beasley and Maki 1976).

monaural - Listening with one ear (Martin 1975); one message presented to one ear at a time (Berlin and McNeil 1976).

monotic - Two different messages presented to one ear in some form of competition (Berlin and McNeil 1976).

phoneme - A distinctive sound class; the minimal unit of distinction; a speech sound with variations, all of which are represented by the same phonetic symbol (Van Riper 1972).

phonetically balanced words - A list of fifty monosyllabic words used for determination of word discrimination scores; theoretically, each list containing the same distribution of phonemes that occur in connected American discourse (Martin 1975).

place of articulation.- The area of the vocal tract where the critical constriction occurs; e.g. tongue behind upper gum ridge for /t/ sound (Tiffany and Carrell 1977).

signal-to-noise ratio (S/N) - The difference in decibels between a signal (such as speech) and a noise presented to the same ear (ears); when the speech has greater intensity than the noise, a positive sign is used; when the noise has greater intensity than the signal, a negative sign is used (Martin 1975).

spondees - Two syllable words (having a common usage in the language) pronounced with equal stress on both syllables (Martin 1975).

stop consonant - A speech sound, the articulation of which is a complete occlusion of the vocal tract, a cessation of breath flow, and a marked rise in breath pressure behind the point of constriction; e.g. /p, b, t, d, k, g/ (Tiffany and Carrell 1977).

sweep - A synthesized frequency transition of 100 m.sec. duration (Berlin et al. 1976).

REVIEW OF LITERATURE

The survey of literature is organized into six parts. The introduction points out the need for more research in auditory processing and explains the function of auditory sensitivity (acuity). Part two discusses auditory perception in general and introduces the auditory figure-ground function. Attention theory is briefly covered in part three, and part four deals with selective attention studies. Developmental considerations in auditory processing are discussed in part five, and the summary brings together the main points of discussion for a concise review.

Introduction

In recent years there has been increasing interest shown in central processing dysfunctions in children. Research in central processing has received some impetus from the concern for the learning behavior of children with specific learning disabilities, although a portion of the credit for recent study of auditory processing must go to those researchers who have been investigating speech perception, selective listening, and cerebral laterality through the dichotic listening paradigm developed by Broadbent (1954). Even though more than 300 dichotic listening studies have been conducted (Berlin and McNeil, 1976), the level of research at this time must be con-

sidered limited when amount of knowledge gained is considered relative to what is still needed in order to adequately understand auditory processing functions so that knowledge can be effectively applied to the remediation of deficiencies and dysfunctions.

The limited research in auditory processing might well reflect the attitude of "taking for granted" the listening/hearing function; i.e. considering the auditory process intact in the absence of peripheral hearing loss. In a review of research in central processing dysfunctions in children, Chalfant and Scheffelin (1969) state that:

The importance of hearing acuity . . . has been clearly established, but there is little known about the central processing of auditory stimuli Several factors may have contributed to the lack of empirical data of auditory stimulus processing First is the lack of data on the nature of auditory stimuli, especially speech sounds. Second, it is difficult to measure and study responses to auditory stimuli. Third, the organization, structure and use of sound in the environment is achieved at different ages by different individuals. p. 9

Friedlander (1975) stresses the importance of assessment of auditory perception in his statement that:

In addition to establishing thresholds of hearing with . . . varieties of laboratory sound and speech samples, it is also important to assess a child's ability to perceive sounds and voices . . . representative of those surrounding him in the natural world. p. 125

A threshold of hearing is established by the measurement of auditory sensitivity (acuity), the peripheral function

involving the sensory reception of sounds from the environment surrounding the mechanism of the ear. This sensory function is what we normally think of as hearing, i.e. the person is aware that a sound is present in the environment. Response to a sound or to a complex of sounds can range from almost no reaction (not being consciously aware of any sound) to a very complex explanation or verbal tirade. Or the response might range from a startle to a flight for life, depending upon the source of the sound and the intent of the source. How well we receive auditory stimuli has been, and remains, a major concern in the learning of language and the maintenance of communication skills after the basis for language is established. We need only look at the deaf, especially those who are deaf from birth, to realize how important this particular sensory function is to language development.

Auditory Perception

In contrast to auditory acuity (sensitivity) auditory perception is a central function, that which takes place between sensation and conceptualization. Perception is primarily a function of the brain while sensation is a function of the peripheral mechanism; i.e. the ear. Thus auditory perception involves more than just "hearing"; a child may exhibit auditory perception problems even though a pure-tone audiometric test indicates normal hearing.

A problem in auditory perception may result from the dysfunction of one or more of several auditory subfunctions such as: auditory discrimination, the ability to recognize similarities and differences in sound (Van Riper 1972); auditory association, the ability to relate meaning to particular environmental sounds and spoken words (Kroth 1971); auditory closure, the ability to complete the missing parts of a message (Kirk and Kirk 1975); auditory memory, the ability to recall a sequence of auditory information (Kirk and Kirk 1975); auditory localization which is spatial orientation for sounds; and auditory figure-ground perception, the ability to discriminate relevant signals from background noises and to separate them meaningfully (same as auditory selective attention) (Chalfant and Scheffelin 1969).

Blair (1969) developed a schematized concept of the auditory behavioral system which shows a hierarchy of auditory functions operating in various ways. This schematic points out the perceptual function relative to other auditory functions and illustrates possible breakdown points in auditory processing.

<u>Input</u>	<u>Peripheral Hearing</u>	<u>Perception</u>	<u>Conceptualization</u>
Speech, vocal utterances other environ- mental sounds	Sensory contact	Signal Acceptance	Symbol Assoc.
	Sensitivity to relevant sound frequencies	Listening set (attention)	Sequential assimilation (temporal order memory)
	Directional hearing	Figure- ground choice (selective attention) Acoustic analysis (discrim- ination)	Semantic recognition (long term memory)

Adapted from Blair (1969, p. 259).

In conjunction with the above schematic, Blair explains that:

It is essential to acknowledge the possibility of a variety of aural disruptions occurring at different levels or stages along a continuum. In the first instance the individual must be auditorially sensitized to the raw sensory data of the environment. Fundamental needs of survival and adaptability are served. Basic environmental contact is made.

Directionality is important to the extent that it contributes to these needs (mentioned above). At the level of signal acceptance the organism perceptually integrates auditory information in a meaningful or purposeful manner. At this level the organism selectively tunes in to the environment, learns to identify and discriminate among the large array of data available to it, and attends to that which becomes subjectively relevant. (Underlined for emphasis.) Speech sounds, vocal utterances, and a variety of other environmental sounds having affective significance become a part of the ongoing input activity.
pp. 259, 260

Between the sensory reception of auditory verbal information and the conceptualization of that information, then, is the process of perceiving; i.e. consciously accepting the signals, attending to them, making a figure-ground choice (selectively attending), and discriminating between and among specific auditory units (e.g. phonemes). The main thrust of the present study is the perceptual function of auditory figure-ground choice (selective attention) which will be discussed after a brief theoretical background on attention is presented.

Attention Theory

Attention is a concept which is probably best understood through definition of several of its distinct subdivisions:

- 1) mental concentration is an attempt to exclude all incoming stimuli which might interfere with the performance of the specified task, e.g. mental arithmetic;
- 2) vigilance is the task of attending for something that might happen;
- 3) search requires that a person hunt among several signals for some specific one;
- 4) activation is the way of getting ready to deal with whatever happens next--sort of an everyday orientation reflex;
- 5) set is a preparation to respond in a particular way;
- 6) selective attention is the problem faced by a person when competing stimuli are present and a choice has to be made

as to which will be attended to and which rejected. Adapted from Moray (1969, p. 6).

Since there is a limit on how many separate stimuli we can attend to (Broadbent 1952; Cherry 1953), we must make decisions as to what is to be attended to and what is not; i.e. what is relevant and what is not, at any particular time. This attending, of course, is subject to distraction by the intrusion of a more relevant message, or by the sudden or overpowering intensity of another environmental activity. Cherry (1953) demonstrated that when subjects repeated a passage of prose presented to one ear, they were unable to tell what the verbal content was that was presented simultaneously to the other ear. Broadbent (1956) found that a buzzer sound causes more interference with a speech task if a non-specified response is required than if a pre-determined response is required, indicating the specific function of selective attention.

Broadbent (1958) proposed what he called the "Filter theory" of attention based on a number of conclusions (principles) he developed after reviewing numerous experiments. He proposed that there exists a filtering mechanism which selects stimuli (messages) on the basis of bias toward certain characteristics (pitch, loudness, spatial position) of the messages. The filter allows only these messages to proceed to the central

analyzing mechanisms. The exclusion of messages with other characteristics reduces the amount of discrimination which the nervous system has to perform.

Preceding the filter in Broadbent's model is a store for short-term memory. The filter, then, selects from this short-term memory store and allows certain information to pass to a limited capacity channel which serves as sort of a "bottle-neck" to limit the access to higher levels of functioning.

Treisman (1966) proposed a model somewhat similar to Broadbent's but which goes a step farther to specify the rules of selection in the operation of the filter. In addition to analyzing physical properties such as pitch and loudness, the filter mechanism can weaken the strength of any signal before it is allowed to pass. Instruction to attend only to a select signal or to one ear results in all other signals being weakened at this point, but all signals are passed farther into the nervous system. All signals reach a pattern recognizer, consisting of a large number of "dictionary units". These units have thresholds and will "fire" when signals with sufficient strength reach them. Apparently, the "dictionary units" referred to by Treisman are previously formed concepts established through experience that relate to the words or non-verbal signals being processed.

Another theory of attention, termed a response selection theory by Deutsch and Deutsch (1963) is similar to Treisman's but omits the filter in favor of allowing the input to proceed, without interference, directly to the level of the dictionary unit analyzer. The dictionary units, then, have different thresholds; e.g. emotionally important units have permanently lowered thresholds, and all signals will "fire" in proportion to their judged importance.

These theories and others (Reynolds 1964; Neisser 1967; Moray 1969) are necessarily restricted by the limits of available knowledge and probably do not sufficiently explain how attention functions in normal, mature individuals--not to mention abnormally functioning children. Individuals who have deficits in auditory processing of language have not been extensively studied to determine how they fit into these attention models. Much of the research that has recently been conducted in auditory processing has been concerned with the function of selectively attending to verbal stimuli in the presence of competing auditory stimuli.

Selective Attention

Studies of selective attention have, for the most part, utilized competing messages through dichotic listening methods of presentation. The term "dichotic listening" refers to the task of auditorially dealing with two stimuli presented

simultaneously, one to each ear. The task may be to determine which came through more clearly or sooner, or to attend to only one of two competing messages, etc. Many dichotic studies have been conducted in an attempt to determine whether cerebral dominance exists for linguistic and nonlinguistic functions. Perhaps the landmark study was by Kimura (1961), who, through application of the dichotic listening method of study, discovered that when different groups of digits are presented simultaneously to each ear, those to the right ear are more accurately reported than those to the left. This finding suggests that pathways from the right ear to the speech processing areas of the left hemisphere are better than those from the left ear. This conclusion is corroborated by many subsequent studies (Kimura 1963; Dirks 1964; Kimura 1967; Knox and Kimura 1970; Nagafuchi 1970; Ingram 1975; Kimura 1975).

Conversely, a left ear advantage for processing of non-verbal sounds is suggested by the results of a number of studies (Milner 1962; Kimura 1964; Shankweiler 1966; Bakker 1967; Knox and Kimura 1970). Broadbent (1974) states that:

the performance of normal people shows a surprising amount of interference between stimuli and responses on one side of the body and those on the other. Furthermore, the superior function of the right ear for speech stimuli applies only for certain kinds of phoneme and . . . acoustic cues. The two hemispheres must be seen, therefore, as performing different parts of an integrated performance, rather than completely separate and parallel functions. p. 31

Broadbent's statement corroborates the observation by this writer that a necessary condition for right ear advantage for verbal material or a left ear advantage for non-verbal material seems to be dichotic presentation; that is, an inter-aural presentation must take place (different stimuli to both ears simultaneously). It has been demonstrated that when stimuli are presented monaurally, neither ear shows an advantage (Dirks 1964; Kimura 1964; Nagafuchi 1970).

Treisman (1964) presented competing messages to both ears on one channel (diotic presentation) and found that normal adults were able to selectively attend to one of the two messages and thus effectively reject the other message. This was substantiated by the subjects' not being able to report anything about the rejected message except that there was verbal interference. Treisman concluded that:

interference from a competing message can take two forms: 1) the Ss may switch from analyzing the correct message to analyzing the irrelevant one when this is potentially intelligible to them; 2) features of the irrelevant message, whether intelligible or not will act as noise, masking features of the selected message until they have been found incompatible and discarded. p. 218

Most dichotic listening studies have used normal subjects although some have used stutterers, testing theories of left ear advantage, mixed dominance, etc. (e.g. Curry and Gregory 1969; Barr and Carmel 1970; Brady, Sommers and Moore 1973; Sussman and MacNeilage 1975). Some have used split

brain and brain-injured patients in the study of lateral dominance and integrated function (Sperry 1974, Milner 1971). Lerea (1966) examined the notion that deficiencies in auditory figure-ground perception are found among brain-injured subjects. The subjects under study were a group of brain-injured individuals and a group of familial mental retardates. They were presented with syllable utterances as the relevant stimuli along with two noise backgrounds--connected speech and white noise. The findings were inconclusive but Lerea suggested that the amount of interference experienced by a listener is dependent upon the type and intensity of the background signals and the complexity of the "figure" (relevant stimulus).

Developmental Considerations

Relatively few dichotic studies have used children, but those few have demonstrated that children as young as age three show a right ear advantage for speech. This finding suggests a left hemisphere dominance for processing of linguistic material. Three-, four-, and five-year-olds were studied by Ingram (1975) and found to have a right ear superiority (advantage) for linguistic material. This confirms the results of an earlier study on three-year-old Japanese children (Nagafuchi 1970) and those of a much earlier investigation using four-year-olds (Kimura 1963).

Witelson and Pallie (1973) in their post-mortem studies of the brains of adults and neonates, found the speech areas of the left hemispheres to be proportionately larger in the newborns as well as the adults, suggesting an innate specialization for language. These findings, although not proving a right ear-left hemisphere dominance, certainly tend to augment the findings of the studies using dichotic presentations.

In a study comparing age levels on selective listening tasks, Maccoby and Konrad (1966) examined three variables: binaural versus dichotic presentation, number of syllables in stimulus words, and practice. The findings showed that scores on one syllable words tended to level off between the second and fourth grades, and scores on multisyllable words continued to increase through the fourth grade. Practice on listening tasks was generally accompanied by better performance, and in general, selective listening skills increased with age from kindergarten through fourth grade. In a later study (Maccoby and Konrad 1967), the increase of listening skills was reported through sixth grade. The relevant and irrelevant stimuli were both presented at the same intensity level in Maccoby and Konrad's studies; and in order to make the task difficult enough, the messages were electronically "blurred" rather than varying the intensity relationship between the relevant and irrelevant stimuli.

Some recent studies in auditory perception deal with the ability of infants as young as one month to discriminate speech sounds. Eimas et al. (1971) determined that infants one to four months of age can discriminate voicing contrasts of consonants presented in consonant-vowel (CV) syllables. Furthermore, it has been demonstrated by Eimas (1974) that two- and three-month-olds also discriminate contrasts in place of articulation of lingua-alveolar versus lingua-velar stop consonants. These studies made use of a nonnutritive, operant sucking paradigm in which the presentation of a speech stimulus was contingent upon the infant's non-nutritive conditioned sucking. Because of age limitations of this technique, Miller and Morse (1976) used a heart rate paradigm and found, through study of electrocardiogram (EKG) waves, that four-month-old infants can also discriminate cues for place of articulation. Although not directly studying speech perception, Butterfield and Siperstein (1972) have demonstrated an ability, in infants 26 to 36 hours of age, to discriminate among vocal music, instrumental music, and noise. This was accomplished by using auditory stimuli to differentially influence the nonnutritive sucking response. It appears that the development of auditory perception begins very early in a child's life, much earlier than we might have believed previous to these studies. As a result of normal maturation

and environmental exposure and experience, auditory perceptual skills seem to progress with the development of language and speech. At the age of five or six, a child is ordinarily ready to take on the new language task, reading, which requires not only auditory skills, but visual skills as well and the two must ultimately be integrated.

Rubin and Pollack (1969) proposed that auditory discrimination ability must precede intermodal (integrated) functioning. Their rationale is that a child must have the ability to differentiate in single sensory modalities before being expected to integrate multi-sensory inputs as is expected in the process of reading. They advocated an organized intense kindergarten program of auditory perception training as a means of developing reading readiness skills. The process of learning to read seems to require the development of a set of discrimination skills similar to those required for the development of oral language. Letters look and sound either alike or different and they occur in various orders and relationships. With many children, the otherwise effortless differentiation and integration of auditory and visual processes are imperfectly learned or not learned at all, and probably result in some degree of reading difficulty. Thus auditory perception problems, if not remediated, may continue to cause difficulties as the child grows, and may affect not only

oral language development but the development of reading skills as well; hence the possibility of influencing academic progress.

Assessment and Remediation

Schiefelbusch et al. (1976) delineate levels of language deficiency in children, describing the child who is non-verbal--using gestures and primitive vocal symbols but no conventional language system, the child who has unintelligible speech while appearing to have adequate comprehension of language, and the child who may function fairly well under optimum conditions but has great difficulty listening to the teacher or comprehending instructions in a normal group setting. The language abilities of any of the children described above do not adapt to normal social situations and learning task requirements as do the language abilities of the normal child. The child with a language disorder presents a difficult problem, and it seems important for teachers and clinicians to have a basic understanding of what is necessary for language to develop normally so that they will have some basis for language intervention.

According to Premack (1970), the child has four essential discrimination tasks to learn in the development of language. First, he must learn that words can be used to represent objects and events. Second, he must discriminate between

environmental events such as objects and actions, and agents (initiators of action) and objects (recipients of the action). Third, he must be able to make gross discriminations such as between "car" and "house", as well as fine discrimination as between "tin" and "pin". The fourth discrimination he must be able to make is among sequential arrangements of the symbols, such as: "the dog bit the man" and "the man bit the dog". The difference in arrangement can make a significant difference in meaning.

Missing from Premack's list of requirements, however, is the discrimination the child must make between relevant and irrelevant stimuli in his environment. For example, the child must learn to selectively attend to speech to the exclusion of noise of other speech simultaneously competing for his attention. In everyday listening situations, there are numerous distracting environmental noises (doors slamming, people talking, street sounds, etc.) which a child must learn to suppress in order to attend to what is being said (Laskey and Tobin 1973). It is not surprising to discover the exclusion of the auditory figure-ground discrimination from such a list of requirements since, traditionally, little concern has been shown for deficient auditory selective attention (figure-ground) abilities. The few sources of concern for this function seem to be relatively recent publications and offer lit-

tle in terms of assessment and practical approaches to remediation.

In a short article written for special education teachers to use as a basis for development of units for auditory processing skills, Falck (1973) defined auditory figure-ground problems, presented possible symptoms, and suggested general possibilities for programming (for remediation):

Programming possibilities: developing instrumental units which increase in level of difficulty; turning background sounds on and off to help child select relevant from irrelevant sounds; building up tolerance to distractors; helping child discriminate, i.e. differentiate figure or wanted sounds. p. 414

Evidently, the assessment of the problem is based on the teacher's observational skills since no particular type of testing instrument is suggested in the article. Of course, sophisticated observation is valuable when one is involved in the guidance and teaching of children, but research-based testing coupled with observation could be even more valuable in that deficit areas might be specifically delineated to aid in efficient assessment and more appropriate treatment.

It has been shown that children with learning disabilities have auditory figure-ground (selective attention) difficulties on several auditory tests using the competing messages paradigm (Katz 1968; Connors et al. 1969; Katz and Illmer 1972; Laskey and Tobin 1973). It appears that it might be quite important to assess auditory attention abilities as

part of a comprehensive evaluation of the learning disabled child as well as the child with language delay.

A child with inadequate auditory figure-ground balance (selective attention) may appear distractible because he cannot adequately screen out irrelevant stimuli. According to Mencher and Stick (1974) the child with inadequate auditory figure-ground balance is often considered hyperactive and poorly disciplined and will likely become academically retarded. The hyperactive child has traditionally been viewed as receiving overstimulation as a result of an inadequate stimulus filter, which in turn results in poor selectivity in the processing of stimuli or the inability to inhibit or ignore irrelevant stimuli (Strauss and Lehtinen 1947; Cruickshank et al. 1961; Alabiso 1972; Kirk 1972; Wasserman et al. 1972; Haring 1974). According to this theory the hyperactive child is unable to adequately filter incoming stimulation, causing the child to become overwhelmed and to react with a high volume of response.

Zentall (1977) takes the opposite theoretical position, proposing that hyperactive children are making inefficient use of environmental stimulation due to excessive stimulus filtering rather than inadequate filtering. Zentall presents a good case, citing empirical data to support his position, such as studies that have found decreases in activity with increases in sensory stimulation with retarded and normal I.Q. subjects

who are classified as hyperactive. He offers an interesting view of the effects of drugs normally thought to work differently on hyperactive youngsters than on normally active children. Instead of simply offering a calming effect, the drugs (e.g. Ritalin and amphetamines) have a consistent arousal-producing effect on all children and since the hyperactive children are underaroused (according to Zentall), the drugs produce an adequate level of arousal, reducing the children's need for additional stimulation through hyperactive behavior. This is an interesting and compelling theory and the suggestions for programming are remarkable; they are almost completely opposite to the popular practice of reducing or eliminating irrelevant stimuli in the child's visual and auditory environment (Cruickshank et al. 1961; Kirk 1972; Haring 1974).

Whatever may be the actual cause of the problem faced by hyperactive children, learning disabled children, or those with language delay, it is obvious that the ability to adequately handle auditory figure-ground competition is a necessary skill for normal functioning of children (and adults) since the processing of auditory-perceptual information must be accomplished each day in situations with continually varying figure (relevant) and background (irrelevant) stimuli. Wiig and Semel (1976) suggest the use of the Goldman-Fristoe-

Woodcock test of auditory discrimination (Goldman, Fristoe and Woodcock 1970) and the Flowers-Costello tests of central auditory abilities (Flowers, Costello and Small 1970) for the assessment of auditory figure-ground abilities. The noise subtest of the Goldman, Fristoe, Woodcock seems to be intended for the assessment of auditory figure-ground abilities; the items are presented with a background of tape-recorded school cafeteria noise as a distractor. However, the validity of this test has been questioned and the test has been experimentally compared (Schubert, Meyer and Schmidt 1973) with the Staggered Spondee Words Test (Katz 1968). It was determined that the GFW noise subtest was of questionable value for assessing auditory figure-ground abilities.

The Flowers-Costello Tests utilize low-pass filtered speech and competing messages for assessment of auditory figure-ground. In the competing messages subtest, sentences are presented against the background of an interesting story. Concerned with possible tapping of abilities other than auditory figure-ground (semantic-cognitive and convergent production abilities) and other contamination, Wiig and Semel recommend that performances on this test should be interpreted cautiously. It is also important to note that the internal reliability of this test drops from .60 at third-grade level to .37 for the fourth-grade level, giving one the impression

that the test may not be appropriate for children at fourth grade or above. Except for a short definition, the suggestion of using the above-mentioned tests is about all that is offered by Wiig and Semel relative to assessment of auditory figure-ground abilities.

A set of activities is offered by Semel (1970) for use in educational settings with groups of children. The stimuli are a set of sequential oral directions given against a background of various recorded sounds. Suggestions are provided for interesting activities in which the children are asked to listen for certain messages being given against the competing noise. This program is one of very few available for the expressed purpose of improving auditory figure-ground abilities. Considering the relative lack of knowledge in auditory processing in general and auditory figure-ground in particular, it is understandable that very little information is available which can specifically be put to practical use in the assessment and management of language problems.

Recent research in auditory processing is beginning to contribute data to aid in more specific assessment. For instance, Tobey et al. (1976) studied the performance of children with auditory-processing disorders on tasks requiring them to identify phonetically-balanced words, spondees and consonant-vowel syllables (CVs). The children with auditory

processing disorders were able to do well on these tasks on binaural presentation, but they performed poorly when required to process two simultaneously presented stimuli, one to each ear (dichotic listening).

The low performance of this group was attributed to the very low number of double-correct trials (correctly identifying both CVs simultaneously presented). The single correct trial scores were comparable to those of the control group. In a similar dichotic identification task with learning disabled children, Dermody (1976) also found a low number of double-correct trials in a low overall performance. Working with normal children, Berlin et al. (1973) found that the number of double-correct responses increased significantly as a function of the subject's age, and accounted for variances in age-level performances.

Many studies have shown a right ear advantage for verbal stimuli in children (e.g. Knox and Kimura 1970; Nagafuchi 1970; Geffner and Hochberg 1971). Results of a more recent study (Berlin et al. 1973) have indicated that the right ear advantage is essentially fixed by age five. This finding was based on the use of nonsense syllables while other studies generally used digits or words. There is a possibility that this could make some difference in the results, although nonsense syllables were found (Curry 1967) to generate an equally

high right ear advantage as words in a study of handedness and dichotic listening tasks with adults.

Sobotka (1973) found that scores for normal and dyslexic subjects are different for dichotic CV and digits tests. Results indicated that some of the subjects were right-eared for CVs, left-eared for digits and vice-versa. Porter and Berlin (1975) investigated the use of digits as compared to consonant-vowel syllables in dichotic listening and concluded that the two types of stimuli might not be measuring the same neural processes.

Studying children with learning disabilities, Williford (1976) noted that sometimes one ear seemed to process information in a distorted fashion, thus causing confusion in binaural listening. The use of an earplug in the "distorted" ear (to screen out a portion of the incoming stimuli) seemed to allow the other ear to more adequately process the input. The earplug did not totally block the conduction of auditory stimuli but reduced the amount of distorted input relative to the amount of "clear" input, allowing for clearly processed stimuli to overcome the interference.

Cullen et al. (1974) found, by varying acoustic parameters (bandwidth, intensity, and signal-to-noise ratio), that the central process responsible for combining speech information from the two ears operates in an additive manner. They suggested that the capacity of this process for handling infor-

mation is slightly higher than the single ear capacity, and before the central combining takes place, speech information handled by one ear is independent of speech information handled by the other. This suggests that listening with both ears is superior to listening with either ear independently.

In a recent experiment, Berlin et al. (1976) investigated the effects of various "challenges" on the monotic and dichotic perception of consonant-vowel syllables. The challenges were: another CV syllable, a "bleat", a broadband noise (white noise), a vowel, and a "sweep". The monotic test required subjects to identify the target CVs while the challenges were presented at 60 decibels (dB) sound pressure level (SPL). It was found that the best monotic masker was the "sweep", while the worst was the broadband noise. Even when the sweeps were 5 dB less intense than the CVs, they completely masked the CV target, whereas the broadband noise had to be 30 dB more intense than the CV target in order to reduce identification scores to the 20 percent level.

In dichotic presentation, the results were different; only bleats and other CVs seriously interfered with the target CVs. The noise, sweep and vowels produced very little interference. Berlin et al. concluded that it is not necessary to use competing, linguistic signals to determine a right ear advantage; nor are peripheral masking capabilities predictors

of central interference. This strengthens the notion that the human auditory system is organized to respond differently at the central level than it is at the cochlear level.

Auditory sequential processing deficits have been noted in children with delayed language development and/or delayed reading skills (Aten and Davis 1968; Monsees 1968; Bakker 1971). Tallal (1976) compared children aged four-and-one-half to eight-and-one-half-years-old with normal language development, normal adults, and dysphasic children in their ability to perceive sequences of nonverbal auditory stimuli. The eight-and-one-half-year-old group and the adults responded virtually the same on rapid presentation of complex tones. Six-and-one-half-year-olds were able to respond well when these tones were presented more slowly. The dysphasics' responses were significantly poorer than those of even the four-and-one-half-year-old normal group on rapid auditory sequencing. Tallal proposed that the ability to process rapidly occurring acoustic stimuli develops with age and reaches an adult level by eight-and-one-half-years. It is interesting to note that this is roughly comparable to the average age of mastery of speech sounds (Van Riper 1972). Although speech sounds were not utilized in Tallal's study, the type of processing under investigation is that which is probably necessary for the perception of speech--rapid processing of complex

tones and noises--from which the child must ultimately derive meaning. The "distance" between the speaker's intention and the listener's understanding of that intention seems short when everything is intact; but a weak link in the system (in this case a problem in the perception of auditory sequencing) can cause a partial or total breakdown of what appears to the normal person to be a simple process, so easily performed as to be practically unnoticed.

Summary

The review of literature has presented a definition for auditory perception, a background in attention theory, a review of the kinds of research that have been done in auditory processing, some developmental data, and the status of research in assessment and remediation.

Research in auditory processing has advanced slowly, and compared to the level of knowledge in the processing of visual stimuli, very little is understood about the auditory function. Perhaps this is because visual responses are more easily observed than auditory responses; or perhaps it is because visual stimuli are more easily controlled, more consistent from measure-to-measure. Whatever the reason has been for the delay in auditory research, there is now an expanding interest that seems likely to bring advancement to a long-neglected area of study. For instance, the advent of the

dichotic listening paradigm for the study of speech perception, selective listening, and cerebral laterality has made possible a more sophisticated study of a complex process.

Much of what has been done in auditory processing research relates to discrimination between phonemes and selective attention through dichotic presentation. Also, auditory processing functions (through dichotic presentation) have been utilized in the study of brain function; e.g. testing cerebral laterality (dominance) theories. Cerebral laterality for verbal and nonverbal information has been demonstrated through post-mortem brain examination, revealing a larger speech area in the left hemisphere of neonates and adults; through examination of split-brain and brain-damaged patients; and through dichotic listening studies of normal individuals.

Theories of attention in normal individuals, theories concerned with distraction in learning disabled children, and theories of over- and under-stimulation in hyperactive children, suggest the existence of a "filtering mechanism" that sorts out auditory stimulation on the basis of relevant versus irrelevant stimuli, relative to the situation at hand. Theories of over-stimulation and under-stimulation have been proposed by researchers concerned with hyperactivity (e.g. autism, learning disability, language delay). The overstimulation notion relates closely to the problem of this study as previously stated. Perhaps the language disordered child has

difficulty filtering out the irrelevant auditory stimuli and retaining the relevant; in other words, perhaps the filtering mechanism doesn't allow the child to inhibit stimulation that he doesn't need. Perhaps it is possible that the child with language disorders has "faulty filter components" and all signals are allowed to pass (rather than just the relevant as Broadbent's model suggests), or perhaps all signals are allowed to pass with equal intensity rather than being weakened as in Treisman's model. It may be possible that the child with a figure-ground selection problem judges all signals to be equally important and the "dictionary" fires for all incoming stimuli rather than only for select stimuli that are appropriate to the situation, as proposed by the theoretical model of Deutsch and Deutsch.

Most of the studies concerned with selective attention were conducted within the dichotic listening paradigm and used verbal material as competition (distraction). These investigations are, of course, important in the sense that spoken messages are a significant type of competition for other spoken messages; e.g. the "cocktail party effect", as mentioned earlier. Dichotic presentation is also highly effective for the study of hemispheric functioning. This type of presentation, however, seems inappropriate for everyday, real-life selective attention tasks. As we ordinarily

receive auditory stimuli, competing or not, through both ears (excepting cases of monaural hearing loss), binaural presentation (same stimuli to both ears) seems more appropriate for the investigation of auditory selective attention problems; e.g. auditory figure-ground deficits.

Through review of the literature, this investigator failed to find sufficient research to adequately answer the questions under consideration in the present study. Some of the prior research studies have utilized binaural presentation, a condition of the present study; some have used white noise as a distractor, another condition of the present study; others have used preschool children, still another condition of this study. No studies known to this writer at this time have compared language-delayed preschool children with normal preschoolers, utilizing binaural and monaural presentation along with the use of white noise as a distractor, as in the present study. Therefore, this study is attempting to answer questions about auditory figure-ground abilities that have not to the knowledge of this investigator yet been adequately dealt with.

METHOD OF PROCEDURE.

The primary objective of this study was to determine whether preschool children with language delay are significantly different in performance on auditory figure-ground (selective attention) tasks than are preschool children whose language development is considered advanced. Secondary objectives were: to determine whether there is a significant difference between the right ear performance and left ear performance in auditory figure-ground abilities, and to determine whether binaural performance is significantly better than monaural performance in auditory figure-ground skills.

This chapter describes the methods and procedures used in conducting the research study and in analyzing the data gathered. The chapter is organized into seven sections: 1) Null hypotheses, 2) Subjects, 3) Stimuli, 4) Procedures, 5) Instrumentation, 6) Design of study, and 7) Statistical analysis.

Null Hypotheses

Three null hypotheses were developed in an attempt to answer the questions posed in chapter 1:

- 1) There is no significant difference between the performance of the preschool children with delayed language and those with advanced language development on an auditory-figure-ground (selective attention) task.

- 2) There is no significant difference in left ear and right ear with or without noise as an irrelevant stimulus.
- 3) There is no significant difference between monaural (left or right ear) and binaural performance with or without noise as an irrelevant stimulus.

Subjects

A total of 60 children (25 girls and 35 boys) between the ages of 56 and 72 months ($\bar{x}=62.2$, $\bar{s}=4.4$) were selected on the basis of percentile rankings on the Screening Test for Auditory Comprehension of Language (Carrow 1975). Thirty children ranking below the 20th percentile were placed in the delayed language group and 30 children ranking above the 80th percentile were placed in the advanced group, eliminating approximately the middle two-thirds of the population tested. There were 19 boys and 11 girls in the delayed group, and 16 boys and 14 girls in the advanced group (see Appendix C for means and standard deviations). Each child was tested by pure-tone audiometry and found to have normal hearing in both ears before the experimental listening task was presented.

The subjects were selected from Community Action (Head Start) Programs in several South-Central Iowa locations, Judy's Nursery School in Ames, and the Speech and Hearing Clinic at Iowa State University of Science and Technology. The South-Central Iowa communities were judged as lower-middle class communities and Ames, Iowa, was considered an upper-

middle class community. Parental permission was obtained prior to including children in the study. A copy of the permission letter and form can be found in Appendix A.

Stimuli

Linguistic (relevant) stimuli utilized were the numbers 1 through 10, randomly paired, randomly ordered, and auditorially presented with sufficient time (4 seconds) for response (repeating) from the subject. They were presented at an average sound pressure level (SPL) of 70 decibels (dB) on the A scale in approximation with intensity levels frequently used in dichotic listening studies. The 70 dB level is sufficiently, but not uncomfortably, loud for good speech discrimination in a subject with normal hearing. It is comparable to the intensity (60-70 dB) of normal conversation at approximately three feet from the ear (Martin 1975).

Numbers were chosen as stimuli because many auditory processing studies had successfully used paired digits as verbal stimuli and because of the relative ease of understanding the numbers when spoken by children with speech problems.

The non-linguistic (irrelevant) stimulus was a "white" masking noise presented simultaneously with 10 of the 20 pairs of numbers (randomly assigned noise) in each mode of presentation: right ear, left ear, both ears. The white noise was presented at 82 dB SPL, resulting in an effective signal-to-

noise ratio (S/N) of -12 dB. This is the level at which the pilot group of normals achieved 75 to 80 percent correct responses. The 75 to 80 percent criterion was selected for two reasons: 1) some degree of difficulty was considered necessary so that no child could "top out the test"; i.e. so there would be no ceiling effect which would make statistical comparisons less effective; 2) word discrimination scores ranging from 70 to 90 percent are considered to reflect a slight difficulty in general speech discrimination ability, comparable to listening over a telephone (Goetzinger 1972).

The signal-to-noise ratio was achieved by experimentally adjusting noise level after setting the signal (speech) at an average sound pressure level of 70 dB. Noise level was first set at 70 dB to obtain a signal-to-noise ratio of 0 (S/N=0), then the noise was increased a few decibels between subjects until pilot subjects were scoring at approximately 75 to 80 percent. At this point the sound pressure level of the noise was at 82 dB for a signal-to-noise ratio of -12 on the dBA scale, compared to S/N=-10 ordinarily used for speech discrimination testing. Sound pressure levels were measured by a Bruel and Kjaer type 2209 Impulse Precision sound level meter.

Procedures

Prior to the investigation, each subject was oriented to the equipment, types of stimuli to be expected, and the

task to be performed. Each subject was shown the tape recorder, earphone switch block and earphones. The investigator explained, "When I put these earphones on your ears, you will hear someone talking. Then you will hear a funny noise. Try to listen to the numbers the man is saying, even when there is noise."

The subjects were asked (on the recording) to repeat the digits that they heard; to wit: "I am going to say some numbers. Some will be easy to hear and some will be hard to hear because of some noise. Listen carefully and say the numbers I say. Are you ready?"

Each subject received 60 number pairs: 20 presented to the left ear, 20 to the right ear, and 20 to both ears. The investigator recorded responses on the response sheet shown in Appendix B.

Instrumentation

The listening task was reproduced on a Realistic SCT-2B solid state stereo cassette recorder on a high quality, low-noise tape. White noise was recorded on one track and randomly paired numbers on the other. Both tracks were fed into a switch block by way of a Y-cord. Earphones were plugged into this switch block allowing a simultaneous channeling of both tracks into the left ear, right ear or both ears. The investigator was able to monitor the task presentation through a

button receiver of hearing aid type in one ear. This was necessary so that responses could be recorded in correct order if the child happened to not respond to one or more of the pairs of numbers.

Two switches were utilized on the switch block; one for switching from monaural to binaural and one for switching from one monaural presentation (left or right) to the other.

Design of Study

The design of the study is illustrated in Table 1. Each group (delayed and advanced) was presented, through three different modes (left ear, right ear, and both ears), paired digits under two conditions (without auditory distraction and with auditory distraction in the form of broadband "white" noise).

Table 1. Design of study^a

GROUP	DELAYED						ADVANCED					
	LE		RE		BE		LE		RE		BE	
MODE	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN
CONDITION	N	NN	N	NN	N	NN	N	NN	N	NN	N	NN

^aLE = left ear; RE = right ear; BE = both ears;

N = noise; NN = no noise.

Each child in each group received exactly the same auditory stimuli as every other child. Only the order of

mode of presentation was different; i.e. the children in each group were randomly assigned to six subgroups to attempt to control for the order of presentation variable. All possible orders were utilized: left ear, right ear, both ears; left ear, both ears, right ear; right ear, left ear, both ears; right ear, both ears, left ear; both ears, left ear, right ear; both ears, right ear, left ear.

Statistical Analysis

The data were treated by three different statistical procedures. The first was an analysis of variance to test for: a) differences between advanced group and delayed group on each criterion (dependent) variable; left ear score without noise (LE), left ear score with noise (LEN), right ear score without noise (RE), right ear score with noise (REN), both ears score without noise (BE), both ears score with noise (BEN) to test the null hypothesis 1 (no significant difference between delayed and advanced groups in auditory figure-ground scores when noise is introduced into the auditory channel); b) differences among subgroups on the basis of order of presentation. This test was completed only as a check on the built-in control of this variable in the experimental design of the study; c) any interaction between the variables "group" and "order".

The second procedure consisted of a series of paired t-tests to test hypothesis 2 (no significant difference between performance of left ear and right ear under conditions of noise and under conditions of no noise); and null hypothesis 3 (no significant difference between monaural and binaural performance under the conditions of noise and no noise).

A third procedure consisted of paired t-tests comparing performance of the delayed group with the advanced group on left ear difference scores, right ear difference scores and binaural difference scores (between noise and no noise scores).

All statistical analyses were performed through the Statistical Package for the Social Sciences (SPSS) program (Nie et al. 1975).

FINDINGS

The problems investigated in this study were expressed by the three questions posed in the introductory chapter. Beyond these, additional analyses were made of the effects of the order of presentation.

Analysis of Variance

Table 2 shows the mean scores and standard deviation for the delayed and advanced groups on left ear score, right ear scores, and both ear scores under conditions of noise and no noise.

Table 2. Means and standard deviations on left ear score, right ear score and both ears score with noise and with no noise in delayed and advanced groups.

Group	Mode ^a	Condition ^b	N	Mean	Standard Deviation
Advanced	LE	NN	30	10.0000	0.0
Delayed	LE	NN	30	9.4333	1.251
Advanced	LE	N	30	6.8333	0.325
Delayed	LE	N	30	2.9667	2.076
Advanced	RE	NN	30	10.0000	0.0
Delayed	RE	NN	30	9.7333	0.691
Advanced	RE	N	30	6.4667	1.852
Delayed	RE	N	30	3.6667	2.073
Advanced	BE	NN	30	10.0000	0.0
Delayed	BE	NN	30	9.7000	0.915
Advanced	BE	N	30	7.8333	0.186
Delayed	BE	N	30	4.4667	2.488

^aLE = left ear; RE = right ear; BE = both ears.

^bN = noise; NN = no noise.

Table 3 presents results of analysis of variance (by regression procedure) on noise scores by group and by order of presentation (subgroup).

Table 3. Analysis of variance by group and by order of presentation. Left ear, right ear, and both ears in noise condition. Delayed and advanced groups.

Mode and Condition	Source of Variation	Sum of Squares	DF	Mean Square	F Ratio	F Prob.
Left ear with noise	Main effects	283.467	6	47.244	15.448	0.001**
	Group	224.267	1	224.267	73.331	0.001**
	Order	59.200	5	11.840	3.871	0.005**
	Two-way Interactions	11.133	5	2.227	0.728	0.999
	Residual	146.797	48	3.058		
	Total	441.397	59	7.481		
Right ear with noise	Main effects	147.733	6	24.622	6.581	0.001**
	Group	117.600	1	117.600	31.430	0.001**
	Order	30.133	5	6.027	1.611	0.175
	Two-way Interactions	14.400	5	2.880	0.770	0.999
	Residual	179.598	48	3.742		
	Total	341.732	59	5.792		
Both ears with noise	Main effects	193.967	6	32.328	8.857	0.001**
	Group	170.017	1	170.107	46.581	0.001**
	Order	23.950	5	4.790	1.312	0.274
	Two-way Interactions	10.483	5	2.079	0.574	0.999
	Residual	175.197	48	3.650		
	Total	379.646	59	6.435		

**p<.01.

The results of analysis of variance yielded a highly significant difference between delayed and advanced groups on left ear mode of presentation with noise (LEN) ($F=73.331$, $p<0.001$), right ear mode of presentation with noise (REN) ($F=31.4310$, $p<0.001$) and both ears mode of presentation with noise (BEN) ($F=46.581$, $p<0.001$) as shown in Table 3.

Analysis of variance also indicated a highly significant difference on the basis of order of presentation in the left ear mode with noise. The F-ratio was 3.871 at the 0.005 level of significance. The other modes showed no significance on order of presentation: right ear with noise, $F=1.611$, $p<0.175$; both ears with noise, $F=1.312$, $p<0.274$ (see Table 3). Although not referred to in a null hypothesis, order of presentation was included in the analysis of variance as a check on the effectiveness of utilizing six orders of presentation as a control on the order variable. Additional analysis of order of presentation in the left ear mode with noise was performed with a one-way analysis of variance, which attributed the significant difference to the advanced group: $F=4.417$, $p<0.006$ (see Table 4).

Table 4. One way analysis of variance. Left ear scores in noise condition. Advanced group.

Source of Variance	DF	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between orders	5	44.1660	8.8332	4.417	0.006**
Within orders	24	48.0007	2.0000		
Total	29	92.1667			

**p<.01.

Analysis by way of the Multiple Range Test (Duncan 1955) determined that the difference was between mean scores of order 1 (LRB) (\bar{x} =5.200) and order 5 (BLR) (\bar{x} =8.880); also between order 6 (BRL) (\bar{x} =5.600) and order 5 (BLR) (\bar{x} =8.800) as indicated in Table 5. The differences in means were significant at the .05 probability level. It is a possibility that the relatively small number of subjects per order of presentation contributed to this significant effect.

Table 5. Results of Multiple Range Test^a. Means for orders of presentation; left ear scores in noise condition. Advanced group.

LRB(1)	BRL(6)	LBR(2)	RBL(4)	RLB(3)	BLR(5)
5.2000	5.6000	6.6000	7.2000	7.6000	8.8000

^aAny two means not underscored by the same line are significantly different.

Difference of means; t-test

Data for the testing of hypotheses 2 and 3 were analyzed by means of the paired t-test. Hypothesis 2 states that there is no difference between left ear scores and right ear scores, with noise or without noise. In all cases of comparison of left and right ear scores (delayed and advanced groups, with and without noise) hypothesis 2 could not be rejected, indicating that there is no significant difference between left ear and right ear performance with or without the noise condition.

Delayed language group

The data in Table 6 indicate no significant difference of means between left ear mode with noise condition (LEN) and right ear mode with noise condition (REN) ($t=-1.80$, $p<.083$). Also no significant difference is indicated between left ear mode (LENN) and right ear mode with no noise (RENN) ($t=-1.66$, $p<0.107$).

Table 6. Paired t values and probabilities observed in comparison of monaural scores. Delayed group.

Variable ^a	Mean	Difference in Means	Paired t	Probability Level
LEN	2.9667	-0.7000	-1.80	0.083
REN	3.6667			
LENN	9.4333	-0.3000	-1.66	0.107
RENN	9.7333			

^aLE = left ear; RE = right ear; N = noise condition; NN = no noise condition.

Advanced language group

The data in Table 7 indicate no significant difference between left ear mode with noise condition (LEN) and right ear mode with noise condition (REN) ($t=0.84$, $p<0.407$). Also, no significant difference was indicated between left ear mode with no-noise condition (LENN) and right ear mode with no-noise condition (RENN) ($t=0.00$, $p<1.000$).

Table 7. Paired t values and probabilities observed in comparison of monaural scores. Advanced group.

Variable	Mean	Difference in Means	t	Probability Level
LEN REN	6.8333 6.4667	0.3667	0.84	0.407
LENN RENN	10.0000 10.0000	0.0000	0.00	1.000

^aLE = left ear; RE = right ear; N = noise condition;
NN = no-noise condition.

Combined groups

Table 8 reveals no significant difference between left ear mode with noise condition (LEN) and right ear mode with noise condition (REN) ($t=-0.56$, $p<0.578$). The comparison of left ear with no-noise condition (LENN) and right ear mode with no-noise condition (RENN) yielded no significant difference ($t=-1.64$, $p<0.107$). The analyses were performed on

combined data from both the delayed and advanced groups.

Table 8. Paired t values and probabilities observed in comparison of monaural scores. Delayed and advanced groups combined.

Variable ^a	Mean	Difference in Means	Paired t	Probability Level
LEN REN	4.9000 5.0667	-0.1667	-0.56	0.578
LENN RENN	9.7167 9.8667	-0.1500	-1.64	0.107

^aLE = left ear; RE = right ear; N = noise condition; NN = no-noise condition.

Null hypothesis 2 could not be rejected in any of the tests performed on the data, indicating that there is no significant difference between left ear and right ear performance under either the noise condition or no-noise condition.

Null hypothesis 3 stated that there was no significant difference between monaural (left or right) and binaural scores and was tested by means of the t-test. Results are shown in Tables 8, 9, and 10.

Delayed language group

Table 9 indicates a highly significant difference between left ear mode, noise condition (LEN) and both ears

mode, noise condition (BEN) ($t=-4.35$, $p<0.001$) in favor of the BEN presentation and in agreement with the binaural summation position (Cullen et al. 1974). No significant difference was indicated, however, in the comparisons of: right ear mode, noise condition (REN) and both ears mode, noise condition (BEN) ($t=-1.63$, $p<0.115$); left ear mode, no-noise condition (LENN) and both ears mode, no-noise condition (BENN) ($t=1.14$, $p<0.265$); right ear mode, no-noise condition (RENN) and both ears mode, no-noise condition (BENN) ($t=0.25$, $p<0.801$).

Table 9. t values and probabilities observed in comparison of monaural and binaural scores. Delayed group.

Variable ^a	Mean	Difference in Means	t	Probability Level
LEN BEN	2.9667 4.4667	-1.5000	-4.35	0.001**
REN BEN	3.6667 4.4667	-0.8000	-1.63	0.115
LENN BENN	9.4333 9.7000	-0.2667	-1.14	0.265
RENN BENN	9.7333 9.7000	0.0333	0.25	0.801

** $p<.01$

^aLE = left ear; RE = right ear; BE = both ears;
N = noise condition; NN = no-noise condition.

Advanced language group

The data in Table 10 indicate a significant difference between the left ear mode with noise condition (LEN) and the both ears mode with noise condition (BEN) ($t=-2.69$, $p<0.012$), and a highly significant difference between the right ear mode with noise condition (REN) and the both ears mode with noise condition (BEN) ($t=-3.79$, $p<0.001$). These findings indicate a significant difference between monaural (left or right) and binaural performance (listening) under noise conditions, suggesting the superiority of binaural abilities in figure-ground choice over monaural abilities.

Table 10. Paired t values and probabilities observed in comparison of monaural and binaural scores. Advanced group.

Variable ^a	Mean	Difference in Means	Paired t	Probability Level
LEN BEN	6.8333 7.8333	-1.0000	-2.69	0.012*
REN BEN	6.4667 7.8333	-1.3667	-3.79	0.001**
LENN BENN	10.0000 10.0000	0.0000	0.00	1.000
RENN BENN	10.0000 10.0000	0.0000	0.00	1.000

* $p<.05$

** $p<.01$

^aLE = left ear; RE = right ear; BE = both ears;
N = noise condition; NN = no-noise condition.

This finding appears to be in accord with the Cullen et al. (1974) binaural summation hypothesis. Comparison of no-noise scores, though, showed no significant difference: left ear mode (LENN) compared to both ears mode (BENN), and right ear mode (RENN) compared to both ears mode (BENN) yielded no significant difference because of perfect scores on all measures ($t=0.00$, $p \ll 1.000$).

Combined groups

Table 11 presents the results of testing hypothesis 3 on combined data from the delayed and advanced groups. Comparison of left ear mode, noise condition (LEN) with both ears mode, noise condition (BEN) yields a highly significant difference: $t=-4.93$, $p \ll 0.000$ in favor of the binaural (both ears) mode of presentation. The right ear mode, noise condition (REN) compared to the both ears, noise condition (BEN) indicated a highly significant difference ($t=-3.56$, $p \ll 0.001$) in favor of the binaural (both ears) mode of presentation.

Table 11. Paired t values and probabilities observed in comparison of monaural and binaural scores. Combined groups.

Variable ^a	Mean	Difference in Means	Paired t	Probability Level
LEN BEN	4.9000 6.1500	-1.2500	-4.93	0.000**
REN BEN	5.0667 6.1500	-1.0833	-3.56	0.001**
LENN BENN	9.7167 9.8500	-0.1333	-1.13	0.261
RENN BENN	9.8667 9.8500	0.0167	0.26	0.799

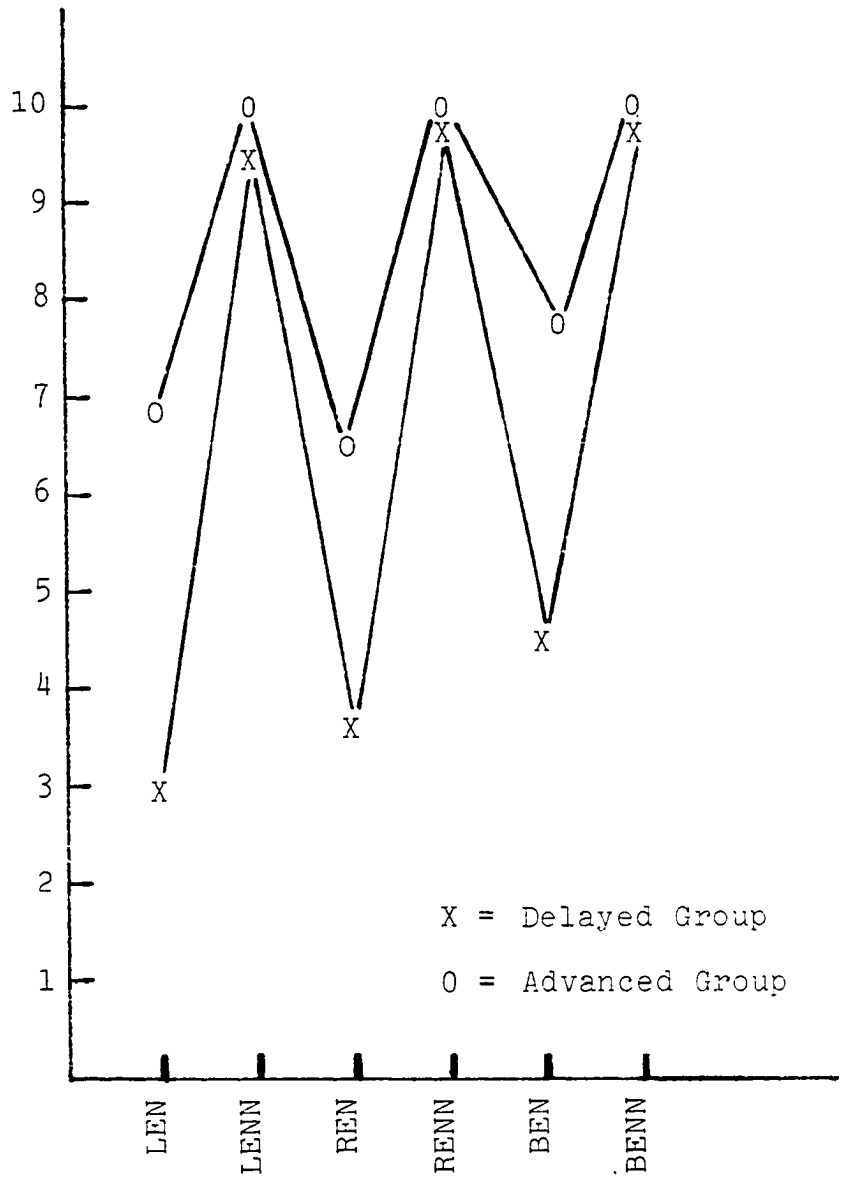
** $p < .01$

^aLE = left ear; RE = right ear; BE = both ears;
N = noise condition; NN = no-noise condition.

Null hypothesis 3 could not be rejected in the comparison of left ear mode, no-noise condition (LENN) with both ears mode, no-noise condition (BENN) ($t = -1.13$, $p < 0.261$); nor could hypothesis 3 be rejected in the comparison of right ear mode, no-noise condition (RENN) with both ears mode, no-noise condition (BENN) ($t = 0.26$, $p < 0.799$) indicating no significant difference in either comparison. The results of analysis of combined groups seem to indicate that binaural listening is superior to monaural listening (left or right) in noise conditions but not in no-noise conditions. These findings sug-

gest that in situations requiring an auditory figure-ground choice (selective attention) listening with both ears may have an advantage over listening with only one ear.

Further illustrations of statistical findings are presented in Figures 1 through 5. Figure 1 shows plotted means for all presentation modes (left ear, right ear, both ears) under both conditions (noise, no noise). It gives a visual representation of differences in delayed and advanced group means on noise and no-noise differences within the groups. In Figure 2 the means totals are plotted to illustrate large and small differences between delayed and advanced groups on total scores: noise total, no-noise total, both ears total, right ear total, and left ear total. Orders of presentation (LRB, LBR, RLB, RBL, BLR, BRL) are illustrated for delayed and advanced groups on left ear scores under noise condition (Figure 3), right ear scores under noise condition (Figure 4), and both ears scores under noise condition (Figure 5). A significant difference was indicated between orders 5 and 6 in the advanced group, and between 1 and 5 in the advanced group as discussed earlier and illustrated in Table 4 and Table 5.



LE = left ear; RE = right ear; BE = both ears; N = noise.

Figure 1. Plotted means: All modes of presentation; left ear, right ear, both ears, under noise and no-noise conditions.

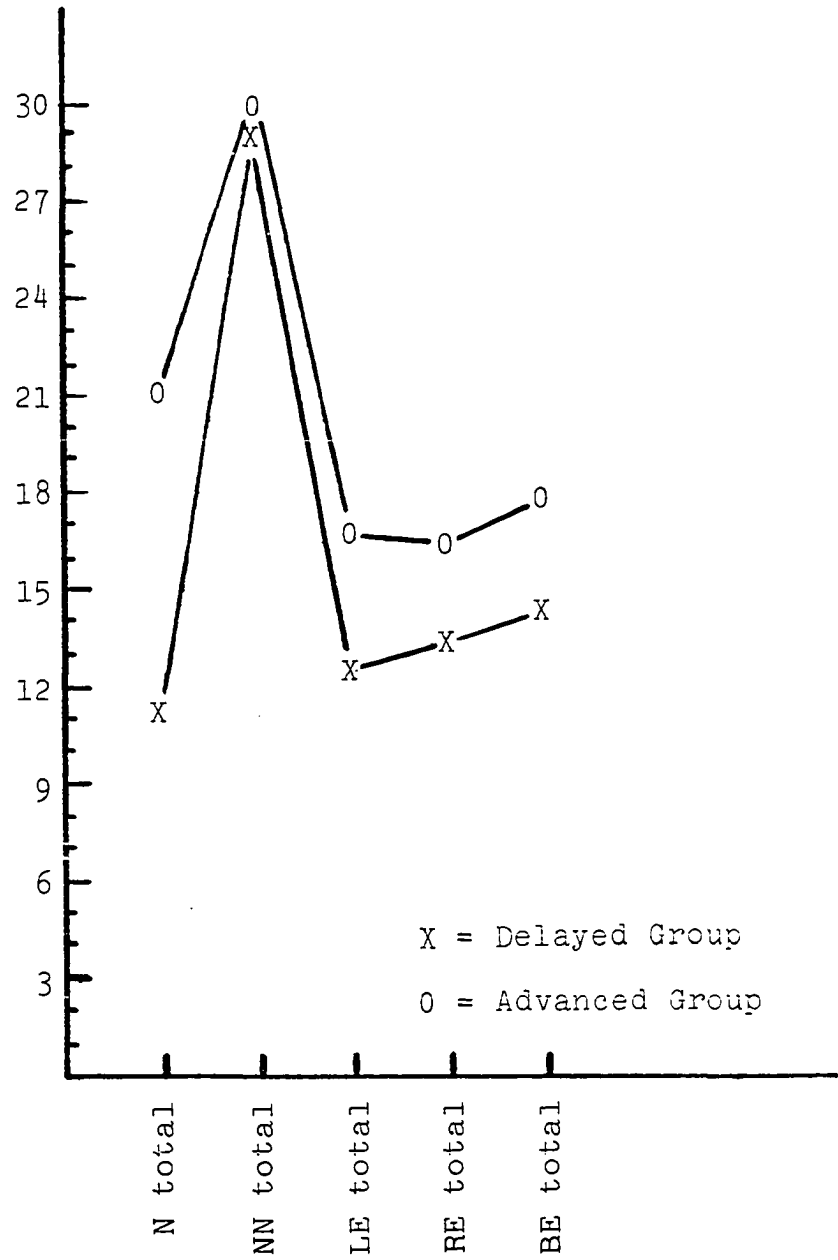


Figure 2. Plotted means: Totals.

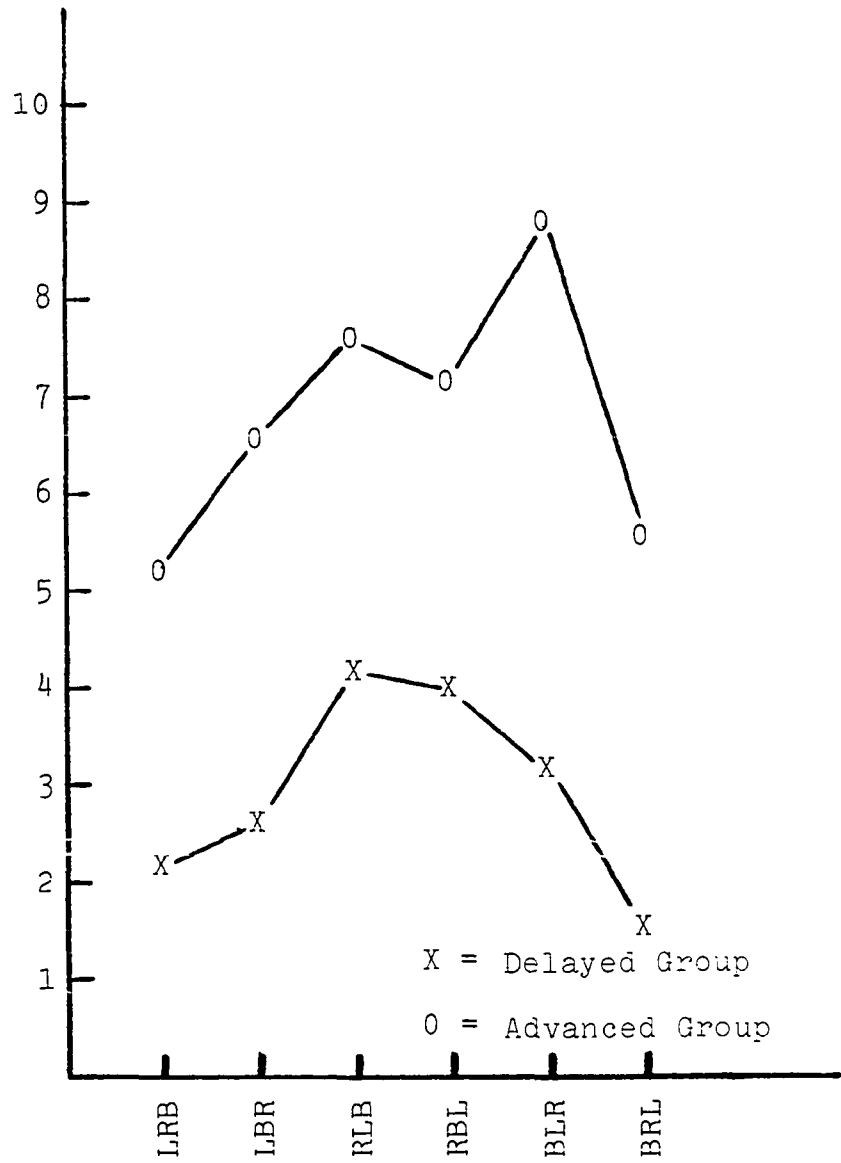


Figure 3. Plotted means: Order of presentation. Left ear scores under noise condition (LEN).

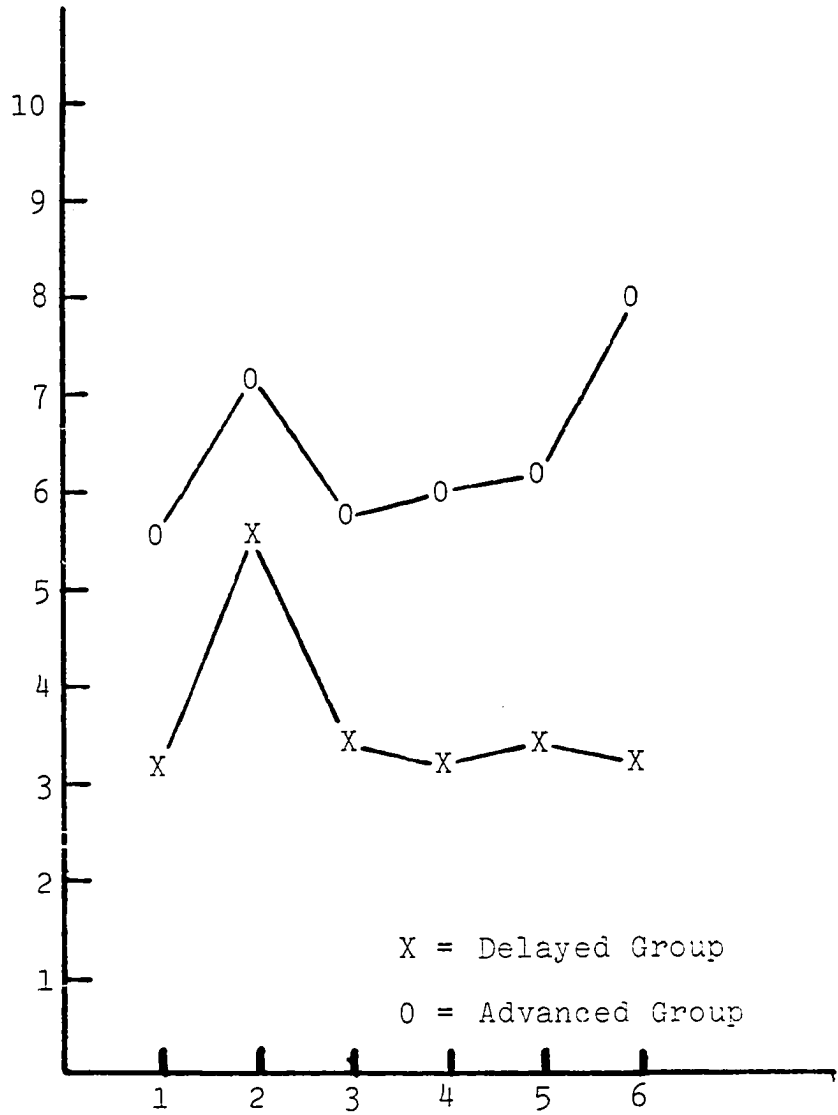


Figure 4. Plotted means: Order of presentation. Right ear scores under noise condition (REN).

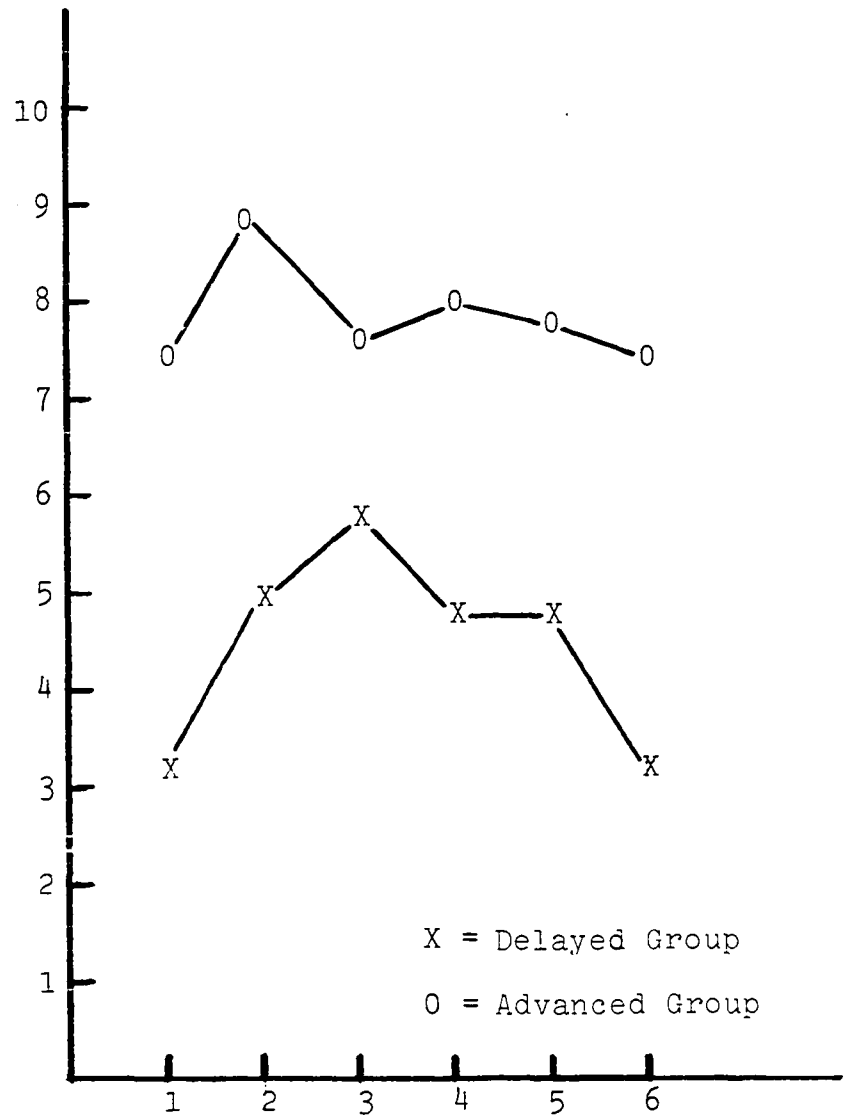


Figure 5. Plotted means: Order of presentation. Both ears scores under noise condition.

DISCUSSION

The discussion is organized into five sections as follows: 1) effects of group and order on performance, 2) differences in mode of monaural presentation, 3) differences between monaural and binaural presentation, 4) limitations of the study, and 5) recommendations.

Effects of Group and Order on Performance

Results of testing null hypothesis 1 indicate a significant difference in performance (between the language delayed preschoolers and those with advanced language development) in terms of auditory figure-ground (selective attention) abilities. This finding per se was expected although the high level of significance ($p < .001$) of the difference was not anticipated. In view of the following observations, however, the significance of the difference might be more easily understood.

During the task presentation sessions it was observed that, in general, children in the advanced group had a tendency to respond to almost all presentations even with a competing noise factor; i.e. they tended to try to "get it right" and to guess when they were not sure. In contrast to this, the delayed group children were less likely to guess, and it seemed if they were not fairly certain of the identification

of the digits they heard that a wrinkling of the brow, some other nonverbal response, or no overt response at all would result. It was also observed that when the advanced group children responded to the items which were accompanied by noise, they had a tendency toward raising the intensity of their voices. When the delayed group made responses to these same items, they seemed to maintain more nearly the same intensity as in their responses to the no-noise presentations. This tendency toward different intensity of response may be just one indication of a general deficiency in the processing of auditory stimuli among the delayed group subjects. On the other hand, an interesting comparison might be made to the increase in vocal loudness (under conditions of noise) called the Lombard voice reflex as described by Martin (1975):

Most hard-of-hearing patients claim they hear and understand speech better in quiet surroundings. The otosclerotic patient (and often patients with other forms of conductive hearing loss) may find that speech is easier to understand in the presence of background noise. This phenomenon results from the fact that normal-hearing persons will speak louder in noisy environments (underlining added for emphasis) Since the otosclerotic patient's hearing loss attenuates to some degree the background noise, he is able to enjoy the increased loudness of a speaker's voice with less distracting noise. p. 251

The important point to be made is that the raising of the intensity of the voice is a normal reaction to background noise, i.e. a reflexive response. Although all children in

this study had normal hearing on a pure tone test, they did not all respond similarly in terms of vocal intensity under noisy background conditions.

Another highly significant effect was attributed to order of presentation in the left ear mode with noise condition. (The other modes showed no significant effect of order of presentation.) Further analysis of variance (one-way) and the use of the Duncan Multiple Range Test (Duncan 1955) indicated that the significant effect was within the advanced group and specifically between order one and order five, and between order five and order six. It is possible that the random assignment of a small number of subjects to each of the six orders of presentation could be responsible for the significant difference between the orders. Order of presentation was built into the design in an attempt to control for this variable. Randomization of subjects assigned to the six different orders might have been more effective with a larger number of subjects in each order subgroup.

Differences in Mode of Monaural Presentation

Statistical analysis indicated no significant difference between left ear and right ear scores, corroborating earlier research findings (Dirks 1964; Kimura 1964; Nagafuchi 1970) of no right ear advantage with monaural presen-

tation of stimuli. The finding of the present study applied to both conditions--noise and no noise. An important point to note here is that there was a "ceiling" or "topping out" effect in the advanced group on the no-noise condition. The fact that all advanced subjects received perfect scores on both left ear and right ear presentations probably caused this finding (for the advanced group) to be of questionable value. The delayed group had something of a "topping out" effect also, in that some subjects got perfect scores, possibly limiting their chances of showing scores which might have been even higher on one ear or the other. The measures on both groups with noise condition, however, seem more reliable; i.e. no one received a perfect score and very few (in the delayed group) "bottomed out" (received a score of zero) on any mode of presentation.

Differences Between Monaural and Binaural Presentations

Hypothesis 3 (no significant difference between monaural and binaural listening) was posed to test the notion of binaural summation (better, more efficient listening performance when both ears are used as compared to either ear alone) (Cullen et al. 1974). The present investigation was also concerned with testing the proposal made by Williford (1976) that sometimes one ear alone can process information

better than both at the same time because of a confusing or distorting effect caused by faulty processing in the other ear. In proposing the existence of this problem, Williford was referring to children with learning disabilities rather than specifically to children with language disorders; but if the problem exists in the one population of children, it may exist in the other since there is often an overlapping of behaviors in these two populations.

Statistical analysis revealed a significant difference between the monaural (one ear) and binaural (both ears) performance on all measures with the noise condition, except for the case of the REN compared with BEN in the delayed group: ($p < 0.115$). The difference that was found was in favor of the binaural presentation, thereby not conforming to the Williford claim but seeming to corroborate the summation hypothesis of Cullen et al. (1974).

One finding that was interesting but inconclusive was that of a difference between the groups on no-noise scores for both monaural (left and right ear) presentations. This finding was not expected and could be indicative of a deficit in auditory discrimination abilities. It should be noted, however, that the significant difference was primarily one of variance and perhaps is a misleading finding since the advanced group all had perfect scores, giving them a variance of

0.0. This "topping out" effect certainly tends to make any findings based on the resulting scores questionable at best.

Limitations of the Study

White noise as a distractor may be less than an ideal variable for this type of study. Although white noise is easily controlled and made consistent from one presentation to another, it may not be the best representation of the kinds of distractors that occur naturally in the ever-changing communication situation that the child faces from day-to-day. Much of the everyday competition for auditory attention will be from speech rather than mechanical noise, as others will be talking within the child's auditory range; e.g. the normal environment in a nursery school room. Such a situation, however, is difficult to control within an experimental design.

The signal-to-noise ratio employed in this study may have resulted in more of a speech discrimination task than was intended. Although the distractor had to be of sufficient strength to give some degree of difficulty to the task, perhaps another type of distractor such as connected speech might have been just as effective in adding difficulty to the task at a lower intensity level.

Every effort was made to remove visual distractions in the present study. It is quite understandable that visual stimuli may be either a help or a hindrance; e.g. the child

might easily be drawn away from an auditory stimulus (speech) because of something interesting happening across the room; or, in the absence of other visual distractions, facial expressions and speech movements could give helpful clues in the understanding of auditory messages. Whether help or hindrance, visual distraction was not a planned part of the study and therefore had to be controlled as closely as possible.

Recommendations for Further Study

With the results of this study in mind and considering the stated limitations, it is recommended that further study be conducted on a similar basis but utilizing several types of distraction stimuli; for example, white noise at varied intensity levels, strings of nonsense syllables, agrammatical sentential material, well-formed sentential material containing a message, and perhaps lists of words or digits. It is further recommended that studies similar to the present one be conducted utilizing a well-controlled free-field situation for presentation of relevant and irrelevant stimuli. In a free-field situation the task can be more natural and can be presented without the disadvantage of using earphones. An important advantage would be that stimuli could be presented in various manners (near field, far field, right field, left field, behind the subject, etc.). This would allow

re-creation of the "cocktail party effect", for instance, which is the kind of situation found in a nursery school environment. This flexibility, of course, would require special facilities and equipment and specially-trained personnel. There is certainly a possibility for grant money to be available for this type of research, or there may be researchers (already equipped with the above-stated necessities but involved in other types of research) willing to cooperate in such an undertaking.

An interesting variation in design might involve introducing background noise at different intensity levels and different levels of complexity; i.e. less people talking, more people talking, etc. A replication of the Putzer and Friedlander (1970) study with varied background noises such as those mentioned above along with simple tasks being explained by the television "teacher" for the children to perform might be another approach to try in a future study. Although this type of study would not perfectly account for a child's figure-ground abilities or for reception/perception abilities in general, it would give some idea (through a child's responses) of how much of the message has been received and processed through the auditory channel. Of course, one group of language-delayed children could be given the clear auditory instructions with no visual instructions treatment

(with teacher using no gestures while explaining the task) and another group could receive much visual instruction (gestures and other visual, nonverbal information) with no (or degraded) auditory instructions treatment. Still another group could receive clear instructions (no interference) on both visual and auditory channels. A comparison could then be made of the three treatments to see which one seems to be most effective for language delayed children.

Replication of the present study is encouraged, and the following recommendations are offered for expansion of the basic design of the study: 1) several age groups might be used instead of just one (e.g. ages three, five, seven, nine and eleven) to test for age trends of figure-ground abilities; 2) various types of background competition (e.g. those suggested earlier in this chapter) could be used to see what kinds of noises or verbal competition are the most effective distractors, and to compare these findings to those of Berlin et al. (1976); 3) more than one type of verbal "figure" could be utilized (e.g. digits, words, consonant-vowel syllables, etc.) as suggested by previous studies and the verbal stimuli could be completely randomized to account for all possible combinations; 4) more subjects could be used in each subgroup (order of presentation) in an attempt to prevent the possible weakness of relatively small numbers as in the present study.

Further study of language delayed and normal children is recommended with regard to the Lombard voice reflex phenomenon. The research question might be: Is there a significant difference between language delayed and normal preschoolers in terms of level of vocal intensity in the presence of loud background noise? Also, a group of language delayed normal-hearing children might be compared to children with mild and moderate hearing impairments to test for similarity in vocal responses in the presence of loud background noises. Research in motivation among preschoolers with language delay seems to also be indicated by the findings and observations of this study; i.e. a highly significant difference was found between the delayed and advanced groups on auditory figure-ground performance, and it was observed that advanced group children tended to try to "get it right" while the delayed language children seemed to not make an attempt when the listening became difficult.

SUMMARY

The present study was designed to investigate the effects of noise as a distractor on the auditory figure-ground (selective attention) abilities of preschool children with language comprehension deficits. It was hypothesized that children with language delay might have that delay because of an inability to filter out or inhibit irrelevant auditory stimuli. The study posed the following questions:

- 1) Is there any significant problem with auditory selective attention among preschoolers with delay in language development as compared to preschoolers with normal language development?
- 2) Is there any significant difference between the left ear and right ear in performance on auditory selective attention tasks among normal preschoolers or among those with delay in language development; i.e. can a right ear advantage for verbal material be demonstrated in monaural presentation with these groups?
- 3) Is binaural listening significantly better (or worse) than monaural listening as reflected in performance scores on the auditory selective attention task?

Subjects were 60 normal-hearing preschool children (30 with delayed language development, 30 with advanced language development) between the ages of 56 months and 72 months, who were selected on the basis of percentile rankings

on the Screening Test for Auditory Comprehension of Language (Carrow 1975). Those children ranking below the 20th percentile were selected for the delayed group and those ranking above the 80th percentile were selected for the advanced group.

Each group (delayed and advanced) was presented through three different modes (left ear, right ear, and both ears), paired digits under two conditions (without auditory distraction and with auditory distraction in the form of broadband "white" noise). Each child in each group received exactly the same auditory stimuli as every other child. Only the order of mode of presentation was different; i.e. the children in each group were randomly assigned to six subgroups in an attempt to control for the order of presentation variable.

Each subject was asked to repeat the digits that were heard (20 in each mode; ten with noise, ten without noise). Subjects were told that some digits would be difficult to hear because of the noise; they were asked to listen closely and do the best they could. A brief orientation to the task was provided.

Three null hypotheses were generated and tested to answer the questions posed by the study:

- 1) There is no significant difference between delayed and advanced group performance on an auditory figure-ground (selective attention) task.

- 2) There is no significant difference between left ear and right ear performance with or without the presence of noise as an irrelevant stimulus.
- 3) There is no significant difference between monaural (left or right ear) and binaural performance with or without the use of noise as an irrelevant stimulus.

Results of testing hypothesis 1 by analysis of variance yielded a highly significant difference between delayed and advanced groups on left ear mode of presentation with noise, right ear with noise, and both ears with noise. This finding indicated that the delayed group children had a significantly lower performance than the advanced group in dealing with auditory figure-ground (selective listening) tasks; i.e. they appeared to have some difficulty in attending closely to the relevant verbal stimuli (digit pairs) in the presence of noise.

Null hypothesis 2 could not be rejected, indicating no significant difference between left and right ear performance, with noise and without noise. This finding suggests that a right ear advantage did not result from monaural listening with the children in this study.

Results of the testing of null hypothesis 3 indicate a significant difference between monaural (left or right) and binaural performance under the noise condition, suggesting

the superiority of binaural abilities over monaural abilities in auditory figure-ground choice. No significant difference was found between monaural and binaural performance under the no-noise condition.

In summation, the initial finding of this study can be interpreted to indicate that a significant problem in auditory figure-ground abilities may exist in language delayed preschoolers. This finding suggests a need for early assessment to identify children with the auditory figure-ground problem and to provide a basis for early intervention to remediate deficits and possibly prevent academic retardation. Second, the left ear performance does not appear to be significantly different from right ear performance on an auditory figure-ground task, conforming with findings of earlier studies of no right ear advantage in monaural listening. Third, binaural listening appears to be superior to monaural listening on an auditory figure-ground task, conforming with the binaural summation notion of interaction between the processing functions of the two ears.

Further research in auditory figure-ground abilities of preschoolers is recommended, using varying and various stimuli for both figure and ground, and utilizing larger samples of children in an attempt to better control for the order of presentation variable. The need for further study

is indicated in the case of an informally observed difference between delayed and advanced groups with regard to the Lombard reflex (raising of vocal intensity in the presence of loud background noise). There also seems to be sufficient reason for recommending a study of motivation among preschoolers with language delay, as indicated by the highly significant difference in auditory figure-ground performance, and the observation that the advanced group seemed to be more highly motivated than those in the delayed group on the auditory figure-ground task.

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APPENDIX A: PARENT PERMISSION REQUESTS

Department of Speech
Pearson Hall
Ames, Iowa 50011

IOWA STATE
UNIVERSITY

Telephone: 515-294-1117

Dear Parents:

I am presently involved in a research study in child language development. The particular type of study I am doing requires that I work with boys and girls who are approximately 5 years of age. The purpose of this letter is to describe my research for you, and to request permission to include your child in the study. I have 17 years experience working with children and am a certified speech pathologist (therapist).

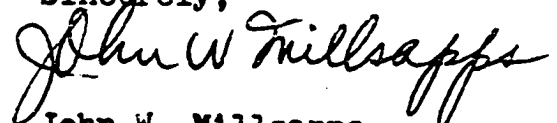
Working with a group of children with slow language development and a group with "normal" language development, I hope to find out if there is any significant difference between the 2 groups in ability to attend to and repeat words when a distraction (noise) is present. It is possible that the results of this study could add to the understanding of problems in language and speech development and may therefore be helpful in planning therapy for children with slow-developing speech and language.

Each child participating in the study will be given a language development test and a hearing test. Later, each child will be asked to listen to some pairs of numbers presented through earphones connected to a tape recorder. Some of the numbers will be spoken without distraction (noise) and some will be spoken with distraction (noise) on the tape at the same time. Each child will be prepared beforehand for what he/she will be hearing so that the noise will be no surprise to him/her, and so that he/she will try to pay attention to the spoken numbers. This task itself should take no more than 1/2 hour per child.

Your child's name will not appear on any statistical evaluations or in any discussion of results. Individual findings will be held in strictest confidence. If you have any questions about the study, please leave a message with your child's teacher and I will contact you when I am in the area. Or write to me at 320 Pearson Hall, Iowa State University, Ames, Iowa 50011.

Thank you for your cooperation.

Sincerely,



John W. Millsapps
Assistant Professor of
Speech Pathology

IOWA STATE
UNIVERSITY

Department of Speech
Pearson Hall
Ames, Iowa 50011

Telephone: 515-294-1117

Date: _____

I do/do not give permission for my child, _____,
(circle one) name of child
to participate in the language development study being
conducted by John W. Millsapps.

Signed _____
parent or guardian

APPENDIX B: RESPONSE RECORD SHEET

Name _____ Group _____
 B.D. _____ Hearing (P.T.) _____
 Language Score _____ Score (Left ear) _____
 %ile ranking _____ Score (Right ear) _____
 Date _____ Score (Bilateral) _____
 Score (Overall) _____

<u>List A</u>			<u>List B</u>			<u>List C</u>		
L	R	B	L	R	B	L	R	B
1.	_____	*	1.	_____		1.	_____	
2.	_____		2.	_____	*	2.	_____	*
3.	_____		3.	_____		3.	_____	
4.	_____		4.	_____		4.	_____	*
5.	_____	*	5.	_____	*	5.	_____	
6.	_____		6.	_____		6.	_____	*
7.	_____	*	7.	_____	*	7.	_____	
8.	_____	*	8.	_____	*	8.	_____	
9.	_____	*	9.	_____		9.	_____	*
10.	_____	*	10.	_____	*	10.	_____	*
11.	_____	*	11.	_____		11.	_____	
12.	_____		12.	_____		12.	_____	*
13.	_____	*	13.	_____		13.	_____	
14.	_____		14.	_____	*	14.	_____	*
15.	_____		15.	_____		15.	_____	*
16.	_____		16.	_____	*	16.	_____	
17.	_____	*	17.	_____	*	17.	_____	
18.	_____		18.	_____	*	18.	_____	
19.	_____		19.	_____	*	19.	_____	*
20.	_____	*	20.	_____		20.	_____	*

(* = noise)

APPENDIX C:
MEANS AND STANDARD DEVIATIONS OF LANGUAGE SCORES

Means and standard deviations of scores on the Carrow Test of Auditory Comprehension of Language. Delayed language and advanced language development groups.

Group	N	Mean Score	Standard Deviation
Delayed	30	11.37	2.05
Boys	19	11.53	2.35
Girls	11	11.09	1.38
Advanced	30	20.97	1.95
Boys	16	21.00	2.29
Girls	14	20.93	1.83

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