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LANGUAGE SKILLS OF CHILDREN WITH
DEVELOPMENTAL DYSPHASIA.

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DEVELOPMENTAL DYSPHASIA

by

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A dissertation submitted to the Graduate
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Abstract

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Donna J. Thal

Advisor: Professor James K. Lang

This experiment was undertaken to measure the performance of children with developmental dysphasia with respect to tone identification and tone sequencing tasks; and to measure the correlation between their performance on tone tasks and their performance on three widely used measures of language skills.

Subjects were eight children with symptomatology of developmental dysphasia who ranged in age from four years two months to eight years one month, and eight normal children matched for age.

Stimuli were two complex tones composed of

frequencies within the speech range. Tone 1 had a fundamental frequency of 100 Hz and tone 2 had a fundamental frequency of 304 Hz.

Implementation of the research plan required that subjects press one or the other of two panels in order to identify which of the two tones was heard. This was done under conditions of experimenter intervention which differed by presence versus absence of the experimenter and use versus non-use of words as cues. If subjects responded above criterion level in the no cue condition of the tone identification task, they were required to perform a task in which a sequence of two different tones was presented. In that task, they had to press two panels in a sequence which corresponded to that of the tones. The sequencing task was also presented under different conditions of experimenter intervention.

When subjects completed the experimental tasks, a language sample was taken following the procedure described by Tyack & Gottsleben (1974) and mean length of utterance was calculated. In addition, the Assessment of Children's Language Comprehension (Foster, Stark and Giddan, 1973) and the Token Test (DeRenzi and Vignolo, 1962) as modified by Whitaker and Noel (1972) were administered. Scores on the language tests were then compared to scores on the tone tests using the Spearman Rank Correlation Coefficient.

Results were as follows:

1. Over half of the dysphasic subjects performed

above the .01 confidence interval only in conditions in which words were used as cues. For those subjects, scores were significantly higher in word cue conditions.

2. Pooled data from dysphasic subjects were not predictive with regard to the language performance of any individual subject.

3. Normal subjects, as a group, performed better than dysphasic subjects, and pooled data were more predictive of the performance of individual normal subjects.

4. Two normal subjects failed to respond above the .01 confidence interval in some conditions of the tone identification task. These subjects performed significantly better in conditions in which words were used as cues.

The results of this study may be interpreted as providing support for the viewpoint (Rees, 1973) that non-linguistic stimuli are not appropriate stimuli for studies which are intended to provide answers to the problems of language impaired children. They also support the opinion which favors the use of linguistic stimuli for early teaching of language to at least some dysphasic children. Similarly, results from this study cannot be interpreted as supporting the notion that non-linguistic discrimination skills, such as those tested with non-linguistic tone stimuli, are necessary precursors to normal language development.

One value of this study is that it provided a methodology which allows the experimenter to focus on

individual subjects and how their performance is changed by changes in the environment. This kind of information can be directly applied to a clinical setting for diagnosis or treatment. It is possible, therefore, that the methodology used in the present experiment may be more useful for research which is intended to supply clinically relevant information than statistical analysis based on pooled data from a small number of subjects.

Future research might continue to examine the kinds of environmental stimuli which change subject performance. Examination of the relationship of performance on tasks which employ synthetic speech stimuli and performance on tests of language skills might be of particular interest. Various units of natural speech might also be examined in an attempt to identify which units are discriminated best. Examination of some of the more subtle aspects of experimenter intervention may also provide information which will prove useful clinically.

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Chapter 1

OBJECTIVES OF THE RESEARCH

INTRODUCTION

Goals of the Research

Problems of auditory processing have been widely assumed to be the basis of the disorders seen in language impaired children (Myklebust, 1954; Monsees, 1961; Wilson, Doerhing and Hirsh, 1960; McGinnis, 1963; Chalfant and Flathouse, 1971; Eisenson and Ingram, 1972). This is particularly true for children who have been labeled developmentally dysphasic.¹ It has been suggested, for example, that the basis for the deficit in dysphasic children may be found in temporal sequencing abilities (Hirsh and Sherrick, 1961; Lowe and Campbell, 1965; McReynolds, 1966; Stark, Poppen and May, 1967; Aten and Davis, 1968). Others (Tallal and Piercy, 1973a, 1973b) suggest that the problem is a basic deficit for processing sounds of short duration. Still others (Malone, 1967; Rees, 1973) suggest that, in both normal and language deficient

¹While there are many labels which can be used to describe language impaired children, much of the literature refers to them as "developmentally dysphasic". For purposes of consistency and brevity, the term dysphasic shall be used to refer to developmentally dysphasic children in this dissertation.

individuals, there is no relationship between the auditory deficits identified by the researchers cited above and linguistic skills.

The first goal of the present research involved measurement of the tone identification and sequencing skills of dysphasic children. The question was, would dysphasic children be able to identify and to indicate the order of two complex tones. Based upon earlier studies with such children, it was suspected that dysphasic subjects would be able to identify two tones which differed in pitch, but that some such subjects would fail to correctly indicate the order of the same two tones.

The second goal of this research involved examination of the kinds of experimenter intervention which would be effective in modifying the performance of dysphasic children on auditory perceptual tests. The question was whether experimenter intervention, which contrasted in terms of (1) presence versus absence of experimenter and (2) linguistically cued versus non-cued trials, would change the performance of dysphasic subjects on a tone identification and a tone sequencing task. It was suspected that these variables of experimenter intervention might result in different percentages of correct responding.

The third goal of the present research involved a comparison of individual responses versus the pooled data of dysphasic subjects with respect to auditory perceptual tests. Specifically, the experimenter wanted to determine whether

data pooled across experimental subjects would suggest interpretation of results which are different from interpretations based on individual data. It was suspected that interpretations of results suggested by pooled data might differ from interpretations suggested by data for individual subjects. The objective was to identify these differences with a view toward altering contemporary clinical approaches to dysphasic children.

The fourth goal of the present research involved a comparison of the scores of normal versus dysphasic subjects with respect to auditory perceptual tests and to make this comparison using both individual data and data for the entire group. The question was whether there would be a difference between the performance of normal subjects and dysphasic subjects on a tone identification and a tone sequencing test. An additional question was whether pooled data would be more representative of individual data of the normal subjects or individual data of the dysphasic subjects. It was suspected that normal subjects would perform better than dysphasic subjects on both tone identification and tone sequencing tests, and that pooled data would be more representative of individual normal subjects than of individual dysphasic subjects.

The fifth goal of the present research involved measurement of the relationship between the tone test results and scores of dysphasic subjects on tests of language skills. The question was whether the scores of dysphasic subjects on

a tone identification and a tone sequencing test would correlate significantly with their scores on tests of receptive and expressive language. It was suspected that there would be a correlation between the tone test scores and the language test scores.

Relationship of the Research to Existing Research

The present writer is aware of only one study in which attention was focused on changes in auditory stimuli which may be used to help dysphasic children learn an auditory processing task (Stark, Poppen and May, 1967). This study is reviewed on page 11. The present research is related in that it was designed as a study of changes in stimulus conditions which facilitate or impede learning of tone identification and tone sequencing skills. In the present research, however, focus was placed on the kinds of experimenter intervention which affect performance rather than on the physical dimensions of the stimulus which characterized the study by Stark, Poppen and May (1967). This focus was expected to allow generalization to the client-clinician relationship.

Many researchers have used pure tones (Hirsh, 1959; Efron, 1963; Lowe and Campbell, 1965) or complex tones (Tallal and Piercy, 1973a, 1973b) to test auditory processing skills in language impaired subjects. All of these investigators generalized from the tone test findings to language. For example, Tallal and Piercy (1973a, 1973b)

interpret the scores of dysphasic subjects on tone tests as supporting the hypothesis that a discrimination disorder for sounds of short duration is the cause of the language deficit found in such subjects. The present writer has found no research in which the presumed relationship between tone test results and language skills of dysphasic children has been critically appraised. Measurement of a correlation between scores of dysphasic subjects on a tone test and their scores on a test of digit sequencing was found in one study (Stark, Poppen and May, 1967). Although the authors interpreted these results as indicating a relationship between memory for sequences and language skills, such an interpretation is equivocal. A more detailed discussion of this study may be found on page 11.

Malone (1967) demonstrated that normal adult subjects could indicate correctly the order of words in sentences at rates twice as fast as they could for pure tones. His results may be interpreted as suggesting that tone tests do not adequately assess the skills required for appropriate use of language. Rees (1973) also claims that there is no published evidence that tone test results have any relationship to language skills. The present writer has found no other published data concerning this relationship, particularly as it relates to language skills of dysphasic children. The present research was designed to provide such data.

Interpretations based on pooled data of a small

number of subjects have been presented in studies of the auditory processing skills of dysphasic children (McReynolds, 1966; Weiner, 1969; Tallal and Piercy, 1973a, 1973b). Stark (1966) notes the highly individual nature of language performance, particularly among dysphasic children. His work may be interpreted as suggesting that analysis of individual data obtained from such children is necessary for providing appropriate remediation services. May (1967) also noted the highly variable nature of responses of dysphasic children. In his study of discrimination learning in dysphasic subjects, he offered more information than other researchers by providing both pooled and individual data. The present writer has attempted to go a step further than May (1967) by analyzing individual and pooled data and then comparing these two analyses to see which would provide the most clinically useful information.

IMPORTANCE OF THE STUDY

Earlier studies in which pure and complex tones were utilized as stimuli did not critically analyze the relationship between the auditory skills tested by the tone tests and the language skills which were, presumably, dependent upon these auditory skills. In spite of this lack, a relationship was assumed to exist and therapeutic and diagnostic procedures were designed and implemented based upon this assumption. The present research is important because it was designed to provide data which would

demonstrate whether such a relationship exists. If it does, the significance of the relationship for predicting language skills can be measured.

Another value of the present research is that it was designed to explore some of the kinds of experimenter-child interaction which may facilitate or impede the child's ability to learn to respond correctly in auditory discrimination and sequencing tasks. This is clinically relevant information which may be directly applied to the design of diagnostic and therapeutic procedures.

Finally, it has been noted that research may be judged useful to the degree that it provides researchable questions (Sidman, 1960). The present study has served to stimulate the formulation of questions which should be the subject of future research. These questions are discussed more fully on pages 95 to 97.

Chapter 2

LITERATURE REVIEW

INTRODUCTION

In undertaking the present study, the investigator was concerned with the determinants of the deficits of language performance which are exhibited by dysphasic children. In order to carry out such a study, a number of decisions had to be made concerning definition of the behavior to be studied, selection of stimuli, choice of subjects, design of methodology and evaluation of data. The research of others was helpful in making these decisions. This chapter will organize the discussion of the pertinent research around the topics noted above.

DEFINITION OF BEHAVIOR TO BE STUDIED

Many researchers have been concerned with the determinants of the language deficit found in dysphasic children. It attempts to identify those determinants, some researchers focused on auditory and/or visual sequencing skills. Others studied auditory perception. The results of those studies have fostered many questions while interpretations of the results have frequently been controversial. Many research findings, for example, have

been interpreted as indicating deficits in sequencing or discrimination skills which were presumed to be prerequisites for normal language acquisition (Lowe and Campbell, 1965; Stark, Poppen and May, 1967; Poppen; Stark, Eisenson, Forrest and Wertheim, 1969; Tallal and Piercy, 1973a, 1973b, 1974, 1975). Numerous testing and teaching procedures have been based on those interpretations. Others (Rees, 1973) argue that research data suggest that the disorder found in dysphasic children is linguistically based. She claims that non-linguistic skills such as discrimination and sequencing are not functionally related to language skills. To the present writer's knowledge, no study has demonstrated such a relationship between results on discrimination and sequencing tasks and the language performance of the subjects. Demonstration of a functional relationship should be considered to be an essential feature of research findings if the research is to be a basis for development of tests and training procedures which are designed to have language skills as their specific focus. This section of the literature review will examine some of the studies in which auditory and/or visual sequencing skills and auditory discrimination skills of dysphasic subjects were studied. Results of these studies will be discussed in terms of their relationship to the language skills exhibited by the subjects used in those experiments. Reviewing the literature in this fashion helped the writer to decide what behaviors to study in the present experiment, and clarified the need to

establish some measure of correlation between those behaviors and language skills.

Sequencing Skills

A large number of researchers have obtained data which support the belief that dysphasic subjects, both adult and developmental, cannot identify auditory and/or visual sequences of stimuli as accurately as non-dysphasic subjects. Efron (1963), for example, studied the ability of dysphasic adults to identify sequences of two pure tones which differed in pitch, and two pulses of light which differed in wave length. The stimuli were separated by various intervals of time from 0 to 600 msec. Results showed that dysphasic subjects, as opposed to non-dysphasic subjects, required significantly longer intervals in order to identify sequences correctly. No convincing relationship has been found, however, between these scores and the language deficits of the dysphasic subjects. In fact, Efron (1963) found that expressive dysphasics required significantly more time to identify auditory sequences than did receptive dysphasics, whereas the reverse was true for visual sequences. These results cannot be taken to indicate the existence of a relationship between pure tone auditory sequencing and language skills since those subjects who performed least accurately on auditory sequencing tasks had the least deficit with respect to speech skills. Efron (In Millikan and Darley, 1967) emphasized this point in discussing his results (Efron, 1963). He stated that the deficit of

auditory sequencing found in his subjects was not related to how well they comprehended spoken language. He did not, however, provide any quantitative support for this assertion.

Efron's (1963) study stimulated a similar study by Lowe and Campbell (1965). They compared eight dysphasic and eight normal children with respect to their skill in identifying sequences of two pure tones which differed in pitch. The length of the interstimulus interval at which the sequence was identified correctly in 75 percent of the trials was measured as the interval of time between the two tones was varied. Results showed that, in contrast to the normal subjects, the dysphasic subjects required significantly longer interstimulus intervals in order to accurately identify sequences of two pure tones. This finding is in agreement with that of Efron (1963). Lowe and Campbell, however, interpret their findings more broadly. They state (apparently without support in their own findings), ". . . the temporal ordering malfunction of the aphasoid child. . . may be a major factor contributing to his communication problem." This does not take into consideration the other findings of Efron (1963) which suggest a lack of relationship between tone sequencing failures and language skills.

The effects of stress on the identification of sequences of single syllable nouns was studied by Stark, Poppen and May (1967). Subjects were required to match an

auditory presentation of three nouns to line drawings of those nouns which were projected onto depressible panels. To be considered correct, panels had to be depressed in the same order as the order in which the words were presented. The Auditory Vocal Sequencing subtest (AVS) of The Illinois Test of Psycholinguistic Abilities (McCarthy and Kirk, 1961) was also administered. Results showed that three of the eight dysphasic subjects obtained scores as high as the eight normal subjects. The other five dysphasic subjects made significantly more errors than either the normal subjects or the three successful dysphasic subjects. The five dysphasic subjects who performed poorly experienced 75 percent of their errors in the first position of the sequence. For these subjects it was found that stress (increasing volume) of the first item significantly improved performance. This improvement, although statistically significant, may not indicate any real sequencing ability. Stress improved scores from 38 percent correct to 46 percent correct. More than half of the subjects' responses, therefore, were still incorrect. Scores on the AVS were significantly lower for the entire group of dysphasic subjects as compared to the normal subjects. In addition, a rank order correlation between the AVS raw score and the total number of correct responses on the experimental sequencing task was 0.66 (significant at the .10 level of confidence) for the dysphasic subjects and 0.26 (not significant) for normal subjects. Stark, Poppen

and May (1967) state that their findings can be interpreted as suggesting that ". . . the essence of the difficulty that aphasic children have in decoding and encoding language may be related to an impaired auditory memory for sequences". Viewed somewhat differently, a very different interpretation can be made. The correlation between the AVS raw scores and the number of correct responses on the experimental sequencing task demonstrates no relationship for normal language users. This can be interpreted as supporting the hypothesis that digit repetition skills (AVS) and auditory visual sequencing skills such as those tested by Stark, Poppen and May (1967) are not related to normal language use. The significant correlation between poor digit repetition skills (AVS) and poor auditory-visual sequencing skills found in dysphasic subjects does not demonstrate a causal relationship between poor sequencing skills and language usage since specific language skills were not variables in the statistical calculations. It should also be noted that correlation procedures do not provide a basis for testing the hypothesis of a causal relationship. In addition, the success of three of the eight dysphasic subjects argues against the interpretation of Stark, Poppen and May (1967). Those subjects, who are by definition language impaired, demonstrated language impairment in the absence of a significant sequencing deficit.

A more direct attempt to relate language and non-language sequencing tasks was made by Aten and Davis (1968).

They studied the performance of neurologically impaired children on three pure tone sequencing tasks and seven tests which employed linguistic stimuli. Neurologically impaired subjects exhibited significantly lower scores than normal controls on the three pure tone tests and on four of the tests which employed linguistic stimuli. The tests were: indicating the number of times a tone was presented by pointing to a card with the corresponding number of dots, indicating the number of times a tone was presented by saying "beep" the same number of times, indicating the duration of a tone by pointing to a block of corresponding length, identifying a sequence of nouns by putting pictures of the nouns in the same order, repeating three, four, and five syllable words, and making correct sentences out of scrambled sentences. Neurologically impaired subjects exhibited scores which were as good as normal subjects on three of the seven tests which used language stimuli. These were: repeating sequences of two to six nonsense syllables, repeating digits forward, and recalling a paragraph. The authors interpret their results as supporting the hypothesis that the incapacity for temporal ordering is a result of neurological impairment. This conclusion does not appear to be justified based on the results of the nonsense syllable and digit repetition tests. Of more interest to the present writer, however, is the fact that a number of tests which employed linguistic stimuli were performed successfully by neurologically impaired subjects while the

tone sequencing and other linguistic sequencing tasks were not. This suggests that there is no simple relationship between sequencing skills and observed language performance. The nature of that relationship, and even its existence, was not explored by Aten and Davis (1968).

The responses of dysphasic children on tasks requiring identification of sequences of speech and non-speech stimuli were compared to those of normal children by Rosenthal (1972). He compared vowel-vowel sequences to high pitch pure tone-low pitch pure tone sequences and vowel-affricate sequences to pure tone-noise sequences. Results showed that all subjects demonstrated a higher percentage of correct responding at all interstimulus intervals for sequences of speech stimuli than for non-speech stimuli. Normal subjects achieved higher scores than dysphasic subjects for all tasks. Rosenthal (1972) also compared responses to fricative-fricative sequences and fricative-affricate sequences. Results showed that dysphasic subjects demonstrated higher scores for the fricative-fricative pair whereas normal subjects demonstrated higher scores for the fricative-affricate pair. In other words, the dysphasic subjects demonstrated higher scores when linguistic cues were defined by the distribution of spectral energy whereas normal subjects demonstrated higher scores when linguistic cues were conveyed by temporally coded distinctions. This was noted as the major finding although no indication of statistical significance was given. Based

on these results, Rosenthal (1972) suggests that some kind of sequencing disorder is implicated in developmental dysphasia. The differences between scores in the presence of speech and non-speech stimuli suggest some other factor, however. As with the other research cited, no direct relationship between the subjects' language skills and results of the sequencing tasks was measured.

In a study of auditory-vocal and oral-motor functioning, Weiner (1969) found that dysphasic subjects received significantly lower scores than normal subjects on tests requiring repetition of a series of vowels and repetition of sentences of increasing length. Weiner (1969) analyzed the kinds of errors made by his dysphasic subjects and found that, when subjects could recall and reproduce the vowels or words, they seldom confused vowel or word order. Errors were usually the omission of correct elements or the substitution of incorrect ones. Weiner (1969) notes that this does not support the idea that the dysphasic subject suffers from a basic sequencing deficit, since his subjects did not confuse the order of the stimuli. This is clearly in disagreement with the interpretations of Lowe and Campbell (1965) and Stark, Poppen and May (1967). Again, however, no attempt was made to directly measure the relationship of scores on the experimental tasks with respect to a measurement of language skills.

Furth (1964) compared scores of normal, deaf, and dysphasic children on tasks requiring the learning of visual

sequences of nonsense figures. Results demonstrated no significant differences between scores for any group of subjects. Based on his results, Furth concluded that, he ". . . cannot state that a sequencing deficiency was demonstrated for dysphasic children or that sequencing performance differentiated deaf from dysphasic children". He noted that his results do not support the notion of a generalized sequencing deficit.

Poppen, Stark, Eisenson, Forrest and Wertheim (1969) performed a series of studies in which they measured the visual sequencing skills of dysphasic children. Their first experiment was essentially a replication of study by Stark, Poppen and May (1967) except that visual stimuli were used in place of auditory stimuli. The dysphasic subjects demonstrated a 75 percent correct response rate for visual sequences as opposed to the 40 percent correct response rate found in the earlier (Stark, Poppen and May, 1967) study which employed auditory stimuli. The largest percent of errors was on the first item of the sequence but stress on that item (by changing color) did not improve performance. The second finding is not in agreement with the findings of Stark, Poppen and May (1967). In the second experiment, delays of 2, 9, 17 and 27 seconds were imposed between presentation of the stimulus sequence and the subjects' responses. Results indicated that dysphasic subjects made significantly more errors than normal subjects regardless of delay. Errors increased with increases in

delay for all subjects, but delay resulted in more errors in the performance of dysphasic than in the performance of normal subjects. The majority of errors occurred in the first position. Rank order correlations were computed between the number correct on the experimental visual sequencing task, chronological age, and the following standardized tests of sequencing skills: The Auditory Vocal Sequencing (AVS) and the Visual Motor Sequencing (VMS) subtests of the Illinois Test of Psycholinguistic Abilities (McCarthy and Kirk, 1961), the Knox Cube Tapping Test (Arthur, 1947) and the Auditory Vocal Sequencing with Language (AVSL) test. The latter was an adaptation of the AVS in which single syllable nouns replaced digits. Significant positive correlations were found for dysphasic subjects between the experimental visual sequencing task and the AVS and between the experimental visual sequencing task and the AVSL. No significant correlation was found between the experimental visual sequencing task and the VMS. Results of the correlation for normal subjects demonstrated significant correlations between the experimental visual sequencing task and the AVS, the AVSL, the Knox Cube Tapping Test and Chronological age. No correlation was found between the experimental visual sequencing task and the VMS. Poppen, Stark, Eisenson, Forrest and Wertheim (1969) attempt to explain the lack of correlation between the experimental visual sequencing task and the VMS by suggesting that their subjects used verbal

mediation in the experimental task. A number of problems arise from such an explanatory attempt. First, their interpretation assumes that no verbal mediation occurred on the VMS. There is no justification for assuming that such mediation occurred in one visual sequencing task but not on another. Second, since no measurement of such mediating stimuli was made, invocation of such to explain an incomprehensible result is not justified. The authors interpret their results as supporting the notion that there is a general sequencing ability which is deficient in developmentally dysphasic children. They state that ". . . the fact that aphasic children have problems with visual sequences, as well as with auditory sequences, suggests that there may be an underlying deficit which explains their language and learning difficulties". These data disagree with those of Furth (1964). Additionally, there was no measurement of relationship between scores on the experimental sequencing tasks and scores representing language skills. Their data exhibited only a correlation between scores on one visual sequencing task and scores on two tests of word repetition. Since correlation does not demonstrate causality, an assumption of such is unjustified. In addition, there is no way to determine whether the correlation had anything to do with the linguistic nature of the words used in the AVS and AVSL tests, or if it was due only to the almost mechanical similarity between performing a simple motor sequence to identify something

seen or something heard.

The studies reviewed above have demonstrated that developmentally dysphasic subjects achieve significantly lower scores on some tasks which require sequencing of auditory stimuli than do normal subjects. The results obtained using visual stimuli have been contradictory and, therefore, inconclusive. None of the studies reviewed above have demonstrated a direct relationship between the results of their sequencing tasks and the language skills demonstrated by their subjects. Despite this, testing and teaching procedures have been developed which are based on the assumption that an auditory sequencing deficit is an underlying factor in language disorders. Since no such relationship has been clearly demonstrated, the present study was designed to measure the degree of relationship between scores on sequencing tests and scores on measures of language skills.

Auditory Discrimination Skills

Some researchers have identified deficient auditory discrimination skills in language impaired children, and have claimed that they are causally related to poor linguistic performance. Others claim that poor discrimination is not the causal factor. It was necessary to review the literature concerning auditory discrimination, as opposed to sequencing, in order to decide whether to include a discrimination task in the design of the present research.

Wilson, Doehring and Hirsh (1960) compared the performance of dysphasic children and children with hearing impairment on a sound discrimination task. Their subjects were required to identify which of four sounds they heard by pointing to a letter with which the sound had previously been paired. The sound stimuli were: long complex tone, short complex tone, long white noise, and short white noise. Criterion was six consecutive correct responses within eighty trials and the subjects' scores were the number of trials to criterion. Performance of dysphasic subjects was highly variable. When data were averaged, non-dysphasic subjects required fewer trials to criterion than dysphasic subjects. The three fastest learners in the dysphasic group, however, reached criterion in fewer trials than many of the normal subjects while six of the dysphasic subjects never reached criterion. Wilson, Doehring and Hirsh (1960) made no statistical analyses. Instead, they noted certain trends and commented on some individual behavior. They noted, for example, that dysphasic subjects appeared to have greater difficulty with sounds of short duration than did normal subjects. A more interesting finding, however, resulted from post experiment attempts to train the six dysphasic subjects who had failed to reach criterion. A procedure which made a gradual transition from use of one card for each letter to be associated with a sound to one card with all four letters on it was made. The subjects were taught to respond to one, two, three, and then four individual

cards. Even when subjects responded correctly in the presence of all four cards, however, the transition to one card with all four letters was not achieved. After this, the authors taught the six subjects to identify each sound by saying long tone, short tone, long noise, and short noise. When this was successfully completed, a large number of trials was still required before transfer to the single card was successful. Wilson, Doehring and Hirsh (1960) note that this suggests a failure of the association process rather than a discrimination disorder. Stated differently, they are suggesting that dysphasic children do not make appropriate generalizations with respect to discriminative stimuli and that such generalizations are important for appropriate use of language.

An underlying discrimination disorder for sounds of short duration has been hypothesized as the cause of the language deficit found in developmentally dysphasic children by Tallal and Piercy (1973a, 1973b). This hypothesis is based on their finding that developmentally dysphasic children score significantly lower than normal children on tasks requiring sequencing and same or different discrimination when the interstimulus interval and the tone duration are shortened. No difference between dysphasic and normal subjects was found on a task requiring same or different discrimination and sequencing of visual stimuli.

Based on these results (particularly on the fact that subjects performed at the same level of correctness on both same-different and sequencing tasks), Tallal and Piercy (1973a, 1973b) state that ". . . the previously reported impairment of auditory sequencing in aphasics may well be due to an inability accurately to perceive stimulus elements at rapid rates of presentation". This interpretation of results is not in agreement with those of researchers who have hypothesized a basic sequencing deficit in dysphasic children. Also, although a high significant correlation between stimulus pattern duration and percent of correct responding was found by Tallal and Piercy (1973b), no measurement of the relationship between the percent of correct responding on the experimental discrimination tasks and the subjects' language skills was attempted. As a result, interpretation in terms of language skills is conjecture. Despite this, in their next two studies Tallal and Piercy (1974, 1975) hypothesize that ". . . developmental dysphasia results from impaired rate of auditory processing and is not a specifically verbal deficit". In the first of these (Tallal and Piercy, 1974), results demonstrated that dysphasic subjects achieved significantly lower scores than normal subjects on tasks requiring identification of synthetic stop consonant-vowel syllables. There was no significant difference between the scores of dysphasic and normal subjects on identification, sequencing, and same-different discrimination of vowel-

vowel pairs. These results disagree with those of Rosenthal (1972) who found that dysphasic subjects performed more poorly than normal subjects on all discrimination tasks, including discrimination of vowel-vowel pairs. In the next experiment, Tallal and Piercy (1975) replicated their previous study (Tallal and Piercy, 1974) using modified stimuli. For the stop consonant-vowel syllable pairs they extended the first three formant transitions from 45 msec. to 95 msec. For the vowel-vowel pairs they synthesized two syllables with a different initial vowel of 45 msec. duration followed by the same vowel of 207 msec. duration. The pairs were /E-I/ and /æ-I/. Results showed significantly poorer discrimination scores for dysphasic subjects when the vowel-vowel pairs were used, and no significant difference between discrimination scores for dysphasic and normal subjects when the extended formant stop consonant-vowel syllable pairs were used. Tallal and Piercy (1974, 1975) interpret these results as supporting their hypothesis that a time constraint--that is, an inability to discriminate sound patterns of short duration--is the cause of developmental dysphasia and, therefore, the disorder is not a specifically linguistic disorder. No attempt, however, was made to measure the relationship between the results obtained in the experimental discrimination task and the language skills of the subjects who served in the experimental tasks.

McReynolds (1966) approached the study of

discrimination skills differently. She compared the ability of dysphasic and normal subjects to discriminate between natural speech sounds in isolation and in the context of nonsense syllables. There was no significant difference between the scores of dysphasic and normal subjects on the tasks which required discrimination of speech sounds in isolation. Scores of dysphasic subjects were significantly lower than scores of normal subjects, however, when sounds were embeded in nonsense syllables. McReynolds (1966) states that the dysphasic subjects' successful discrimination between complex speech stimuli in isolation argues against a basic discrimination deficit as the cause of their disorder. She did not, however, explore the relationship of the ability to identify individual sounds in isolation and in nonsense syllables to linguistic skills which involve the use of larger linguistic units.

No conclusion can be drawn from the variety of results obtained in the literature concerning auditory discrimination. In addition, none of the studies reviewed above demonstrated any relationship between scores on discrimination tasks employed and specific language skills. This motivated the writer to design a study which would attempt to identify the existence of a relationship between scores on discrimination tasks and measures of language skills.

Research concerning the determinants of the language disorder observed in developmentally dysphasic children has

produced no definitive answers. Controversy still exists concerning the nature of the basic deficit. In addition, no hard evidence of a functional relationship between the skills examined and language skills has been demonstrated. This must be done prior to meaningful interpretation of research results in terms of language, and such interpretation is of major concern to those involved in remediation of language disorders. As a result, the present writer attempted to design a study which would identify the auditory discrimination and sequencing skills of dysphasic subjects and provide some measure of the relationship between those skills and scores representing the level of language comprehension and expression for each subject.

SELECTION OF STIMULI

In attempting to identify the determinants of the disorder called developmental dysphasia, experimenters have employed stimuli which range from pure tones to speech-like but non-linguistic complex sounds to linguistic stimuli embedded in complex linguistic structures. None of the studies reviewed by the writer exhibited a functional relationship between performance scores obtained using non-linguistic stimuli and scores representing the linguistic skills of subjects. Even so, most researchers interpreted their results in terms of language performance. The decision to use both tones and words as stimuli in the present study, and to measure the amount of correlation between scores on

tasks using tones and scores on language tests, grew out of the writer's increasing awareness that causal relationships between non-linguistic skills and language usage have only been assumed. The literature which was helpful to the writer in making the decisions concerning stimuli to be used in this study will be discussed below in terms of the kinds of stimuli employed.

Studies Which Used Non-linguistic Stimuli

Many of the studies concerning auditory processing of normal and language impaired subjects have employed non-linguistic stimuli. Hirsh (1959) used pure tones of different frequencies, noises of different spectral composition, tone-noise and click-noise pairs, and clicks of different spectral composition, in a study which employed normal adult subjects. He demonstrated that an interstimulus interval of approximately 20 msec. was necessary for normal subjects to identify which of two sounds came first at a criterion of 75 percent correct. Efron (1963) used pure tones of different pitch and lights of different wave length to examine the ability of aphasic and non-aphasic adults to indicate which of two stimuli came first. He found that aphasic subjects required significantly longer interstimulus intervals for correct sequence judgement at all levels of correct responding than did non-aphasic subjects. Lowe and Campbell (1965) used pure tones of different pitch to study the sequencing skills of developmentally dysphasic children. Their results showed

that dysphasic subjects required significantly longer interstimulus intervals than normal subjects to indicate which of two pure tones came last. Short and long complex tones, and short and long white noises were used by Wilson, Doehring, and Hirsh (1960) in their study of developmentally dysphasic subjects. Results showed great variability among dysphasic subjects in ability to associate each sound with an arbitrarily chosen letter. Dysphasic scores ranged from better than most normal subjects to inability to perform the task at all. Complex tones which were similar to vowels in their acoustic structure were used by Tallal and Piercy (1973a, 1973b) to study auditory sequencing and same-different discrimination skills of developmentally dysphasic children. Their results demonstrated that dysphasic subjects required significantly longer combinations of interstimulus interval and tone duration than did normal subjects in order to identify sequences correctly and to identify whether two tones were the same or different.

All of the researchers cited above generalized to speech and/or language perception when drawing conclusions from their results. The present writer is aware of no data which demonstrate a relationship between the results obtained and the speech and/or language skills of the subjects. Rees (1973), in a review of the literature, argues that the data actually argue against the usefulness of non-linguistic stimuli for providing answers to the problems of either adult or developmental dysphasia. This opinion is supported by Malone's (1967) data which

demonstrated no relationship between results of pure tone sequencing tasks and sentence repetition skills in normal adult subjects. Tallal (1975a) argues that the complex stimuli which she used (Tallal and Piercy, 1973a, 1973b) should be considered appropriate for use when interpretation of results is to be made in terms of speech and language because those complex stimuli mimicked the acoustic structure of linguistic stimuli. No data were presented, however, to support the validity of this assumption. This was considered to be further evidence that a study which measured the relationship between scores on tests which employed non-linguistic stimuli and scores on language measurements was needed. In addition, Tallal's (1975a) argument provided motivation for the use of complex tones with formant structure similar to that of vowels.

Studies Which Used Both Linguistic and Non-linguistic Stimuli

Aten and Davis (1968) used pure tones, nonsense syllables, words and sentences to study the identification and sequencing skills of neurologically impaired subjects. Results demonstrated that neurologically impaired subjects performed significantly more poorly than normal subjects on all pure tone tests and on four of the seven tests which employed linguistic stimuli. There was no significant difference between the performance of normal and neurologically impaired subjects on three of the seven tests which employed linguistic stimuli. Rosenthal (1972)

used pure tones, white noise, fricatives, and affricates in an attempt to delineate what aspect of linguistic and non-linguistic stimuli were associated with poor identification of auditory sequences by developmentally dysphasic subjects. Results demonstrated that both normal and dysphasic subjects obtained higher scores when linguistic stimuli were used than when non-linguistic stimuli were used. Normal subjects achieved higher scores than dysphasic subjects on all tasks, however. In addition, normal subjects performed better on tasks which employed temporal contrasts as opposed to spectral contrasts whereas the opposite was true for dysphasic subjects.

The data of both of the studies cited above demonstrate differences in performance in the presence of non-linguistic as opposed to linguistic stimuli. The relationship between them, however, was not explored. This was considered an additional reason to use both kinds of stimuli and to measure the relationship between the scores obtained with each.

Studies Which Used Linguistic Stimuli

Tallal and Piercy (1974) used synthetic vowels and synthetic stop consonant-vowel constructions in a study which required individual stimulus identification, identification of sequences, and same-different discrimination. There were no differences in performance between normal and dysphasic subjects when synthetic vowels were used. When stop consonant-vowel constructions were used, however, dysphasic

subjects performed significantly more poorly than normal subjects on all tasks. The study cited above (Tallal and Piercy, 1974) was then replicated (Tallal and Piercy, 1975) using synthetic vowel-vowel pairs (/ɛ-I/ and /æ-I/) in which the first vowel had a duration of 43 msec. and the second a duration of 207 msec., and stop consonant-vowel pairs in which the first three formant transitions were extended from 43 msec. to 95 msec. Normal and dysphasic subjects demonstrated no differences in performance when the stop consonant-vowel pairs were used. On all tests which used the vowel-vowel pairs, however, dysphasic subjects achieved significantly lower scores than normal subjects. The authors interpret the results of both of the above in terms of the language deficit found in developmental dysphasia, although the relationship between results obtained using synthetic speech stimuli and those obtained using natural speech are not clear. It is well known among speech scientists, for example, that normal adult listeners do not always identify a given synthetic speech stimulus as the phoneme which is suggested by the acoustic structure (Studdert-Kennedy, 1977). Even after being told that a given synthetic speech stimulus is, for example, a /ba/, some normal listeners insist that it does not sound like a /ba/. Without some measurement that demonstrates the equivalence of the synthetic speech stimuli and natural speech stimuli, no one is justified in assuming that the failure to discriminate synthetic speech stimuli demonstrates

a cause of language impairment.

Stark, Poppen and May (1967) used words to study the sequencing ability of developmental dysphasic subjects. Their results showed a large amount of variability among dysphasic subjects, as did the data of Wilson, Doehring and Hirsh (1960). Some achieved scores as high as normal subjects whereas others received scores which were significantly lower than those achieved by normal subjects. McReynolds used isolated phonemes and phonemes in the context of nonsense syllables to examine the ability of dysphasic subjects to identify which of two sounds they heard. Results demonstrated no difference between dysphasic and normal subjects when phonemes were presented in isolation. When phonemes were embedded in the context of nonsense syllables, however, dysphasic subjects achieved significantly lower scores than normal subjects.

Stark, Poppen and May (1967) and McReynolds (1966) interpret their results in terms of language, as have most of the other researchers in this area. Since they used linguistic stimuli, such generalization appears justifiable. Their research required the identification of sequences of words and the identification of phonemes which were isolated or embedded in nonsense syllables, respectively. The relationship of these skills to the total language deficit seen in individual dysphasic children remains to be explored.

Since there is a lack of data concerning the existence of a relationship between scores of dysphasic

subjects on tasks in which non-linguistic stimuli are employed and their scores on similar tasks in which linguistic stimuli are employed, a study which attempted to identify such a relationship was needed. The present writer, therefore, designed this study so that such a relationship could be measured.

CHOICE OF SUBJECTS

Due to the nature of the experimental questions, it was necessary to select developmentally dysphasic children as subjects for the present experiment. The next question, then, concerned the criteria appropriate for labeling a child developmentally dysphasic. Literature written by the most widely respected authorities in the area of developmental dysphasia was, therefore, reviewed in order to help the present writer to establish appropriate criteria for choosing subjects.

Few authors outline identical criteria for classification of children as developmentally dysphasic. The only constant similarity among such criteria appears to be specific failure in the normal development of language (Monsees, 1961; Benton, 1964; Eisenson, 1963, 1966, 1968; Mykelbust, 1971a). Many other deficits are considered as accompanying or as being the source of this language deficit.

Eisenson and Ingram (1972) note that their definition of developmental dysphasia includes the assumption of an

etiology in auditory perceptual dysfunction. Barry (1961) defines the developmentally dysphasic child as one who has an inability to use or understand language as a result of central nervous system defect or damage. Monsees (1961) claims that the core of the disability found in developmentally dysphasic children is a disorder in the perception of temporal sequence, auditory and perhaps also visual. Many other authors (Lowe and Campbell, 1965; Stark, Poppen and May, 1967; Poppen, Stark, Eisenson, Forrest and Wertheim, 1969; Rosenthal, 1972; Tallal and Piercy, 1973a, 1973b, 1974, 1975) have claimed that the disorder of developmental dysphasia includes a basic auditory and/or visual perceptual disorder. Weiner (1972) found that the developmentally dysphasic subjects they studied were inferior to normal children in executing oral-motor acts and that their inferiority increased as the complexity of the oral-motor act increased. The assumption, sometimes stated and sometimes implied, in all of the above is that the behaviors or deficits described are neurogenic or central in origin.

Studies performed by Goldstein, Landau and Kleffner. (1958, 1960) found no unequivocal neurological criteria for differentiation between developmentally dysphasic and deaf children. Although as a group their developmentally dysphasic subjects had a greater number of motor function abnormalities than did their deaf subjects, 32 percent had no additional abnormalities in any of the neurological examinations performed. They note that in most cases central

nervous system damage is only inferred. Lack of documented central nervous system damage, then, does not rule out diagnosis of developmental dysphasia.

Another possible criterion for developmental dysphasia could be variability of threshold on hearing tests (Myklybust, 1954). This was ruled out by Reichstein (1964). He discovered that, although developmentally dysphasic subjects demonstrated more variability than normal subjects on hearing threshold tests when data were pooled, analysis of individual data revealed something totally different. In the latter case, the developmental dysphasic subjects divided clearly into two groups. One group had highly inconsistent thresholds while the other was indistinguishable from normal subjects. This too, then, is not a sufficient criterion for identifying developmentally dysphasic children.

Freedom from emotional disturbance may also help an experimenter to be sure that his subjects' language disorders are not due to emotional factors. As noted by de Hirsch (1967), however, differentiation between disorders which are dysphasic and those which are due to psychopathology is not usually straightforward. Myklebust (1954, 1971a, 1971b) notes that children with developmental dysphasia frequently have concomitant emotional and/or behavioral disorders. According to Myklebust (1971a), a child is diagnosed as developmentally dysphasic when there is a discrepancy between his linguistic skills and what would be expected based on his other developmental skills. Although

psychopathology does not cause developmental dysphasia, the presence of some emotional maladjustment does not rule out developmental dysphasia as the major problem.

Some experimenters (Wilson, Doehring and Hirsh, 1960) defined developmental dysphasic subjects for the purpose of their study to include only children who were nonverbal. Others (Stark, Poppen and May, 1967; Poppen, Stark, Eisenson, Forrest and Wertheim, 1969; Tallal and Piercy, 1973a, 1973b, 1974, 1975), used subjects who demonstrated varying amounts of language comprehension and expression. Weiner (1972) noted that most clinics see children with much milder dysphasic disorders than the extremes reported in the literature. He, therefore, chose to use subjects with relatively mild language disorders.

The literature cited above strongly suggests that diagnosis of developmental dysphasia in children is no simple matter. Consequently, an empirical approach to diagnosis is preferred by many. Monsees (1961), for example, notes that more than one examination is necessary for making such a diagnosis. In addition, she recommends diagnostic therapy to confirm the decision. This approach is also recommended by McGinnis (1963) and by Kleffner (1961). They both claim that developmentally dysphasic children can best be identified through a period of diagnostic teaching which clearly shows that these children cannot learn by methods which are effective for other, clearly non-dysphasic children.

The information in the literature reviewed above was used by the present writer to form criteria for choosing subjects for the present study. In order to focus as much as possible on the language disorder itself, children with normal motor development, intelligence, hearing and emotional adjustment were chosen. In addition, all subjects had received language therapy for at least one year and had been judged to be dysphasic through diagnostic therapy as well as diagnostic testing.

CHOICE OF METHODOLOGY

In designing the present study, the writer had to decide how the stimuli were to be presented and what response was to be made by the subjects. A review of the literature which was helpful in making those decisions follows.

Behavior Modification

A vast amount of data concerning the efficacy of behavior modification techniques in training and research has appeared since Skinner's (1938) original publication. This is true even if we limit ourselves to the area of speech and language pathology. Girardeau and Spradlin (1970), for example, present a collection of studies which clearly demonstrate the usefulness of behavior modification in speech and language rehabilitation and research. A similar collection is presented by Sloane and MacAuley (1968).

Briefly, behavior modification techniques involve

reinforcement of a response emitted in the presence of a certain stimulus. As a result, presentation of that stimulus comes to serve as a signal that a given response will be reinforced. Consequently, the frequency of the reinforced behavior increases in the presence of the specific stimulus which has become associated with the reinforcement (Skinner, 1938; Keller and Schoenfeld, 1950; Ferster, Culbertson and Boren, 1975).

This technique has a number of advantages over other techniques. It allows the experimenter to measure changes in behavior which correspond to slight changes in the environment (Bijou and Baer, 1966). Responses are simply and precisely defined, allowing a high degree of experimental control (Holtz and Azrin, 1966). In addition, results of research employing behavior modification procedures provide techniques and procedures for establishing control over the behavior being studied rather than just confirmation of an hypothesis (Holland, 1961). This is especially important for research which is done in order to provide clinically useful information.

Behavior modification contingencies can be designed individualistically and are applicable to a wide variety of situations. Many successful applications have been made in research dealing with disorders of speech and language. MacAuley (1966), for example, has employed behavior modification techniques successfully to study the development of useful language in non-verbal retarded children. Lovaas

(1968, 1977) and Schell, Stark and Giddan (1967) have presented behavioral procedures for teaching speech to psychotic children. Flanagan, Goldiamond and Azrin (1965), Martin (1968) and Shames and Egolf (1976) are only a few of the researchers who have demonstrated the effectiveness of application of behavior modification procedures to the investigation of and remediation of stuttering. The same has been done with articulation (Mowrer, Baker and Schultz, 1968; McLean, 1970) and many aspects of language (Guess, Sailor, Rutherford and Baer, 1968; Risley and Hart, 1968; Schumacher and Sherman, 1970; Wheeler and Sulzer, 1970; Baer and Guess, 1971; Sailor and Taman, 1972; and Ingram, 1974). Behavior modification procedures have been successfully employed in the research of McReynolds (1966, 1967), Stark, Poppen and May (1967), Gray and Fygetakis (1968a, 1968b), and Rosenthal (1972) to study developmentally dysphasic children. The usefulness of behavior modification techniques in research has also been discussed by Holland (1961), Bijou and Baer (1966), Holtz and Azrin (1966) and Spradlin and Girardeau (1970). Results of the research cited above provided compelling evidence of the usefulness of behavior modification techniques in the study of language disordered subjects. The next question to be answered, then, was what particular procedure to use.

Match-to-sample

Much of the research to date has employed a match-to-sample technique to study the behavior of subjects with

language impairment. This is a procedure in which a stimulus is presented (for example, a word) and the subject is required to identify another stimulus (for example, a picture of the word) that goes with or matches the original stimulus. Reinforcement follows a correct match. A detailed description of the match-to-sample procedure may be found in Ferster, Culbertson and Boren (1975). The advantages of this technique are discussed by Sidman and Stoddard (1966), Rosenberger, Mohr, Stoddard and Sidman (1968), and Rosenberger, Stoddard and Sidman (1972). They note, for example, that a match-to-sample procedure allows the subject to indicate his choice by nonverbal responses even when the stimulus materials are verbal. This is important when studying individuals with language impairment. Match-to-sample is equally applicable to linguistic and non-linguistic stimuli and responses. It also allows precise specification of the stimuli used and the response required. In addition, match-to-sample procedures insure a stable response and subject cooperation while, at the same time, serving to instruct the subject in the nature of the task required. This is a large advantage when subjects are linguistically impaired. These advantages were considered by the writer to be compelling reasons for choosing the match-to-sample procedure for use in the present study.

TREATMENT OF DATA

The next decision to be made concerned treatment of

data. The writer had to decide whether to analyze pooled data or individual data. A decision also had to be made concerning what metric to use to measure the correlation between tone test results and language test results. The literature which helped the writer to make those decisions is reviewed below.

Pooled Versus Individual Data Treatment

Sidman (1952, 1960) argues persuasively against the use of pooled data in between group studies. Such a method produces data which do not necessarily correspond to any individual performance. According to Neale and Liebert (1973), the investigator who uses pooled data must be unconcerned with the fact that some variance in his results is unaccounted for. This problem is equally applicable to averaging results over a group of subjects (Neale and Liebert, 1973). It is entirely possible to get results which have no relationship to any individual subject's responses. The danger becomes all the more troublesome when you deal with a small number of subjects from a population which may not have a normal distribution. The wide variability seen in some studies of dysphasic children (Wilson, Doehring and Hirsh, 1960; Reichstein, 1964; Stark, Poppen and May, 1967), and the small numbers of subjects used in such studies, suggests that both of the dangers noted above may apply to studies of dysphasic children. On the other hand, external validity becomes a problem when research results are analyzed on the basis of individual data (Neale and Liebert, 1973).

The present writer chose to analyze data on an individual basis and as pooled data. It was the writer's opinion that, by doing so, it would be possible to find out which of the two problems, lack of applicability to individual subjects or lack of external validity, posed the greatest difficulty in terms of generalization to clinical situations, at least for the study reported herein.

Confidence Intervals and Comparison of Proportions

Natrella (1963) notes that interpretation of results can be greatly simplified and more meaningful if confidence intervals are calculated instead of applying the usual tests of significance. Another advantage noted by Natrella (1963) is that the width of the confidence interval is in the same units as the parameter being studied. As a result, the information obtained by such a metric is easy to understand and easy to compare with other information. These were compelling reasons for choosing this analytic technique. It simplified the task of understanding the analysis of the many subjects as individuals and made comparisons between individual and pooled data a much simpler task.

The comparison of two observed proportions (or percentages) as described by Natrella (1963) allows the experimenter to compare two observed proportions in mutually exclusive classes to determine if the observed contrast is

significant. The present writer chose this method to compare responses across conditions.

Correlation Measures

Neale and Liebert (1973) note that correlation techniques are used to answer questions of the form "do variable X and variable Y go together or vary together?" Siegel (1956) notes that Spearman's rank correlation coefficient is appropriate for analysis of ordinal variables. These facts support the use of Spearman's rank correlation coefficient to answer questions concerning correlation posed in the present study.

Chapter 3

METHODS AND PROCEDURE

INTRODUCTION

The present experiment was undertaken to measure the performance of children with developmental dysphasia with respect to tone identification and tone sequencing tasks; and to measure the correlation between their performance on the tone tasks and their performance on three widely used measures of language skills.

The implementation of this research plan required that subjects press one or the other of two panels and, by so doing, make an identification as to which of two tones was heard. This was done under conditions of varying forms of intervention by the experimenter. If subjects responded at criterion level on the tone identification task, and did so with no assistance from the experimenter, they were required to perform a task in which a sequence of two different tones was presented and they had to press two panels in a sequence which corresponded to that of the tones. The sequencing tasks were also presented under conditions of varying experimenter intervention. When subjects achieved criterion level of response on either the identification task or both the identification and the sequencing tasks, a language sample was taken and the mean

length of utterance was calculated. In addition, two tests of receptive language, commonly administered to dysphasic children, were administered. Scores on the language tests were then compared to scores on the tone tests using measures of correlation. These procedures will be described in more detail below.

SELECTION OF SUBJECTS

Subjects for this study were eight language impaired children who possessed the symptomatology described as characteristic of developmental dysphasia. Criteria for such categorization have been described by many investigators, including Monsees (1961) and Eisenson (1972). A detailed description of these criteria may be found on pages 33 to 37. Using these criteria, and the variety of language and audiometric tests¹ available at the Queens College Speech and Hearing Center, these subjects were judged to be developmentally dysphasic by the clinicians of the center and by the experimenter. In addition, as part of the experiment,

¹There are many tests of language skills. Most of these are available at the Queens College Speech and Hearing Center. Individual variation exists in terms of which tests were used clinically to examine the language skills of individual subjects who served in this experiment. To identify each test battery would amount to providing a case presentation of each subject. The experimenter chose, therefore, to omit identification of such specifics from the text of this dissertation. That information will be provided upon request to interested persons.

expressive and receptive language skills of dysphasic subjects were measured by mean length of utterance, the Assessment of Children's Language Comprehension (Foster, Giddan and Stark, 1973) and Whitaker and Noll's (1973) version of the Token Test (DeRenzi and Vignolo, 1962). All subjects demonstrated language impairment. They also demonstrated a pattern of responding on the Token Test which was similar to that found by Tallal (1975b) for dysphasic children. All judges were qualified speech pathologists holding the Certificate of Clinical Competence in Speech Pathology from the American Speech and Hearing Association. Dysphasic subjects ranged in age from four years two months to eight years one month with a mean chronological age of five years seven months. All of these subjects passed a hearing screening test at 20 dB HTL. There were no observable peripheral disturbances observed in the subjects' behavior or documented in clinical records. All subjects had nonverbal IQ scores within normal limits as measured by the Leiter International Performance Scale (Arthur, 1952).

Eight normal subjects, matched for age, served as controls and ranged in age from four years two months to eight years seven months with a mean chronological age of five years seven months. They were judged to be normal speakers by the clinicians of the Queens College Speech and Hearing Center, by the experimenter and by their parents. Where age permitted, normal linguistic skills were further substantiated by the fact of their placement in normal

classrooms in regular schools. For those subjects who were too young for school, normal language was further substantiated by calculating a mean length of utterance and by administering the Assessment of Children's Language Comprehension (Foster, Giddan and Stark, 1973) and Whitaker and Noll's (1972) adaptation of the Token Test (DeRenzi and Vignolo, 1962). All normal subjects passed a hearing screening test at 20 dB HTL.

MEASUREMENT OF LANGUAGE PERFORMANCE

As a measure of expressive language skills, a language sample was taken following the procedures outlined by Tyack and Gottsleben (1974) and mean length of utterance was calculated for each dysphasic subject. This particular method has been demonstrated to be a useful method for describing and analyzing children's language skills (Morehead and Ingram, 1970; Ingram and Eisenson, 1972; Brown, 1975). Two measures of receptive language skills were also used. The Assessment of Children's Language Comprehension (Foster, Giddan and Stark, 1973) was chosen because it effectively demonstrates differences in receptive language skills between young normal and neurologically handicapped children. Whitaker and Noll's (1972) version of the Token Test (DeRenzi and Vignolo, 1962) was chosen because it has been demonstrated to be a sensitive measure of receptive language disturbance in children (Tallal, 1975b).

PREPARATION OF EXPERIMENTAL STIMULI

Stimuli used in this experiment were complex tones composed of frequencies within the speech range. They were constructed with formants similar to vowels and, thus, could be considered speech-like although they did not sound like any identifiable vowel. The stimuli were essentially replications of those used by Tallal and Piercy (1973a, 1973b). Tone 1 had a fundamental frequency of 100 Hz and tone 2 had a fundamental frequency of 304 Hz. Both were of 250 msec. duration and both had formants at 495, 750 and 1500 Hz. The tones were generated on an ϕ ve III serial speech synthesizer under computer control and finally recorded on Scotch brand AV 176 magnetic tape utilizing a Crown SX 822 tape recorder. All stimuli were prepared at Haskins Laboratories in New Haven, Connecticut.

PRESENTATION OF EXPERIMENTAL STIMULI

Five tape recordings were produced for training and presentation of experimental conditions. On tape one, tone 1 and tone 2 were recorded ten times, respectively. Tape two consisted of tone 1 and tone 2 recorded randomly eighty times (each tone forty times). Tape three was the same as tape two except that the word "low" preceded tone 1 and the word "high" preceded tone 2. Tape four consisted of sequences of tone 1 followed by tone 2 or tone 2 followed by tone 1 such that eighty sequences (forty of each) were

randomly arranged. Tape five was the same as tape four except that the words "low, high" preceded the tone 1, tone 2 sequence and the words "high, low" preceded the tone 2, tone 1 sequence. Tones were separated by an interstimulus interval of 300 msec. on tapes four and five. The playback of these tape recordings was achieved using a SONY model TC-377 stereo tape recorder which had been modified by BRS-Lehigh Valley Electronics Company so that it was remotely programmable and so that headphones could be used to monitor recordings. Sennheiser model HD 424 headphones were the final stimulus source for subjects. Tones were presented at a comfortable listening level. Specific procedures for stimulus presentation in coordination with response training and experimental sessions will be described later.

INSTRUMENTATION FOR PROGRAMMING OF EXPERIMENTAL EVENTS

The experiment was conducted in a room which measured eight feet by ten feet. The subject and the response panels were separated from the programming equipment by a six foot moveable screen.

The experimental procedures were almost entirely automated so that experimenter variables could be more precisely controlled. From the point of view of the experimental subject, the following occurred. The subject was seated in front of a Lehigh Valley Electronics triple level Human Test Console which was on a low table. Two response panels and a token dispenser were mounted on the

console. A panel with a blue square was on the subject's right, and a panel with a red circle was on the subject's left. A diagram of the experimental equipment may be found in Appendix A. Depression of a panel activated microswitches at the slightest pressure. A token dispenser was situated between the two response panels. The subject heard tones through headphones and was required to press the appropriate panel or sequence of panels. A correct response was followed by a light flash on the token dispenser and the receipt of a token. The equipment which controlled these functions was comprised of electromechanical relays and a programmable tape recorder. A description of how events were programmed follows.

1. Control pulses were recorded on one track of the magnetic tape such that they immediately preceded the experimental stimuli recorded on the other track. These pulses were sensed, amplified, and used to activate electromechanical relays which controlled all of the other equipment. Another set of pulses, placed immediately after the experimental stimuli, automatically stopped the programmable tape recorder.

2. When a subject depressed a response panel, a pulse was created which controlled the reinforcement mechanism and various counters. Correct responses activated a token dispenser and electromechanical counter. Incorrect responses activated a second electromechanical counter and prevented activation of the token dispenser.

3. Control pulses created by the experimenter

(by depression of a switch) restarted the programmable tape recorder.

Responses were recorded on electromechanical counters as described above, for each set of twenty trials. Responses were also recorded by hand on a tally sheet. This was done so that patterns of responding which might have interfered with learning the task could be identified. Although the tally sheets allowed identification of individual preferences for responses on the left or the right key, no useful information which was different from that provided by the counters was obtained. Tally sheet data, therefore, were not used for interpretation of results.

CONDUCT OF TRAINING AND EXPERIMENTAL SESSIONS

The experiment was divided into training sessions and experimental sessions. The training sessions were used to familiarize the subjects with the experimental environment and to teach them what kind of response was expected. In the experimental sessions, subjects were required to respond in tone identification and sequencing tasks under conditions of varying experimenter intervention. These are described in more detail below.

Training Sessions

Each subject was seated on a small chair in front of the test console. The experimenter placed headphones on the subject's ears and on her own. The subject was given a

series of instructions and demonstrations designed to show him the nature of the task and what was expected of him. These instructions are described in detail in Appendix B. During this part of the training procedure, tone 1 was presented ten times and then tone 2 was presented ten times. A token and verbal reinforcement immediately followed each correct response. The experimenter re-started the tape recorder only after the subject had taken his token out of the dispenser, placed in the a plastic cup in front of him, and placed his hands either on the table or on his lap. This procedure was followed throughout each session of the experiment.

After ten presentations of tone 1 followed by ten presentations of tone 2, the subject was given another set of instructions and demonstrations designed to explain what was expected of him. These are described in detail in Appendix C. The experimenter then gave twenty trials in which tone 1 and tone 2 were presented randomly. During this part of the training procedure the subject was given as much help as possible to make correct responses. This included: (1) giving strong verbal reinforcement for correct responses, (2) telling the subject that his choice was correct after he made his choice but before he reached the panel, (3) telling the subject which panel was correct if he was unsure, and (4) picking up the subject's hand and "putting him through" the correct response if he persisted in making no response at all.

When the subject responded consistently by pressing a panel without help from the experimenter for the last ten of the twenty tone presentations, he began serving in the experimental tasks. If responses were inconsistent he experienced another twenty training trials. No subject required more than forty training trials.

Experimental Sessions

In the experimental sessions, six different experimenter intervention conditions were presented and subjects were required to respond in each condition on identification and sequencing tasks.

Conditions of experimenter intervention. The following intervention conditions were levels of an independent variable and were presented, in random order, two times each for twenty trials each time.

Condition 1. The experimenter was seated next to the child. Both wore headphones. The experimenter said, "Yes, that's right," or "No, not that one," appropriately as the subject reached for a panel after hearing a tone but before the subject depressed the panel.

Condition 2. The experimenter was seated next to the child. Both wore headphones. The experimenter said, "low" before presentation of tone 1 and "high" before presentation of tone 2.

Condition 3. Condition 3 was a combination of conditions 1 and 2. The subject heard the verbal stimulus

"low" or "high" and received verbal feedback "yes, that's right" or "no, not that one" before pressing the panel.

Condition 4. The experimenter was seated behind the moveable screen, out of the subjects' sight. The word "low" was spoken (on the tape) before tone 1 and the word "high" was spoken (on the tape) before tone 2.

Condition 5. The experimenter was seated next to the subject. Both wore headphones. The experimenter did not interact with the subject in any way.

Condition 6. The experimenter was seated behind the moveable screen, out of the subjects' sight. Only tones were presented to the subject.

Tone identification task. All subjects were required to respond under each of the conditions described above in a tone identification task. In that task, one of the two complex tones was presented randomly and the subject was required to press the left key for tone 1 and the right key for tone 2. Instructions and demonstrations presented to the subject are described in Appendix C.

Tone sequencing task. If a subject responded at a level greater than chance in condition 6 (the no cue condition) of the tone identification task, he served in a tone sequencing task. The conditions under which the subject was required to respond in the sequencing task were identical to those for the identification task. A set of instructions and demonstrations (described in Appendix D) was presented, and the subject was required to press the panels in the same

order as the order of presentation of the tones. The left panel was still pressed for tone 1 and the right panel for tone 2. A token was delivered only upon completion of the correct sequence of panel depression.

DATA COLLECTION AND ANALYSIS

The number of correct responses and the number of trials were counted in each condition in each task. The percent of correct responses was computed for the last twenty trials in each condition in each task. The last twenty trials were used in order to give the subject the benefit of any advantages which might have resulted from experience with the task.

In order to measure the percent of responding above chance levels in each condition, two sided confidence interval estimates of the true proportion (Natrella, 1966) were calculated at the .01 confidence level. This was done for the last twenty trials in each condition for individual subjects and for pooled data from both groups of subjects. Results obtained from pooled data were then compared to the results of data from each individual.

Statistics of proportions for comparing two observed proportions in mutually exclusive categories (Natrella, 1966) were applied to test for significant differences between the conditions in which the experimenter was present or absent (conditions 2 and 4, 5 and 6) and the conditions in which word cues were or were not used (conditions 2 and 5, 4 and

6). This statistic was also used to analyze individual data and pooled data from each group. Results from pooled and individual data were then compared. These tests were applied at the .01 and the .05 confidence levels.

Spearman rank correlation coefficients were calculated to measure the degree of relationship between the number of correct responses in the last twenty trials in condition 6 (the no cue condition) of the tone tests and each of the following: mean length of utterance, raw score on the Assessment of Children's Language Comprehension (Foster, Giddan and Stark, 1973) and raw scores on Whitaker and Noll's (1972) adaptation of the Token Test (DeRenzi and Vignolo, 1962). Results of the data analysis are discussed in Chapter 4.

Chapter 4

RESULTS AND DISCUSSION

RESULTS

The present research was designed to answer five questions. The analysis of results will be described in this chapter in the context of these five questions. Each of the five sections of the chapter will be divided into four subsections as follows: the question, data treatment used, findings and interpretations.

LEVELS OF RESPONDING BY CONDITION

Question

The first question to be answered was; can dysphasic children, taken from a typical speech clinic population, identify and indicate the order of two complex tones which differ in pitch?

Data Treatment Used

Confidence intervals were determined, using the procedure presented by Natrella (1966), and applied to data representing each experimental condition for each subject. This allowed the experimenter to select those experimental conditions in which scores were significantly higher than a level of responding which might be due to the random effects

of uncontrolled factors.

Findings

Figure 1 depicts the percent of correct responses for each subject in each of the six experimental conditions related to the tone identification task. The .01 confidence intervals are depicted as two solid lines. Responses on the identification task for subjects 3D, 4D, and 6D were above the .01 confidence interval in all conditions. Subject 7D responded above the .01 confidence interval in conditions 4, 5, and 6, while subjects 1D, 2D, and 5D responded above that interval in conditions 2, 3, and 4. Subject 8D responded above the .01 confidence interval in conditions 1, 2 and 3.

Scores of dysphasic subjects who served in the sequencing task are depicted in figure 2. The confidence intervals are shown as two solid lines. Responses on the tone sequencing task for only one subject (6D) were above the .01 confidence interval in all conditions. Subject 3D responded above the .01 confidence interval in conditions 2, 3 and 4, while subject 4D responded above that interval in condition 2. Subject 7D failed to respond above the .01 confidence interval in any of the six conditions.

Interpretation

For all subjects (except one) who failed to respond at a level significantly greater than chance in at least one

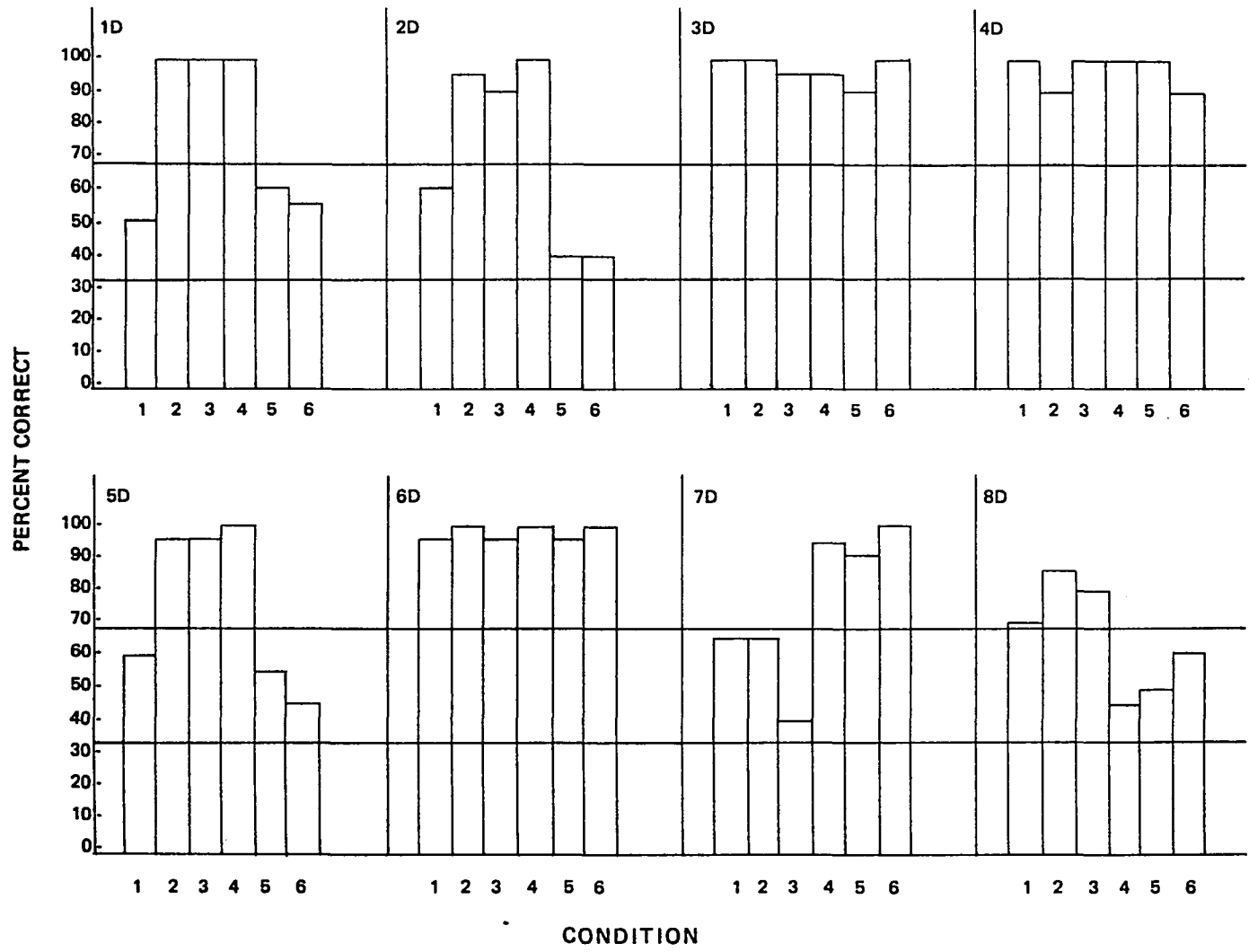


Fig. 1 Scores of eight dysphasic subjects on a tone identification task. The .01 confidence intervals are shown as solid lines.

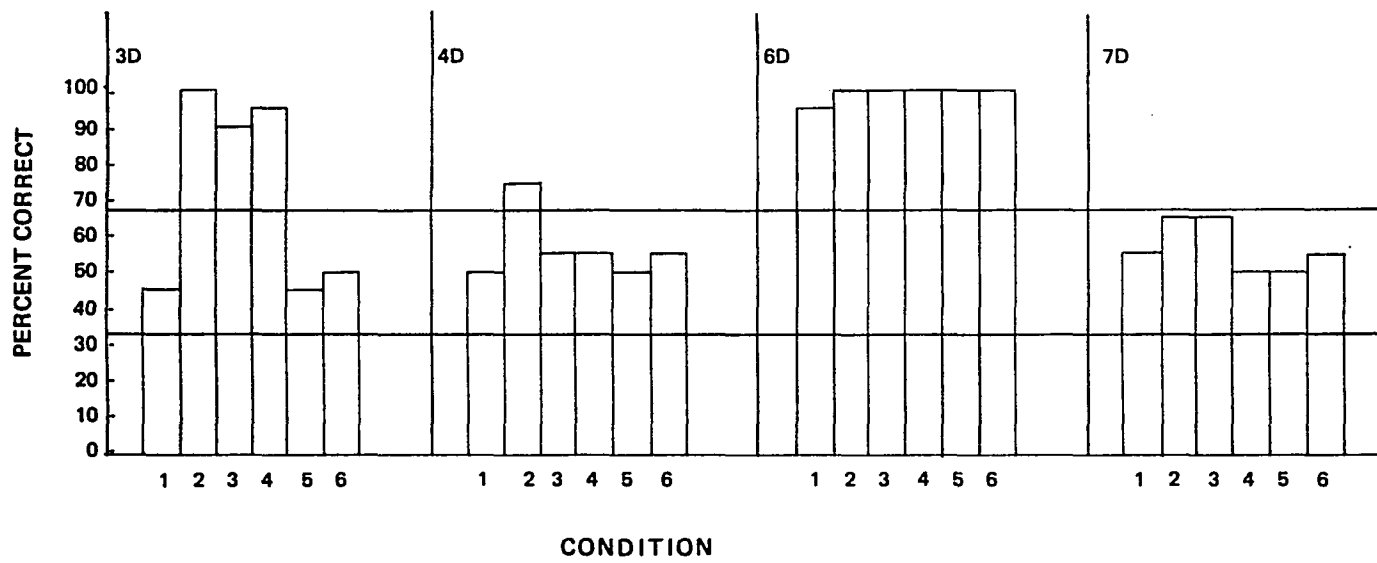


Fig. 2 Scores of four dysphasic subjects on a tone sequencing task.
The .01 confidence intervals are shown as solid lines.

condition, but responded above the .01 level of confidence in at least one condition, scores above the .01 level of confidence occurred in conditions in which word cues were given by the experimenter. This was true in both the identification and sequencing tasks. Since the high level of correct responding in the presence of word cues was not maintained when word cues were not provided, the data may be interpreted as demonstrating that these subjects could discriminate between linguistic stimuli despite their failure to discriminate between non-linguistic stimuli. Subject 7D was the exception. He responded at a level significantly greater than chance in conditions in which no experimenter was present or no cues of any kind were provided. These results indicate superior discrimination for tones without the attention of an adult. This same subject failed to respond above the .01 confidence interval in any condition on the tone sequencing task. Thus, for the dysphasic subjects who served in this experiment, only four out of eight successfully identified (discriminated between) two complex tones, and only one out of four successfully indicated the sequence of two complex tones.

DIFFERENCES BETWEEN CONDITIONS

Question

The second question to be answered was: what kinds of experimenter intervention will significantly affect scores

of dysphasic subjects' on tone identification and sequencing tasks; and what will be the nature of any significant affects.

Data Treatment Used

The significance of differences between proportions was calculated as a means of making comparisons between experimental conditions. Comparisons were made between conditions in which use or non-use of word cues was the only difference (these were comparisons of condition 2 to 5 and 4 to 6) and between conditions in which experimenter presence or absence was the only difference (these were comparisons of condition 2 to 4 and 5 to 6). This was done using the data of individual subjects and for data pooled across subjects. Since pooled data for dysphasic and normal subjects will be discussed in the next section, only individual data will be discussed in this section.

Findings

Tables 1 and 2 depict the significant differences, in percent correct, respectively, between conditions for dysphasic subjects in a tone identification and a tone sequencing task.

Tone identification task. In the tone identification task, subjects 1D, 2D, 5D, and 8D performed significantly better in condition 2 (word cue used) than in condition 5 (no word cue used). Subjects 1D, 2D, and 5D performed significantly better in condition 4 (word cue used) than in condition 6 (no word cue used). Subject 7D responded

Table 1

Significant Differences in Percent Correct Responding
Between Conditions for Dysphasic Subjects
In a Tone Identification Task

Subject	Conditions Compared			
	2 to 5	4 to 6	2 to 4	5 to 6
1D	Significant .01 level	Significant .01 level		
2D	Significant .01 level	Significant .01 level		
3D				
4D				
5D	Significant .01 level	Significant .01 level		
6D				
7D			Significant .05 level ^a	
8D	Significant .05 level		Significant .05 level	
Group	Significant .01 level	Significant .01 level		

^aThe only significant difference in which higher scores occurred in the higher numbered condition.

Table 2

Significant Differences in Percent Correct Responding
Between Conditions for Dysphasic Subjects
In a Tone Sequencing Task

Subject	Conditions Compared			
	2 to 5	4 to 6	2 to 4	5 to 6
3D	Significant .01 level	Significant .01 level		
4D				
6D				
7D				
Group	Significant .01 level	Significant .01 level		

significantly better in condition 4 (experimenter not present) than in condition 2 (experimenter present). Subject 8D responded significantly better in condition 2 (experimenter present) than in condition 4 (experimenter not present). In no case was there a significant difference between condition 5 (experimenter present) and condition 6 (experimenter not present).

Tone sequencing task. On the tone sequencing task, subject 3D responded significantly better in condition 2 (word cue used) than in condition 5 (no word cue used) and in condition 4 (word cue used) than in condition 6 (no word cue used). Subjects 4D, 6D, and 7D showed no significant differences between any conditions.

Interpretation

The scores of subject 1D, 2D and 5D on the tone identification task demonstrate significantly better performance in conditions in which words were presented as cues by the experimenter. This supports the findings noted in the previous section. Responses in the presence of word cues were not only above the .01 level of confidence, but subjects scores were significantly better in conditions in which word cues were supplied by the examiner. For subject 8D, this same outcome was observed only when the experimenter was present, while for subject 3D, this same outcome was observed in the tone sequencing task. Subject 7D scored significantly higher in conditions in which the

experimenter was not present or in which the experimenter provided no cues. This possibly indicates interference with discrimination skills produced by adult presence for this particular child.

For the eight dysphasic subjects who served in this experiment, then, scores of four were significantly better when intervention consisted of presentation of word cues by the experimenter. One subject required that words be supplied and the experimenter be present for significantly better performance. For one other subject, performance was significantly better when the experimenter was not present and/or the experimenter provided no cues.

THE COMPARISON BETWEEN POOLED DATA AND INDIVIDUAL DATA

Question

The third question to be answered was: do pooled data for dysphasic subjects suggest different interpretations than do the data for individual dysphasic subjects.

Data Treatment Used

Confidence intervals were determined, using the procedure presented by Natrella (1966), and applied to data representing each condition for the pooled data. The significance of differences of proportions was calculated for differences between conditions for the pooled data. These results were then compared to results obtained from each individual subject's data.

Findings

Pooled data were analyzed in terms of levels of responding in each condition and significance of differences between conditions. For purposes of clarity, these will be discussed separately.

Levels of responding by condition. Figures 3 and 4, respectively, depict scores representing group and individual responses in each condition for tone identification and tone sequencing tasks. Open bars represent scores of individual subjects and hatched bars represent scores obtained by pooling data in each condition. Pooled scores are repeated eight times, next to each individual's data, in order to facilitate comparison. The .01 confidence intervals are depicted as solid lines.

Pooled scores were above the .01 confidence interval in all conditions for the tone identification task and in conditions 2, 3, and 4 in the tone sequencing task. A visual examination of figures 3 and 4 shows that pooled scores are not a convincing model of or predictor of the scores of individual dysphasic subjects.

Significance of differences between conditions.

Results of the analysis of significant differences between conditions are presented in table 1 for the identification task and in table 2 for the sequencing task. In both the identification and the sequencing tasks, pooled data revealed a significant difference between condition 2 (word cue used)

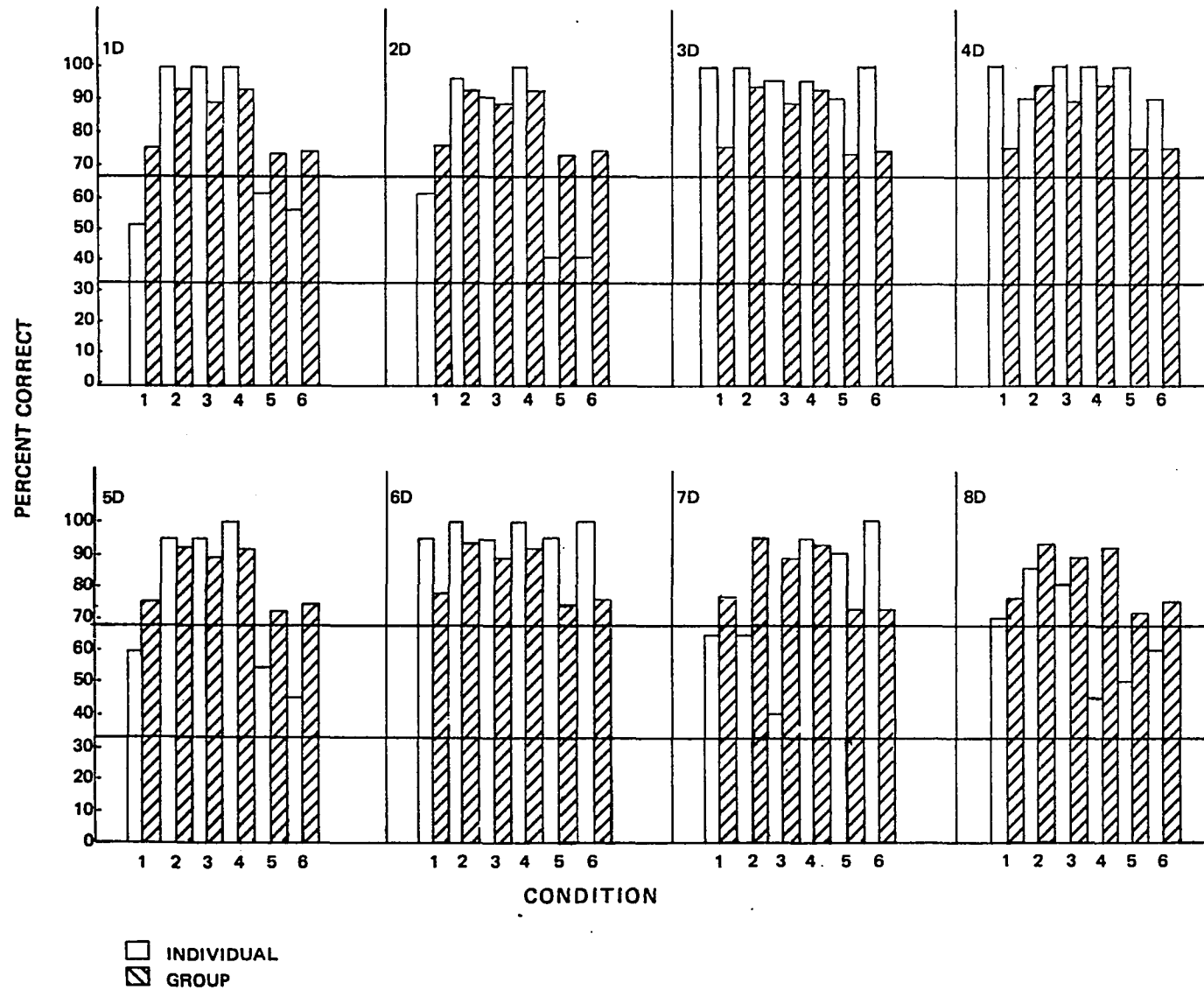


Fig. 3 Comparison of scores of eight individual dysphasic subjects to pooled scores on a tone identification task. The .01 confidence intervals are shown as solid lines.

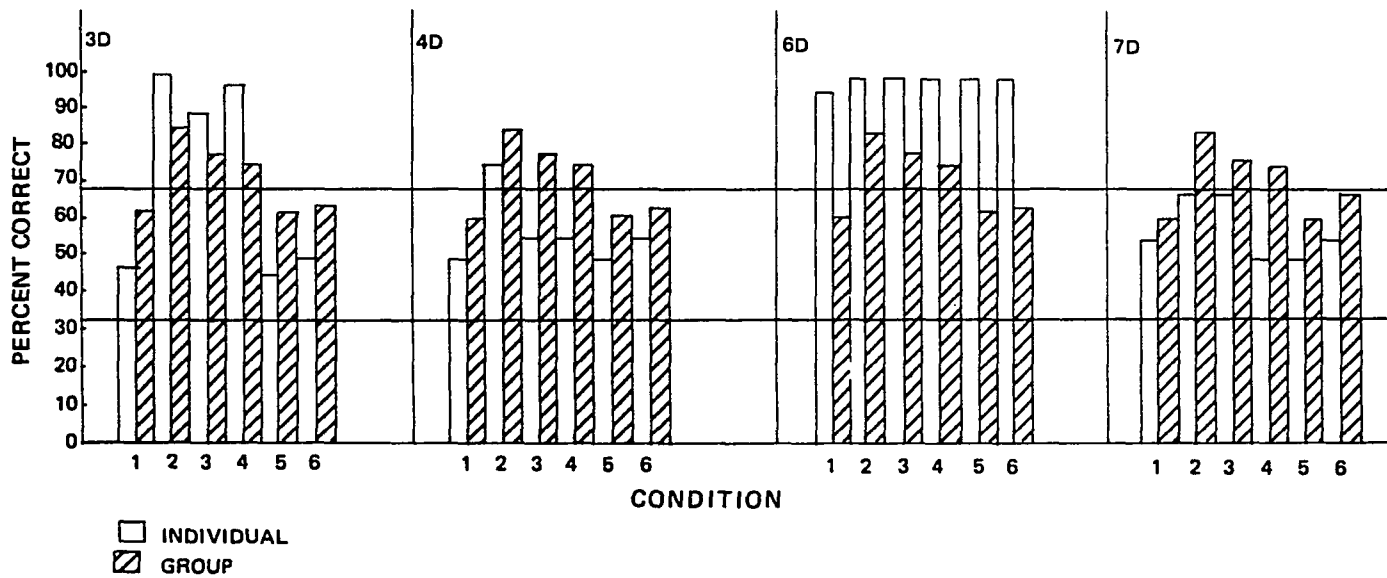


Fig. 4 Comparison of scores of four individual dysphasic subjects to pooled scores on a tone sequencing task. The .01 confidence intervals are shown as solid lines.

and condition 5 (no word cue used) and between condition 4 (word cue used) and condition 6 (no word cue used). The difference was one which revealed superior performance in the conditions in which word cues were used.

Interpretation

Group data are clearly misleading as predictors of performance of individual subjects with regard to levels of responding. In the tone identification task, pooled data represent percent of correct responding above the .01 level of confidence for three out of eight subjects. In the tone sequencing task, pooled data represent none of the subjects. Group data are equally misleading with regard to the significance of differences between conditions. Only half of the subjects demonstrated the same significant differences in the tone identification task as those found in the pooled data for that task, and only one subject of four did so in the tone sequencing task. Thus, for dysphasic subjects who participated in this study, pooling of data suggested very different interpretations than did individual data for more than half of the subjects.

COMPARISON OF NORMAL SUBJECTS TO DYSPHASIC SUBJECTS

Question

The fourth question to be answered was: are scores of developmentally dysphasic children significantly different from scores of normal children on tone identification and

tone sequencing tasks.

Data Treatment Used

Confidence intervals were determined and applied to data representing each condition for each subject in order to select the experimental conditions in which scores were larger than would be expected from chance effects. Statistics of the difference between proportions were used to determine if there were significant differences between conditions in both the tone identification and the tone sequencing tasks. The same procedures were applied to pooled data.

Findings

In order to facilitate comparison with the data from dysphasic subjects, data from individual normal subjects and pooled data from the entire group of normal subjects were analyzed separately.

Individual normal subjects. Figures 5 and 6 respectively, depict the percent of correct responses for each normal subject in each condition of the tone identification task and the tone sequencing task. Confidence intervals are depicted as solid lines.

Six of the eight normal subjects (2N, 3N, 4N, 6N, 7N, and 8N) responded above the .01 confidence interval in all conditions of the tone identification task. Two normal subjects (1N and 5N) responded above the .01 confidence interval in conditions 2, 3, and 4 only. Of the six normal subjects who served in the tone sequencing task, five (2N,

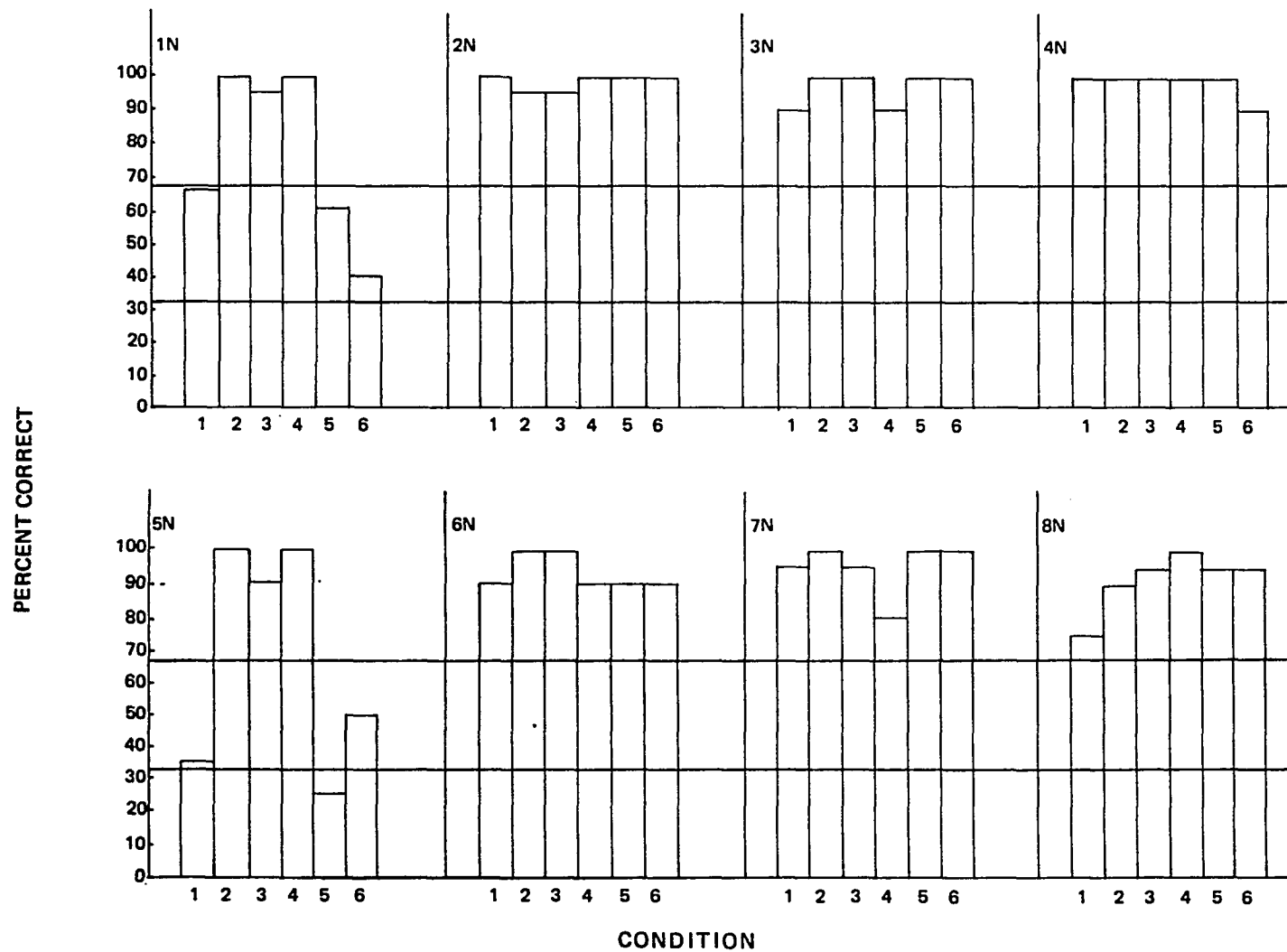


Fig. 5 Scores of eight normal subjects on a tone identification task. The .01 confidence intervals are shown as solid lines.

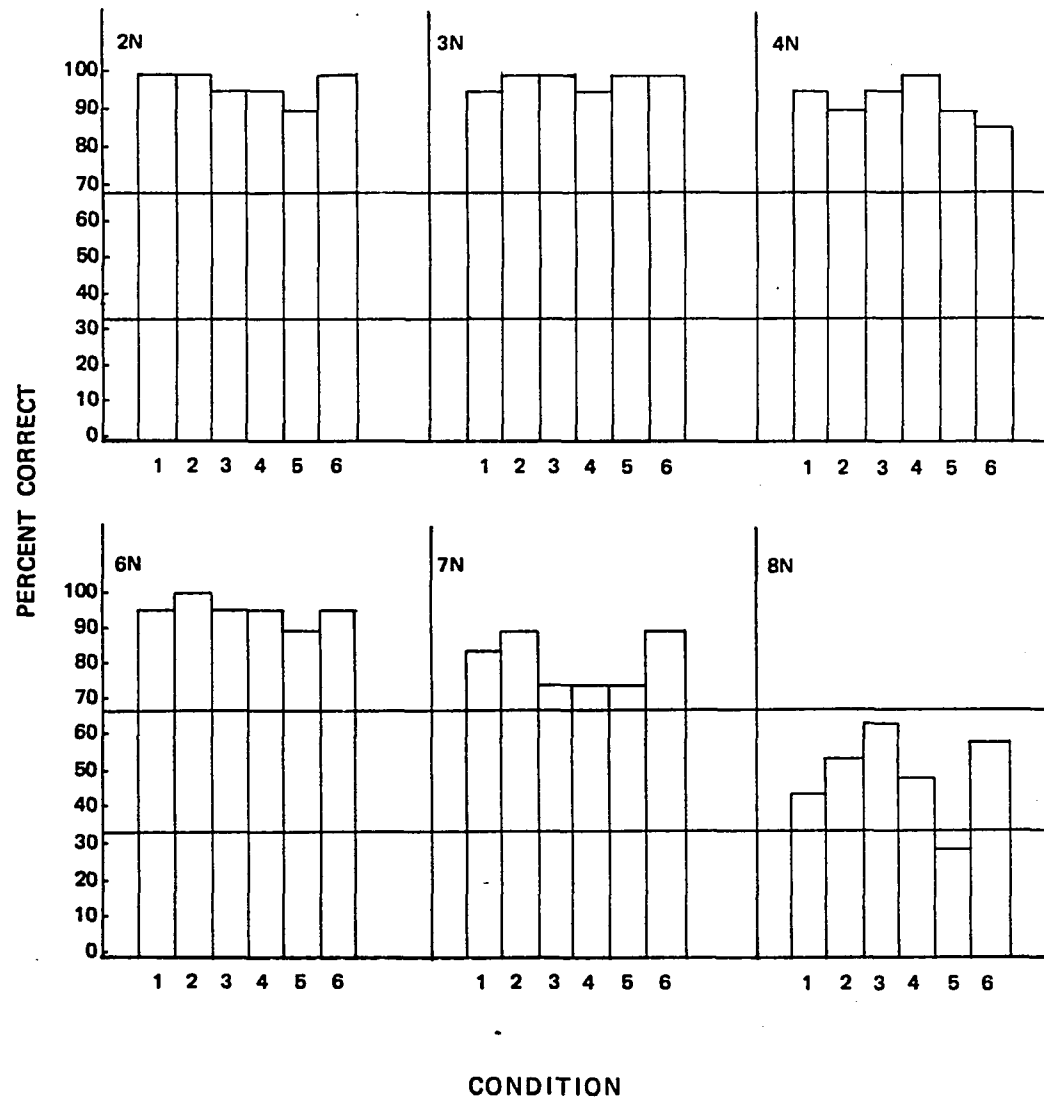


Fig. 6 Scores of six normal subjects on a tone sequencing task. The .01 confidence intervals are shown as solid lines.

3N, 4N, 6N, and 7N) responded above the .01 confidence interval in all conditions. One subject (8N) failed to respond above that level in any condition.

Table 3 depicts the statistically significant differences between conditions in the tone identification task. Subjects 1N and 5N performed significantly better in condition 2 (word cue used) than in condition 5 (no word cue used) and in condition 4 (word cue used) than in condition 6 (no word cue used). There were no significant differences between any conditions for any subject on the tone sequencing task.

Pooled data of normal subjects. Pooled data for normal subjects (figures 7 and 8, respectively) indicate scores above chance level in all conditions of the tone identification task and of the tone sequencing task. Table 3 represents the statistically significant differences between conditions of the tone identification task for the pooled data. Data indicate significantly better performance in condition 2 (word cue used) than in condition 5 (no word cue used) and in condition 4 (word cue used) than in condition 6 (no word cue used). There were no statistically significant differences between conditions in the tone sequencing task.

Interpretation

Pooled data from normal subjects, for scores larger than expected by chance in the tone identification task, are

Table 3

Significant Differences in Percent Correct Responding
Between conditions for Normal Subjects
In a Tone Identification Task

Subject	Conditions Compared			
	2 to 5	4 to 6	2 to 4	5 to 6
1N	Significant .01 level	Significant .01 level		
2N				
3N				
4N				
5N	Significant .01 level	Significant .01 level		
6N				
7N				
8N				
Group	Significant .01 level	Significant .01 level		

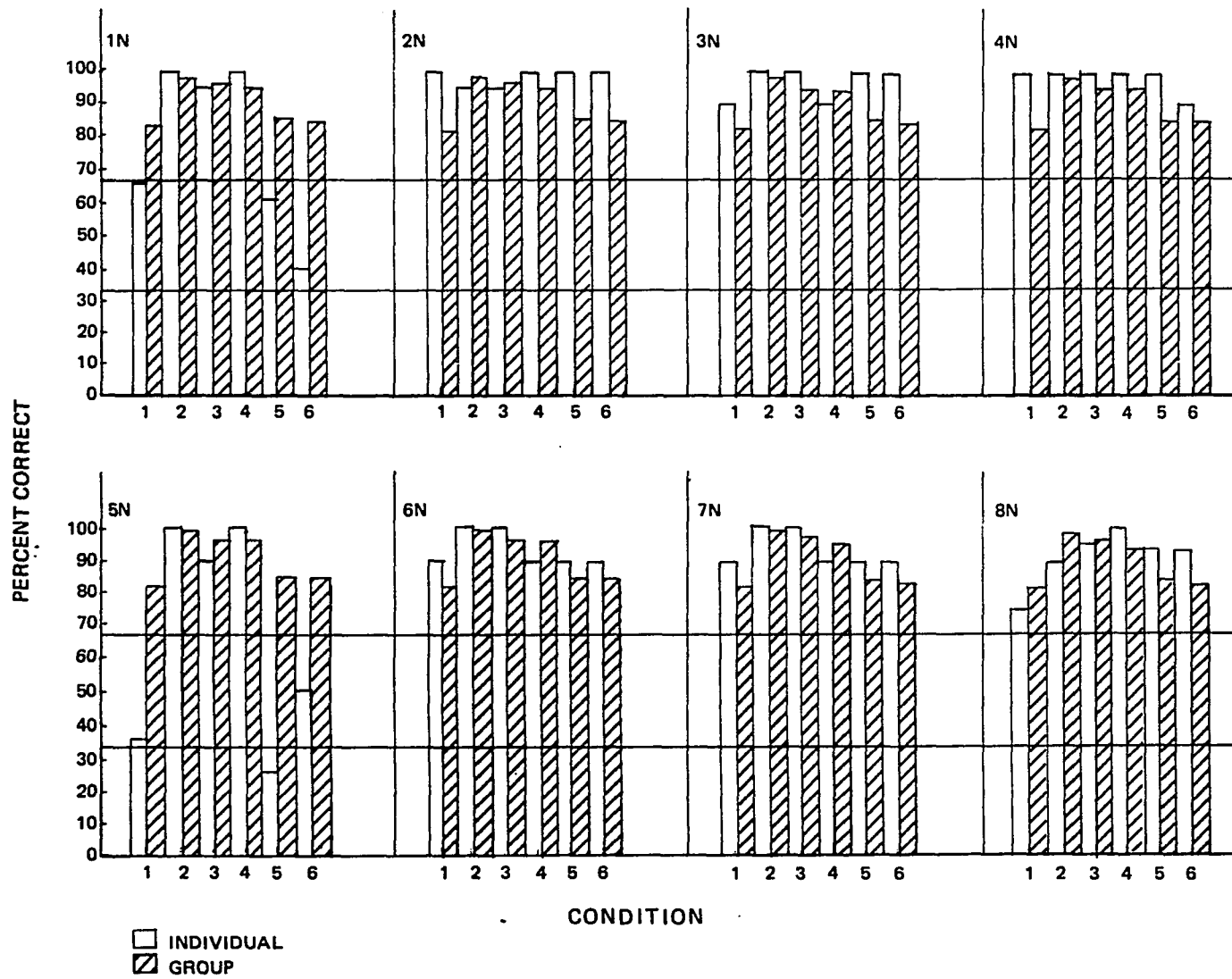


Fig. 7 Comparison of scores of eight normal subjects to pooled scores on a tone identification task. The .01 confidence intervals are shown as solid lines.

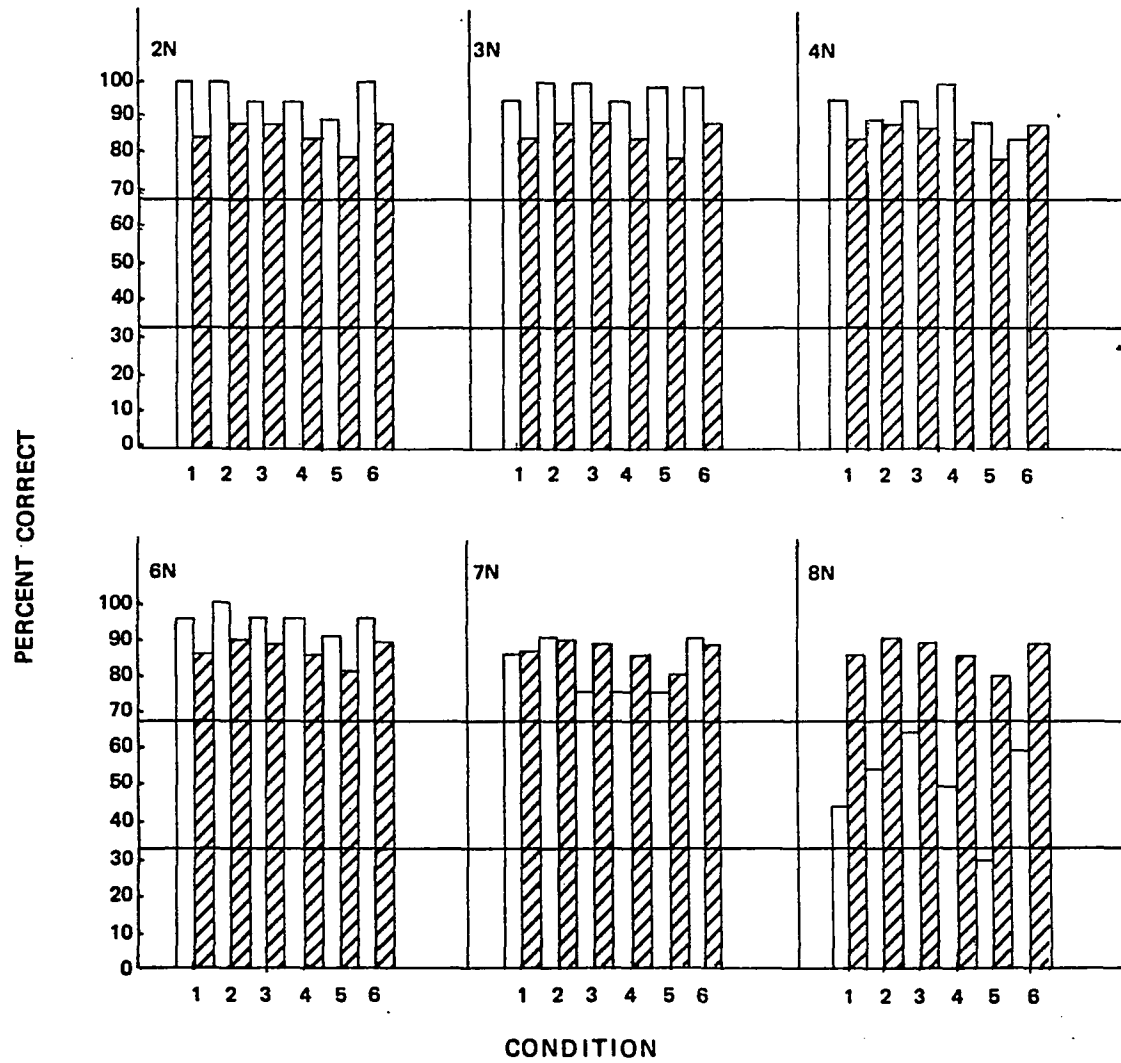


Fig. 8 Comparison of scores of six normal subjects to pooled scores on a tone sequencing task. The .01 confidence intervals are shown as solid lines.

very similar to pooled data from dysphasic subjects for the same task. Both sets of data indicate responding at levels significantly above the .01 confidence interval in all conditions of experimenter intervention. Inspection of individual results (Figures 1 and 5), however, reveals few similarities. Most normal subjects scored above the .01 confidence interval in all conditions on this task whereas many (five of eight) dysphasic subjects did not. The two normal subjects who did fail to achieve scores at greater than levels expected from chance in some conditions, however, scored above the .01 confidence interval in the conditions which used words as cues. For these subjects (1N and 5N), as for four of the dysphasic subjects (1D, 2D, 5D, and 8D), correct discrimination between two words existed without correct discrimination between complex tones. Visual inspection of figures 3 and 7 shows that pooled data for normal subjects is much more representative of individual performance (six out of eight) than pooled data from dysphasic subjects (three out of eight).

Scores above the .01 confidence interval for normal subjects in the tone sequencing task are different from both pooled and individual data from dysphasic subjects in the same tasks. Pooled data from normal subjects indicate responding above the .01 confidence interval in all conditions and represent five out of six individual subjects. Pooled data from dysphasic subjects indicate responding above

the .01 confidence interval only in conditions in which the experimenter supplied words as cues and are representative of one out of four subjects. This can be seen in visual examination of figures 4 and 8.

Significance of differences between conditions was found only in the tone identification task. Subjects 1N and 5N performed significantly better in the same conditions as did subjects 1D, 2D, 5D and partially, 8D. Pooled data of normal subjects is the same as pooled data for dysphasic subjects. Neither set of data is predictive with respect to the majority of individual results within each group.

In summary, scores of individual dysphasic children were clearly different from those of individual normal children on both tone identification and tone sequencing tasks. More normal children performed above the .01 confidence interval in all conditions than did dysphasic children. In addition, pooled data were much more representative of individual normal children than of individual dysphasic children. It is of interest to note, however, that the two normal subjects who did not score above the .01 confidence interval on the tone identification task demonstrated the same pattern of responding as did four of the dysphasic subjects. That is, they responded at levels above those expected by chance only when words were supplied as cues.

COMPARISON OF TONE TEST SCORES
AND LANGUAGE TEST SCORES

Question

The fifth question to be answered was: is there a significant relationship between either tone identification or tone sequencing test scores of developmentally dysphasic children and their scores on tests of language skills?

Data Treatment Used

Spearman rank correlation coefficients were calculated to measure the degree of relationship between each of three different measures of language and scores of dysphasic subjects in condition 6 (the no cue condition) of the tone identification and sequencing tasks.

Findings

Table 4 depicts the results of the correlation calculations. None of the relationships depicted were significant at either the .01 or the .05 level of confidence.

Interpretation

The above results argue strongly that tone test scores have little predictive value with respect to language skills of dysphasic children.

The results of this study and interpretation of results will be discussed in the next section.

Table 4

Spearman Rank Correlation Coefficients Measuring the
Relationship Between Scores in the No Cue Condition
Of the Tone Identification and Tone Sequencing
Tests and Language Tests

Language Test	Correlation	
	Identification	Sequencing
Mean Length of Utterance	.07	.32
Assessment of Childrens' Language Comprehension	.02	.83
Token Test	.56	.63

DISCUSSION

Research is useful to the extent that it generates new research questions and/or to the extent that potentially useful research findings may be generalized to some larger (in this case clinical) population. Several new and researchable questions have been suggested by the present research and a more detailed discussion of these is to be found on pages 95 to 97.

Caution must be exercised concerning generality of findings in that the data are characterized by considerable variability. Despite this, data from this research may be appropriately viewed in terms of several contemporary issues in the field of study involving language development and language remediation. Several of these issues are discussed below and provide a reference frame for consideration of the data of this research.

THE RELATIONSHIP OF NON-LINGUISTIC STIMULI TO LANGUAGE SKILLS

While focusing attention on the stimuli of this research, and the responses of subjects to them, it has been possible to arrive at several related but distinct interpretations. A number of these concern the relationship of non-linguistic stimuli, which may be used in research or therapy, to language skills.

Stimuli Used to Teach Dysphasic Children

Data from the present research may be useful in the resolution of the issue concerning the kinds of stimuli which might be used in research and therapy with dysphasic children. Wilson, Doehring and Hirsh (1960), Lowe and Campbell (1965), and Tallal and Piercy (1973a, 1973b) used non-linguistic stimuli in experiments with language impaired children. All of them interpreted results in terms of the language deficit found in their subjects. Rees (1973) argues that the data (reviewed by her) actually argue against the usefulness of non-linguistic stimuli for providing answers to the problems of language impaired individuals. This opinion is supported by the data provided by Malone (1967) which demonstrated that there is no relationship between results of pure tone sequencing tasks and sentence repetition skills in normal adult subjects. Eisenson and Ingram (1972), on the other hand, argue that linguistic stimuli confuse dysphasic children and, therefore, training should begin with non-linguistic stimuli. As a result, they developed a training program for dysphasic children which was intended to establish representational behavior through an approach which initially bypassed the auditory modality. Using this program, visual matching and sequencing are taught without verbal stimuli. Instructions to the children are given through pantomime. Auditory stimuli are introduced only after a considerable amount of training. First, non-linguistic auditory stimuli which are characteristic of common objects are introduced.

Next, onomatopoetic words such as meow, bang and moo are introduced. More abstract words may be introduced only after the child has been successful at all the previous levels. Eisenson and Ingram (1972) base their arguments in support of the need for such a program on data presented in the literature. They provide no data, however, which directly support the use of the program described above with language impaired children.

Data from the present research relate to this issue in two ways. First, the viewpoint of Rees (1973) would seem to be supported by the lack of significant correlation between language test scores and scores on either the tone identification task or tone sequencing task. Second, data from the present experiment show that some dysphasic subjects respond better in identification and sequencing tasks if linguistic stimuli are used. This supports the viewpoint which favors use of linguistic stimuli for teaching the skills necessary for language use to at least some dysphasic subjects and would seem to refute the viewpoint of Eisenson and Ingram (1972) who contend that linguistic stimuli interfere with learning in dysphasic children.

Non-linguistic Prerequisites for Language Discrimination Skills

Another issue of current interest relates to non-linguistic precursors to language. Some authors (Tallal and Piercy, 1973a, 1973b), have provided data which indicate that dysphasic children have a deficiency in discrimination skills

for non-linguistic complex tones. They interpret this finding as demonstrating a basic deficit in perceptual functioning to which the language deficit is secondary. The implication is that discrimination and sequencing skills for non-linguistic stimuli must precede those skills for more complex linguistic stimuli. Rees (1973), on the other hand, has argued that there are no data which provide support for the existence of such a relationship.

The present research supports the interpretation of Rees (1973). In this study some children, both normal and dysphasic, demonstrated linguistic performance skills at the same time that they demonstrated no complex tone discrimination or sequencing skills. For these subjects, then, failure to identify or sequence tones did not preclude the ability to identify or sequence words. The tone test failures were particularly striking when they occurred in normal subjects because those subjects were highly proficient speakers. Additional evidence in support of the hypothesis that discrimination and sequencing skills for non-linguistic stimuli are not prerequisites for the same skills with linguistic stimuli is the lack of significant correlation between tone test scores and language scores found in the present study.

Tone Tests and Language Skills

The many attempts to use tone test results as a basis for inferences about language skills or language deficits

raise an issue concerning the nature of the relationship between tone tests and language skills. Since no correlation between the tone tests and measures of language skills was found, it may be stated that the complex tone tasks used in the present study provided no basis for making predictions about language skills measured by the language tests employed. If we are to accept that these well respected, commonly used tests are valid measures of language skills, then, one may suggest that the tone test scores have little or no predictive validity with respect to language skills. This contradicts the interpretations made by earlier researchers who used tones as stimuli, but supports the contentions (noted above) of Malone (1967) and Rees (1973). Additional support for the hypotheses of Malone (1967) and Rees (1973) can be seen in the attempt to teach subjects 1D, 2D, and 5D to respond correctly in condition 6 of the tone identification task, and subject 3D in the tone sequencing task, by employing a fading technique. The technique consisted of making a transition from condition 2 (experimenter and word cue present) to condition 6 (experimenter and word cue not present) by slowly decreasing voice volume and gradually moving the experimenter's seat further away from the subject. Since the technique was quite gross, results provide only speculative data. Nonetheless, all four subjects ceased responding correctly immediately following removal of the word cue. Responding persisted at above chance level so long as the word cues were audible (soft whisper) and ceased abruptly.

when word cues were no longer provided regardless of experimenter presence or absence for all four subjects. This occurred despite a considerable amount of training. If some functional relationship between tone test results and word discrimination skills did exist, transfer from correct responding to word stimuli to correct responding to tone stimuli should have been more quickly and easily achieved.

EXPERIMENTER OR CLINICIAN SUPPORT

Another issue to which data from the present study can be related deals with the kinds of experimenter or clinician support which are most effective for dealing with dysphasic children. Although the present study really provides data concerning only experimenter presence or absence and use or non-use of word cues, the experimental paradigm used in this study and the research findings may be a basis for inferences about the study of variables of experimenter or clinician support.

Experimenter Presence

In this research, the presence of the experimenter produced no differences in responding for six of the eight dysphasic subjects. One subject, however, responded significantly better when the experimenter was not present. One other subject responded better when the experimenter was present. These data suggest that, for some children, the presence of an adult may facilitate correct responding whereas, for others, presence of an adult may impede correct

responding. For the latter, use of a teaching machine might be more appropriate than the typical clinician-client, face-to-face therapy. Future research is necessary to further clarify the effects of experimenter or clinician presence on learning by language impaired children. The experimental design of this research might be useful for gathering such information.

Word Cues as Discriminative Stimuli

The present experiment provided a substantial amount of data to support the proposition that some dysphasic children can identify and sequence two naturally produced words even when they cannot do so with two complex tones. This has been discussed in detail on pages 83 to 84. It is mentioned again here because provision of word cues may be considered to be a kind of support which a clinician may provide in order to help a child learn language. Further research is needed, however, to delineate the kinds of linguistic cues which will result in the best learning. The present experiment provides an experimental paradigm which may be expedient in such continued investigation.

GENERALIZATION FROM POOLED DATA

The present study provides data which support the belief that one cannot reliably generalize from pooled data, obtained from a small number of dysphasic subjects, to the individual child with developmental dysphasia. This is in agreement with more general statements made about pooled data

by other researchers (Sidman, 1960; Neale and Liebert, 1972). The issue which then arises is whether one can generalize in any way from any of the data gathered in the present study. Additionally, can studies such as this produce data which are generalizable in a clinically relevant way?

Generalization from research of this sort is possible in terms of the methodological approach used. In other words, the information gathered in the present study can be generalized in terms of the functional relationships between the discriminative stimuli employed and subjects' responses. By focusing on the changes in responding which occurred as a result of the introduction of various discriminative stimuli, for example, it became clear that correct performance increased for some subjects in the presence of word cues and, for others, when the experimenter was not present. When analysis is made at the level of function rather than the level of data, the concern is not so much with how many dysphasic children display a given kind of performance but, rather, with the kinds of experimental manipulations which significantly change their performance. This, in turn, allows generalization directly to therapeutic procedures. For example, since subjects 1D, 2D, 5D and 3D responded at levels significantly greater than the .01 confidence interval in conditions in which words were supplied as cues, it is clear that they would benefit from a manipulation of different stimuli than subject 7D, who performed above that level in conditions in which the experimenter was not present or no

cues were supplied. This kind of information is easily applied to individual subjects and may be directly generalizable to methods of clinical intervention. The methodology used in this experiment may also serve as a model for differential diagnosis. This is possible because the methodology requires identification of the discriminative stimuli which effectively change an individual subject's performance. Such an analysis allows the diagnostician to identify changes in the environment which facilitate or disrupt correct performance as well as behaviors which are present or absent. In terms of clinical applicability, this may be far more valuable than the search for universal pattern of performance using statistical analysis based on pooled data.

DIFFERENCES BETWEEN NORMAL AND DYSPHASIC CHILDREN

An issue concerning the difference between normal and developmentally dysphasic children can also be addressed from the data obtained in the present study. When one analyzes results on the level of data as was done by Lowe and Campbell (1967) and Tallal and Piercy (1973a, 1973b), it appears that normal children possess certain discrimination skills which developmentally dysphasic children do not. Although these differences exist, their relevance to language appears to be questionable and knowledge of their existence is of little pragmatic value. The functional relationships analyzed in the present research, on the other hand, demonstrate many similarities and these may be useful in the

design of remediation procedures for the dysphasic child. Subjects 1N and 5N, for example, demonstrated the same functional relationship between word stimuli and the discriminative response as did subjects 1D, 2D, 5D, and 3D. Specifically, all of these subjects responded above the .01 confidence interval only in conditions in which words were provided as cues. Discrimination skills do appear to be different in terms of the larger number of normal subjects who can discriminate among a wider variety of stimuli. Such a finding, however, in no way demonstrates a basic perceptual deficit in dysphasic children which sets them apart from normal children. The fact that many of the dysphasic subjects who served in the present study performed in a manner quite like that of some normal subjects suggests that such a difference is not significant. Analysis of the functional relationships between the various discriminative stimuli, responses to them, and the reinforcer for each, may provide more accurate and more useful information than is to be seen in the study of scores on some task. Deficiencies in dysphasic children may be demonstrated to be more closely related to for example, attention (i.e. selective discrimination), or to certain other variables which have not been the object of experimental control in research to date.

Clearly further research is essential before highly reliable inferences can be made on the basis of data of the type cited herein. These data do, however, serve to delineate

many new ways to look at some old issues as well as suggesting some new avenues of research.

ADVANTAGES AND LIMITATIONS OF THE PRESENT RESEARCH

Clinical studies such as the present one are frequently seen to have limitations due to the fact that they are conducted in a clinical setting and this study did suffer from some problems of confounding. For example, some of the subjects who served in this study participated in the experimental sessions before their therapy sessions, and some participated after. Some participated before therapy one day and after on another. Also, the experimental procedures were conducted over one entire 15 week semester and during this time many changes in each subject could have occurred. Sometimes subjects were sick and missed a session while others progressed through the experimental program without absence. All of these factors may have introduced sources of variance for which no control was established. Viewed somewhat differently from the laboratory oriented attempt to find pure characteristics, this type of research has a significant advantage. Since a major goal of the present research (and others like it) is to identify those factors which are most relevant to the clinical setting, a typical clinical environment is possibly the most appropriate place to conduct such experiments. The kinds of problems cited above are typical of those which occur in the therapy situation. Consequently, the present model can be seen to

provide a more realizable setting than one which attempts to control all external forces.

The aforementioned problems of uncontrolled variables were dealt with by randomizing experimental conditions and presenting each condition twice. Subjectively, the experimenter observed no difference between experimental performance obtained before therapy versus after therapy. This may have been due to the fact that the experimental task was very different from therapy tasks. The experiment was designed such that all subjects seemed to enjoy participating. This was an additional advantage in that all subjects looked forward to participating in the experimental task and no subject ever refused to participate or reacted negatively during the experiment.

Another limitation was imposed by the shortage of space at the Queens College Speech and Hearing Center where the present experiment was conducted. This situation forced the experimenter to use a single rather small room for both the programming equipment and the response setting. As a result, subjects could hear the clicking of relays as the experimental sessions progressed. Initially, a few subjects made inquiries concerning the presence of the programming equipment. After the second session, however, no distractions were noted. None of the subjects seemed to pay attention to the sounds of the programming equipment during the experimental procedure.

The data from this study exhibited substantial

variability. This may be because subjects who served in this experiment might not have been representative of dysphasic children. On the other hand, it may be that the population generally described as dysphasic is not, in fact, a homogeneous group. This writer is of the opinion that the literature provides some support for the second statement. Future research may successfully address that issue. Because the variability of the pooled data in this study imposed a limitation in terms of generalization, however, the writer was forced to analyze the data more thoroughly. This became an advantage, particularly since generalization to a clinical setting was desired. In this research, the auditory processing characteristics of dysphasic subjects were best analyzed in terms of the kinds of experimental manipulations which changed individual subject performance. One major value of this research lies in the fact that the analyses of those manipulations provided data which are directly generalizable to methods of clinical intervention. This has been discussed in more detail on pages 88 to 90. On those pages, the writer discussed some ways in which the methodology employed in this study provided information which identified some of the specific clinical needs of individual subjects. This study, then, may be useful as a model for obtaining information about other kinds of speech and language impaired children which is directly applicable to clinical procedures.

The individual analyses used in this research also provided some valuable information concerning the kinds of

stimuli used which would not have seemed important if only pooled data had been analyzed. Individual data, for example, showed that more than half of the dysphasic subjects responded significantly better when words were used as cues. These are data on which many questions relating to theories of the basis of language disorders may be founded. A similar suggestion may be made concerning the finding of no significant correlation between scores on the tone tests and scores on tests of language skills. If no significant correlation exists, then the assumption of a functional relationship between tone test scores and language skills is unwarranted.

Results of this study provide support for the notion that linguistic stimuli are appropriate for teaching language to some dysphasic children. They also support the opinion that tests which employ non-linguistic stimuli may not be appropriate for making predictions about language skills. These findings are of value because they may be the basis for suggesting a reevaluation of the kinds of tests and procedures employed for diagnosis and treatment of language impaired children in clinical settings.

The findings noted above served to direct ideas for future research and they will be used to advantage in formulating those ideas.

SUGGESTIONS FOR FUTURE RESEARCH

Several very specific avenues for future research have been made evident by the experience of doing this

research. Many of these relate directly to the issues discussed earlier. Suggestions for future research will, therefore, be discussed in terms of the issues to which the present research related.

Kinds of Stimuli Used in Auditory Discrimination Research

The present research was designed to provide data on which clinically useful inferences could be drawn concerning the auditory discrimination skills of developmentally dysphasic subjects. Findings of the research served to suggest that word cues were useful clinically whereas complex tones were not. Future research is essential to establish actual or potential usefulness of synthetic speech stimuli such as those used by Tallal and Piercy (1974, 1975). Additional research should also serve to identify and focus attention on those units of natural speech stimuli (the phoneme, syllable and phrase) which are discriminated best and which would be most effective units to use at various stages of therapeutic intervention.

Kinds of Experimenter or Clinician Support

The present study analyzed only two aspects of experimenter/therapist intervention. Those were the presence or absence of the experimenter and the use or non-use of word cues by the experimenter. Future research should be designed to identify possibly more subtle aspects of experimenter intervention and to relate those aspects directly to clinical

intervention and its affect on client performance. Much more research needs to focus on the kinds of discriminative cues supplied by the experimenter, the effects of various kinds of reinforcement, and how these interact.

Differences Between Normal and Dysphasic Children

The results of the present research demonstrated some similarities in the kinds of deficits of discrimination skills found in both dysphasic and normal subjects. More research of a comparative nature is needed to evaluate similarities and differences and to discover how these will enhance both diagnosis and the effectiveness of therapy.

Attention as a Factor in Discrimination Skills

A question remains concerning the degree to which variance in performance measures, of both dysphasic and normal subjects, is attributable to lack of attention to the salient feature(s) of the discrimination and/or sequencing task. This is true for earlier studies as well as the present one. Research must be designed which will serve to identify behaviors which are the result of a lack of attention or are due to attention to the wrong discriminative stimulus or to the wrong features of a stimulus.

Chapter 5

SUMMARY AND CONCLUSIONS

SUMMARY

The present research was designed to study five questions. The first involved the assumption that dysphasic subjects would not be able to either identify complex tones or be able to indicate the sequence of them. The research was, therefore, designed to measure the tone identification and tone sequencing skills of children with developmental dysphasia.

The second question involved the assumption that, for dysphasic subjects, different kinds of intervention by the examiner would result in different levels of responding. The study was designed, therefore, to examine the effect on performance of two kinds of experimenter intervention; experimenter presence or absence and use of word cues or omission of word cues.

A third assumption was that analysis of data for individual subjects versus pooled data would suggest different interpretations of results. Data were, therefore, analyzed to reveal performance of subjects as individuals and then pooled across subjects in order to see if different interpretations might be suggested and, if so, the question

was raised as to how these interpretations might influence clinical decision making.

A fourth assumption was that normal subjects would perform significantly better than dysphasic subjects. Data from normal and from dysphasic subjects were, therefore, compared.

The fifth question concerned the measurement of relationship between scores obtained using complex tones as test stimuli and scores obtained on tests of language skills of dysphasic subjects. In order to answer this question, correlation coefficients were calculated in order to show the relationship between tone test scores (with no experimenter intervention) and scores on three tests of language performance.

Procedure

Eight children with symptomatology of developmental dysphasia and eight normal children served as subjects. Ages ranged from four years two months to eight years one month for dysphasic subjects and from four years two months to eight years seven months for normal subjects.

Following a training procedure involving a demonstration of the nature of the experimental task, subjects were required to press one of two panels in a manner which would indicate which of two tones they heard. This task was performed with varying kinds of experimenter intervention. Conditions of experimenter intervention included use of word

cues versus omission of word cues and experimenter presence versus experimenter absence. If subjects responded above criterion level on the tone identification task which included no experimenter intervention, they were asked to respond in a task in which a sequence of two tones was presented and they were required to press two panels in a sequence which corresponded to that of the tones. The sequencing task was presented under the same conditions of experimenter intervention as was the tone identification task. When subjects achieved criterion level of response on either the identification or both the identification and the sequencing tasks, a language sample was taken following the method described by Tyack and Gottsleben (1974) and a mean length of utterance was calculated. In addition, an assessment of receptive language was obtained by administering both the Assessment of Children's Comprehension of Language (Foster, Giddan and Stark, 1972) and the Token Test (DeRenzi and Vignolo, 1962) as adapted by Whitaker and Noll (1972). A correlation coefficient was then computed using language test scores and tone test scores.

Results

In order to present the results clearly, the writer has chosen to discuss them in four separate sections below.

Percent correct and significance of differences between conditions. For all subjects but one who failed to respond at a level greater than chance in at least one

condition, scores significantly greater than chance occurred in conditions in which word cues were used. For these subjects there was also a significant difference in percent correct between conditions employing word cues and conditions not employing word cues. This was demonstrated in both the identification and the sequencing tasks. The above result indicates correct performance for discrimination between two words in the absence of correct performance for discrimination between two complex tones. The one subject who was an exception to this responded at a level significantly greater than chance in conditions in which no experimenter was present. This possibly indicates that, for this subject, the presence of an adult interferes with discrimination skills.

Comparison of pooled versus individual data. If clinical decision making is to be based on research studies such as the one reported herein, it is worthwhile to wonder if the behavior of individual clients can be predicted by review of averages computed from pooled data. Findings of the present study would suggest caution in this regard.

In terms of the percent correct in each condition, pooled data were misleading as predictors of the performance of individual subjects. In the tone identification task, pooled data represented only 38 percent of the individual subjects. In the tone sequencing task, pooled data represented none of the individual subjects.

In terms of the significance of differences in

percent correct between conditions, pooled data were misleading as predictors of the performance of individual subjects. Only half of the subjects demonstrated the same significant differences as were indicated by the pooled data in the tone identification task. Only 25 percent did so in the tone sequencing task.

Comparison of data from normal versus dysphasic subjects. If one were to analyze only the pooled data from the tone identification task, it would appear that there are no significant differences between normal and dysphasic subjects. Inspection of individual results (figures 1 and 5), however, reveals few similarities. Most normal subjects scored above the .01 confidence interval in all conditions whereas more than half of the dysphasic subjects did not. The two normal subjects who did fail to achieve scores above chance level in some conditions, however, demonstrated the same pattern of correct responding as dysphasic subjects. That is, they scored above the .01 confidence interval in the conditions which used words as cues.

In comparing individual data to pooled data (figures 3 and 7) it becomes apparent that pooled data were much more representative of individual performance for normal subjects than for dysphasic subjects.

On the tone sequencing task, neither pooled nor individual data from normal subjects were similar to data from dysphasic subjects on the same task. Pooled data were more representative of the performance of individual normal

subjects than of individual dysphasic subjects. Individual data show that most normal subjects scored above the .01 confidence interval in all conditions whereas only one dysphasic subject did so.

In terms of the significance of differences between conditions in the tone identification task, two normal subjects performed significantly better in the same conditions as did four of the dysphasic subjects. Pooled data from normal subjects are the same as pooled data from dysphasic subjects. Neither are predictive with respect to the majority of individual results within each group.

Correlation between tone test scores and language test scores. Measures of correlation indicated no significant relationship between tone test scores in conditions of no experimenter intervention and language test scores. These results may be interpreted as indicating that tone test scores have little predictive value for language skills of dysphasic children.

CONCLUSIONS

Interpretation of Results

Results of the present study may be interpreted as supporting the hypothesis that tasks requiring the identification and sequencing of complex tones are inappropriate for use in experiments which intend to study normal and deficient language skills. Based on the results of this study, scores on such tasks appear to have no

relationship to language skills as measured by commonly used tests of language comprehension and expression.

The significantly higher scores of many dysphasic subjects and two normal subjects in conditions which used word cues provides some support for the hypothesis that non-linguistic sequencing skills are not prerequisites for development of language skills. Further research is necessary to determine whether this applies to skills other than word identification and sequencing.

Results of the present study may also be interpreted as demonstrating that it may not be appropriate to generalize from pooled data gathered from subjects with dysphasia to any individual dysphasic child. As a result, pooled data from such subjects provide information which may be of limited clinical usefulness.

Using an analysis of the functional relationship between the discriminative stimuli and individual subject responses, it was possible to identify which subjects performed significantly better in conditions in which the discriminative stimuli were linguistic cues. It was also possible to identify the one subject who responded significantly better when no cues were given by the experimenter. These data were directly applicable to clinical intervention with each subject. In this regard, the present methodology may also provide a useful tool for identification of the relationships between various discriminative stimuli and language skills in other kinds

of language impaired subjects.

Suggestions for Future Research

A number of specific areas for future research have become apparent through the experience of doing this research. Those mentioned below are only some of the ideas which may be generated from the present study.

Results of this study served to suggest that word cues were useful clinically whereas complex tones were not. Future research is needed to establish the usefulness of synthetic speech stimuli and to identify those units of natural speech which would be the most effective units to use at various stages of therapeutic intervention.

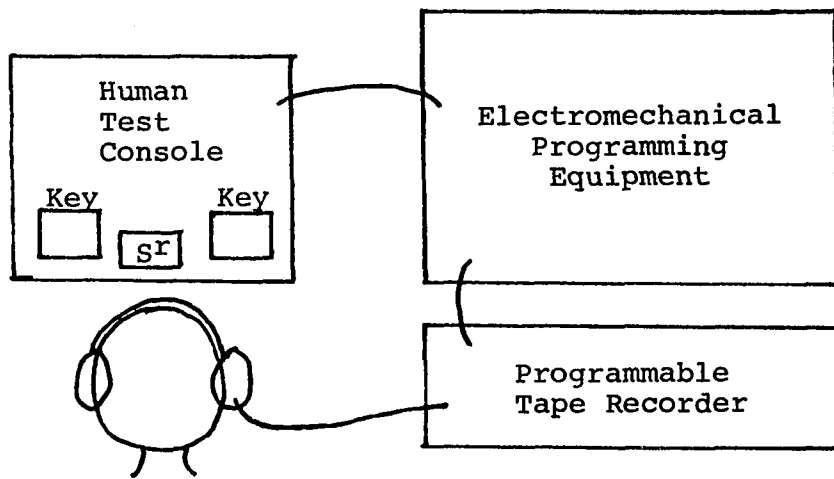
Another possible focus of future research could be on the identification of more subtle aspects of experimenter intervention than those examined in this study, and the relation of those aspects to their affects on the clinical performance of language impaired subjects.

Since certain similarities between normal and dysphasic children were seen in the data of this study, more research of a comparative nature may be in order. Future studies could be designed to evaluate the similarities and differences between normal and dysphasic subjects and to discover how knowledge of these will improve diagnostic and therapeutic procedures. The methodology used in this study may prove useful in the study of a number of the questions mentioned above.

APPENDICES

APPENDIX A

Diagram of Equipment



APPENDIX B

Instructions Given to Subjects for the
Initial Training Procedure

We're going to listen to some sounds. When you hear the sound press here (E points to red circle). Watch me. Listen (tone 1 presented). I heard it -- now I press. Now you do it. (tone 1 presented). You heard it, now you press. Good! (This was followed by ten presentations of tone 1 and then the instructions below.)

Now we're going to hear another sound. When you hear the sound press here (E points to the blue square). Watch me. Listen (tone 2 presented). I heard it -- now I press. Now you do it.

APPENDIX C

Instructions Given to Subjects for the Tone Identification
Task (Training and Experimental)

Now sometimes you will press here (E points to key with red circle) and sometimes you will press here (E points to key with blue square). Listen and press the right one. Watch me first. (Tone presented) it was this one (E presses correct key). My turn again. (Tone presented) Now it was this one (E presses correct key). (Continued for five consecutive trials) Now it's your turn. Listen and press the right one.

APPENDIX D

Instructions Given to Subjects for the
Tone Sequencing Task

Now you will hear two sounds. Sometimes you will press here (E presses key with red circle) and then here (E presses key with blue square). Sometimes you will press here (E presses key with blue square) and then here (E presses key with red circle). Listen and press the right ones. Watch me first. (Tones presented) It was this one and then this one (E presses keys in correct sequence. This is continued for five consecutive trials). Now it's your turn. Listen and press the right ones.

APPENDIX E

Scores of Dysphasic Subjects (in Percent Correct)
On the Tone Identification Task

Subject	Conditions					
	1	2	3	4	5	6
	Scores					
1D	50	100	100	100	60	55
2D	60	95	90	100	40	40
3D	100	100	95	95	90	100
4D	100	90	100	100	100	90
5D	60	95	95	100	55	45
6D	95	100	95	100	95	100
7D	65	65	40	95	90	100
8D	70	85	75	45	50	60

APPENDIX F

Scores of Dysphasic Subjects (in Percent Correct)
On the Tone Sequencing Task

Subject	Conditions					
	1	2	3	4	5	6
	Scores					
4D	45	100	90	95	45	50
5D	50	75	55	55	50	55
7D	95	100	100	100	100	100
8D	55	65	65	50	50	55

APPENDIX G

Scores of Normal Subjects (in Percent Correct)
On the Tone Identification Task

Subject	Conditions					
	1	2	3	4	5	6
	Scores					
1N	65	100	95	100	60	40
2N	100	95	95	100	100	100
3N	90	100	100	90	100	100
4N	100	100	100	100	100	95
5N	35	100	90	100	25	55
6N	90	100	100	90	90	90
7N	95	100	95	80	100	100
8N	75	90	95	100	95	95

APPENDIX H

Scores of Normal Subjects (in Percent Correct)
On the Tone Sequencing Task

Subject	Conditions					
	1	2	3	4	5	6
	Scores					
2N	100	100	95	95	90	100
3N	95	100	100	95	100	100
4N	95	90	95	100	90	85
6N	95	100	95	95	90	100
7N	90	95	80	80	80	95
8N	40	50	60	45	25	55

APPENDIX I

Mean Length of Utterance (MLU) of
Dysphasic Subjects

Subject	MLU
1D	3.36
2D	6.34
3D	5.80
4D	5.35
5D	3.25
6D	6.39
7D	2.92
8D	3.25

APPENDIX J

Raw Scores of Dysphasic Subjects on
The Token Test

Subject	Score
1D	20
2D	35
3D	45
4D	48
5D	23
6D	49
7D	27
8D	21

APPENDIX K

Raw Scores of Dysphasic Subjects on the Assessment
Of Children's Language Comprehension

Subject	Score
1D	74
2D	80
3D	75
4D	76
5D	75
6D	79
7D	75
8D	72

APPENDIX L

Intelligence Quotients of Dysphasic Subjects as Measured
By the Leiter International Performance Scale

Subject	IQ Score
1D	100
2D	96.8
3D	119
4D	139
5D	123
6D	112
7D	100
8D	105

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