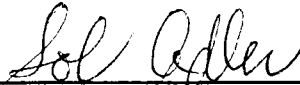


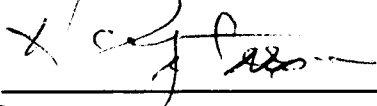
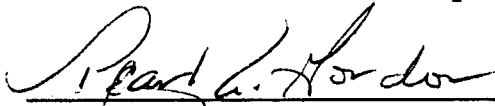
To the Graduate Council:

I am submitting herewith a dissertation written by Lynn Adams entitled "Analysis of Prosody in the Speech of High-functioning Autistic Children." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy with a major in Speech and Hearing Science.



Sol Adler, Major Professor

We have read this dissertation
and recommend its acceptance:



Accepted for the Council:



Associate Vice Chancellor
and Dean of the Graduate School

ANALYSIS OF PROSODY IN THE SPEECH OF
HIGH-FUNCTIONING AUTISTIC CHILDREN

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Lynn Adams

May 1993

DEDICATION

This dissertation is dedicated to my
family who has given me the love and
support to fulfill my dreams.

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ABSTRACT

The purpose of this study was to examine prosody in the speech of high-functioning autistic children in a variety of speaking situations.

High-functioning autistic children and normally developing children between the ages of 11-0 and 14-0 years served as the two groups of subjects. Experimental tasks included syllable pattern repetition, sentence repetition and conversation. The recorded speech samples were analyzed acoustically for fundamental frequency, intensity, and syllables per second. The samples were also judged by trained listeners for perception of pitch, loudness and speaking rate. Group differences and task effects were explored.

Group differences were observed on one of the acoustical measures (fundamental frequency) and on all of the perceptual measures (pitch, loudness, speaking rate). Group and task interactions were not observed on either the acoustical or perceptual analyses. Group differences were observed on accuracy of pattern repetition with the autistic group demonstrating less accuracy on both repetition tasks. Group differences were also found when the conversational samples were judged for use of intonation and stress with the experimental group being rated as abnormal on both variables. Significant correlations were found between the perceptual and acoustic measures on some of the tasks.

The results of this study suggest that listeners judge speech samples of high-functioning autistic children to be different, however these differences were not accounted for from the acoustic analysis used in this investigation. The high-functioning autistic children were less accurate on pattern repetition and their intonation and stress patterns were found to be abnormal compared to the normally developing group.

It was concluded that even when the severity of the autistic syndrome was mild, listeners perceived differences in the use of prosody in various speaking situations. Implications for intervention as well as future research were discussed.

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CHAPTER I

Statement of the Problem

Introduction

Prosody, or the "melody of speech", has an important role in the communication process. It contributes to both speech production and speech perception, carrying vital information beyond that contained in the segmental aspects of speech. The emphasis or stress we place on a word or phrase signals the listener that this portion of the utterance is important. The intonation we attach to our speech indicates our feelings, emotions, and our meaning. Often, the only difference between a sincere statement and sarcasm is the prosodic pattern. The physical parameters of prosody include frequency, intensity and duration. Perceptual features of prosody include intonation, rhythm, rate and stress all of which serve to provide information to the listener beyond that contained in the specific words and grammatical structures employed.

The development of the prosodic patterns of language appears to follow a general sequence regardless of the language being acquired. Furthermore, prosody is found to develop earlier than the segmental aspects of language. For example, falling pitch is the most common contour

observed in speech in the first year of life (DeLack & Fowlow, 1978; Kent & Murray, 1982), while the rising contour is contrastive to the falling pitch and thereby develops later (Vihman, 1988). The use of these contours is apparently established in the first two years of life. It may well be, that deficiencies in the use of prosody in the first year of life could interfere with the segmental development in the second year and thus impede language acquisition. Such an impediment, as Gray and Wise (1959) suggest, may have important ramifications for both the speaker and listener. They described language development in the child as:

"the medium by which he fits himself into his social environment, integrates his thinking and activities into the thinking and activities of those about him, and lets people know what he wants. His awareness of others and his own place in the social order develops as his speech develops and he learns gradually, chiefly through speech, to take his place in that order" (pg. 3).

Deficient use or manipulation of the prosodic features may result in a lack of communicative competence as described in the preceding quotation. One aspect of communicative competence is language pragmatics. Pragmatics refers to the rules regarding the use of language. Prosody, which relies

on the features of stress, rhythm, pitch and intonation (Warren-Leubecker & Bohannon, 1989) has a role in the pragmatic aspect of language development and use. When used appropriately, prosody facilitates communication and speakers can communicate their intentions.

It was Kanner (1971) who first noted prosodic differences in the speech of autistic persons. He described the quality of the autistic person's speech as flat and monotonic. Furthermore, more recent studies have shown that these deficits in prosody appear to persist in the autistic child's speech regardless of any improvement the child might manifest in speech communication skills (Baltaxe & Simmons, 1983; Rutter & Lockyer, 1967). Even some autistic children with near normal or normal language functioning may demonstrate difficulties in the use and comprehension of prosody which aids in the interpretation of the fine nuances of speech and language (Baltaxe, 1984). Such persistent problems have led Rutter (1966) and Ornitz and Ritvo (1976) to refer to the quality of the speech of autistic children as "literal" and "atonal, arrhythmic and hollow".

Numerous investigations have examined the abnormal prosody in the general autistic population using sentence repetition tasks and conversational speech samples (Bagshaw, 1978; Baltaxe, 1981; Baltaxe, 1984; Baltaxe, Simmons & Zee, 1984; Fletcher, 1976; Goldfarb, Braunstein & Lorge, 1956;

Goldfarb, Goldfarb, Braunstein & Scholl, 1972; Pronovost, Wakstein & Wakstein, 1966; Simmons & Baltaxe, 1975). The results of these investigations have shown a broad range of prosodic errors including problems with the use of pitch, intonation, inflection, rate/timing and stress.

In recent years, emphasis has shifted from research of the self-abusive, self-stimulating, and noncommunicative autistic child to include milder forms of the disorder. This subgroup of the autistic population is referred to as high functioning. Volden and Lord (1991) and Rumsey and Hamburger (1990) defined high functioning autistic children as having verbal and/or performance IQ's of greater than 80 on standard intelligence tests. Lord, Mulloy, Wendelboe and Schopler (1991) and Mesibov and Stephens (1990) defined high functioning autistic persons as having measured intelligence quotients of greater than 60. Furthermore, this subgroup of the autistic population has been described as verbal and demonstrating mild/moderate ratings on the Childhood Autism Rating Scale (CARS) (Lord, et al., 1991). As children, high-functioning persons with autism are generally able participate in regular classroom settings for at least a portion of the school day (Rumsey and Hamburger, 1990).

The advent of Public Law 94-142 which mandated appropriate educational and/or habilitative opportunities to all persons with handicaps combined with the potential mainstreaming of handicapped persons, both in school and the

workplace has resulted in a need to address communication skills in these persons. If prosodic deficits are found in the speech of high functioning autistic persons, these deficits may serve to hinder their functioning in society. Studies have indicated that listeners respond differently to persons presenting prosodic deficits (ie. hearing impaired persons, stutterers) and that training to achieve more natural prosodic patterns result in positive listener responses (Bloodstein, 1981; Boone, 1966).

The Problem

While numerous investigations have indicated problems with prosody in the autistic population, none have reported results relative to prosodic differences within the population of mildly autistic or high functioning children. Research pertinent to the use of prosody by high functioning autistic population should be pursued. Furthermore, previous research has used propositional, sentence repetition tasks as stimuli to examine the use of prosody, while neglecting both nonpropositional and conversational tasks.

The Purpose

The purpose of this investigation was to evaluate and describe the type of prosodic impairment found in the speech of the high functioning portion of the autistic population. Objective examination using the Visi-Pitch yielded data used in the examination of main effects including group and task differences. Subjective evaluation by a panel of trained listeners allowed for judgments which were examined for main effects including group and task differences. Finally, the objective and subjective data were utilized to examine correlational relations between the two measures.

This investigation addressed the following questions:

- 1) Do high functioning autistic children demonstrate prosodic differences from normal children?
- 2) If differences exist, are they measurable using acoustic analysis and listener judgements?
- 3) Is there a relationship between acoustic analysis and listener judgements of prosody?

CHAPTER II

Review of the Literature

Autism

The following is a general discussion of major points regarding the definition, etiology, diagnosis, and communication characteristics associated with the autistic syndrome.

Definition

The syndrome, it is not a disease, but rather a collection of symptoms was first identified by Kanner in 1943 (Kanner, 1971). He noted three characteristics of autism including:

- (1) lack of responsiveness to others (social aloofness)
- (2) insistence on sameness in environment
- (3) early onset in first two years of life.

Autism is categorized as a subgroup of the broad heading "pervasive developmental disorder" in the Diagnostic and Statistical Manual-III, Revised (American Psychiatric Association, 1987). It is characterized by distortions in the timing, rate, and sequences of many psychological functions involved in the development of areas such as

social skills and language. The essential symptoms of childhood autism are a lack of responsiveness to other people, disturbances of developmental rate and/or sequences, disturbances of responsiveness to sensory stimuli, gross impairment of speech, language and other cognitive capacities. Furthermore, all symptoms and signs must be present prior to thirty months of age (Ferrari, 1982; Schopler, 1978).

The Autism Society of America (ASA) (1992) defines autism as a

"severely incapacitating lifelong developmental disability that typically appears during the first three years of life. The result of a neurological disorder that affects functioning of the brain, autism and its behavioral symptoms occur in approximately fifteen out of every 10.000 births. Autism is four times more common in boys than girls. It has been found throughout the world in families of all racial, ethnic and social backgrounds. No known factors in the psychological environment of a child have been shown to cause autism" (pp. 27).

Some behavioral symptoms of autism include:

- (1) disturbances in the rate of appearance of physical, social and language skills.
- (2) Abnormal responses to sensations.

(3) speech and language are absent or delayed, while specific thinking capabilities may be present.

(4) abnormal ways of relating to people, objects and events.

Autism can occur by itself or in association with other disorders which affect the function of the brain such as viral infections, metabolic disturbances, and epilepsy (pp.27) (Autism Society of America, 1992).

The characteristic of early onset is no longer essential for diagnosis as it has been recognized that the onset of symptoms may not occur until as late as five or six years of age (Prizant & Wetherby, 1988).

Etiology

The autistic syndrome is suspected to have multiple etiologies. There appears to be a familial trait in some families and the ratio of affected males to females is 4 to 1. Among the etiologies are theories of abnormal brain physiology and brain pathology of genetic and/or environmental origin. While specific etiology remains unknown, it is hypothesized that the pathophysiology of autism is a consequence of abnormal function of cerebral systems required for the experience and expression of drive, affect, and socialization (Rapin, 1987). DeLong (1978) hypothesized that dysfunction is due to a significant lesion in the left medial temporal lobe which appears early in life, impairing the learning of material ordinarily

processed by the left hemisphere. Recent reports have indicated that in some, but not all, autistic boys without severe mental deficiency, the syndrome is associated with hypoplasia of the lobules VI and VII of the cerebellum (Courchesne, 1988).

Numerous brain-behavior theories have been postulated for the autistic syndrome. Damasio and Maurer (1978) and Maurer & Damasio (1982) proposed a model based on dysfunction of the mesiolimbic, striatal, and thalamic systems. Dysfunction of the thalamus has been suggested by Coleman (1979). Focusing on the autistic child's inability to modulate incoming sensory information, Ornitz (1985) proposed that the site of dysfunction is to be found in the central vestibular connections. Frith (1989b) discusses the hypothesis that dysfunction in the dopamine system results in the autistic syndrome.

Diagnosis

The early diagnosis of autism is a difficult task with few children identified during the first eighteen months of life (Prizant & Wetherby, 1988). The development of a consistent early profile is difficult due to the "mode of presentation" during the first year of life. Coleman and Gillberg (1985) identified at least two modes of presentation including the "model" infant who seldom cries and the "terrible" or highly irritable child who could

seemingly never be truly calmed. Additionally, it is now accepted that there are at least two subgroups of children within the autistic population. Freeman and Ritvo (1984) identified these two groups based on their onset of symptoms. They estimated that about 80 percent of autistic children demonstrated observable developmental delays early in life, while approximately 20 percent were essentially normal in their development during the first one or two years of life.

Autism must be differentially diagnosed from other disorders affecting development including mental retardation, hearing impairment, developmental language disorders, visual impairment, Tourette syndrome, and elective mutism. Any of these disorders can co-occur with autism, but cannot be determined to be causal factors of the autistic syndrome. The use of the terms "brain damage" and "minimal brain dysfunction" are not helpful in this instance as the site and nature of damage or dysfunction can be variable (Wing & Attwood, 1987). Psychiatric conditions such as schizophrenia, catatonia, and obsessional disorders must also be differentiated from the autistic syndrome (Wing & Attwood, 1987).

In the Diagnostic and Statistical Manual-III Revised, (DSM-III,R) (American Psychiatric Association, 1987), autism falls in the major category of "pervasive developmental disorders". This category includes infantile autism which

is found to arise early in life presumably on the basis of in-born or acquired central nervous system dysfunction. The pathognomonic symptom is the "autistic social dysfunction" which is (1) not observed in even very young children and (2) not accounted for by mental retardation (Cohen, Paul & Volkmar, 1987). The DSM-III-R criteria for diagnosis of autism are included in Appendix A.

Oral Communication Problems

Kanner (1973) described the communication of autistic children to include 1) mutism, which is occasionally interrupted by the production of a full sentence, usually when the child is in what he/she perceives to be a stressful situation; 2) literalness, including the inability to accept synonyms or differing connotations of the same utterance; 3) echoic repetition of whole sentences; 4) production of sentences that appear to have no relationship or meaningful connotation to the situation in which they are said; 5) pronominal reversals, primarily involving the child's reference to him- or herself as "you"; and 6) failure to use speech, when present, for communicative purposes.

In relation to the segmentals of speech and language, autistic children have been found to demonstrate phonological development similar to that of non-affected children. Word use has been studied with findings indicating that autistic children can develop large

vocabularies, but still demonstrate violations of semantic constraints (Simmons & Baltaxe, 1975), and with retrieval and organizational tasks (Tager-Flusberg, 1981).

Investigation of the use of syntax and morphology by autistic children indicates that while autistic children appear to develop the fourteen grammatical morphemes (Brown, 1973) in the same order as normal children, they tend to have difficulty in the use of the morphemes involving verb tense (Bartolucci, Pierce & Streiner, 1980).

One of the most pronounced characteristics of the communication of autistic children is the frequent use of echolalia. Although it is a salient feature of autistic communication it is neither synonymous with nor unique to the syndrome. Although some echolalia does appear to be nonfunctional and self-stimulatory, both immediate and delayed echolalia can serve communicative purposes for the autistic speaker (Prizant & Duchan, 1981). In some sense, echolalia seems to function as a language acquisition device not entirely dissimilar to a style used by some normal children although it is used to the "extreme" by the autistic child (Paul, 1987). Prizant (1983) proposed that the problems in the use of deictic terms observed with autistic persons may actually be a function of delayed echolalia.

Rutter and Schopler (1987) updated the communication deficits of the autistic to include 1) a delay or total lack

of development of spoken language, not compensated for by gesture or mime; 2) failure to respond to the communication of others; 3) relative failure to initiate and sustain conversational interchange; 4) stereotyped and repetitive use of language; 5) use of "you" when "I" is meant; 6) idiosyncratic use of words; and 7) abnormality in the use of prosody (pitch, stress, rate, rhythm, and intonation).

Use of the Childhood Autism Rating Scale

Although other assessment instruments are available (Freeman, Ritvo, Guthrie, Schroth & Frankel 1978; Rimland, 1971; Rutter, Kalish, Wenar & Wolf, 1977), the Childhood Autism Rating Scale (CARS) is an instrument which was developed for ease of administration, availability and, most importantly, use of severity levels (mild/moderate, severe).

The CARS was developed in 1980 to assess the presence and severity of autism (Schopler, Reichler, DeVellis & Daly, 1980), and was revised in 1988 by Schopler, Reichler and Renner. The CARS, a fifteen item scale is administered by a trained rater during an observation of the child. Each of the fifteen items is scored on a scale from one (no abnormality) to four (severe abnormality). When necessary, the rater consults with individuals who know the child well (e.g., parents,

teachers) and can report on behaviors not elicited during the observation. The CARS yields a severity level of normal, mild/moderate or severe. The mild/moderate level is inclusive of both mildly and moderately autistic persons. The CARS was standardized on a group of 537 autistic children, 55 percent of whom were less than six years of age and only 11 percent of whom were 10 years of age or older. The CARS is reported to be reliable (Parks, 1983) and valid for children up to the age of 13 years (Teal, 1982). Garfin, McCallon and Cox (1988) found the CARS to be "an internally consistent instrument for use with autistic children", indicating that the behaviors assessed by the CARS are relevant to those exhibited by autistic children.

Prosody

Definition

Cutler and Isard (1980) referred to prosody as the "sauce of the sentence which subtly changes or enhances the flavor of the original." Prosody refers to the composite of the acoustic parameters of fundamental frequency, intensity, and duration and their relationship with each other (Baltaxe & Simmons, 1985). Lehiste (1970) identifies the prosodic features as intonation, stress, and quantity (duration). Prosody is what gives speech its emotional tone (Baltaxe & Simmons, 1985). Asp (personal communication, November 1991)

provides a theory that speech is an "extension" of our emotions with the prosodic features (inflection, pitch, syllable stress) being the "reflection" of these emotions.

Development of Prosody in Normal Children

Studies of the development of prosody in normal children strongly support the idea that, early in language development, prosody is more advanced than phonological, syntactic, and semantic development. The early use of prosody by the speaker appears to enhance the perceptions of the listener, and facilitate effective communication (Crystal, 1979; Ervin-Tripp, 1966; Lieberman, 1968; Tonkava-Yampolskaya, 1973). The literature indicates that the development of prosody appears to occur prior to other linguistic features. The earliest developing prosodic devices include manipulation of the fundamental frequency (pitch), manipulation of duration and timing and, the use of stress.

Eguchi and Hirsh (1969) found that pitch (fundamental frequency) was relatively stable for both sexes between the ages of seven and ten years. The authors noted greater intrasubject variability in pitch between the seven to ten year olds than with subjects aged eleven to thirteen years. A rising fundamental frequency contour, which allows for the upward inflection used in questioning, has been noted to develop during the second year (Tonkava-Yampolskaya, 1973).

Kressin, Marquardt and Asp (1976) found that by two years of age, children have a less than three percent error in the imitation of simple rising and falling inflections.

Branigan (1979) has shown that the falling fundamental frequency contour seems to be one of the earliest developing prosodic devices. Koike and Asp (1977) reported that five-year-olds were significantly more adept than three-year-olds at imitating more complex prosodic patterns. Allen and Hawkins (1980) suggest that the control of fundamental frequency and hence pitch manipulation are acquired first.

Available studies of the durational and timing characteristics in children's speech productions have shown that, although such characteristics develop early, children do not achieve adult durational values until mid-childhood and some durational features may not be acquired until early puberty. Young children show longer segment, syllable, and phrase durations than do adults (DiSimoni, 1974a, 1974b, 1974c). Smith (1978) examined the temporal parameters of speech production of two to three year old children and four to four and one-half year old children. The results indicated that the younger group of children had already produced differentiated vowel duration in stress and unstressed syllables. Tingley and Allen (1975) studied the timing characteristics of five, seven, nine and eleven year old children and found that control of timing improved with

age. A study of four-, six- and twelve-year-old children by Kent and Forner (1980) produced similar results.

Individual observations and studies have generally shown that children appear to become responsive to stress patterns of words and phrases by about age two and begin to use stress distinctions in their own speech soon after (Miller & Erwin, 1964). Wieman (1976) showed that children with a mean length of utterance of two words demonstrated an established stress pattern. Hornby & Haas (1970) noted that children as young as four years of age already used contrastive stress as a primary marker of topic-comment distinctions.

In summary, the available information on children's acquisition of prosody indicates that prosodic development appears in advance of other segmental aspects of language. Furthermore, the prosodic parameters, pitch, duration and timing and the prosodic feature, use of stress, are present in the earliest utterances of normally developing children.

Development of Prosody in Autistic Children

Investigation of the use of prosody by autistic children began with Goldfarb, Braunstein and Lorge (1956). Using eighteen children classified as either schizophrenic or with reactive behavior disorders, tape recordings of nondirected conversational speech were made. A speech-language pathologist, unaware of any clinical diagnosis,

made judgements of the samples. Parameters examined included pitch, duration and volume. The results of that study included observations of excessively high pitch with insufficient pitch change and intonational abnormalities referred to as "flatness". Pronovost, Wakstein and Wakstein (1966) examined the speech and language behavior of fourteen institutionalized children, aged five to fifteen years diagnosed as childhood schizophrenics. The authors reported that the echoed speech of their subjects did not imitate the rhythm or intonation of the stimuli, but rather tended to be monotonous in pitch, rhythm and intensity. Goldfarb, Goldfarb and Braunstein (1972) investigated the speech and language of twenty-five schizophrenic children of elementary age. They reported that the subjects produced either too much or too little of a given prosodic feature, or exhibited both too much and too little of said features.

Simmons and Baltaxe (1975) examined language samples from seven adolescent autistic persons, ranging in age from fourteen to twenty-one years and found the adolescent autistic subjects continued to demonstrate varying degrees of prosodic impairment, even following improvement in language comprehension and production. Fletcher (1976), using six pre-adolescent and adolescent subjects, found a significant difference between autistic children and normal controls on sentence repetition tasks requiring imitation of intonation, with the experimental group performing less

well. Furthermore, an age difference was noted with the younger autistic children performing better than the adolescent subjects. Bagshaw (1978) reported that while the autistic subjects demonstrated variability in their use of intonation and fundamental frequency similar to that of the normal control group, they tended to show greater variability in total utterance duration. Baltaxe (1981) reported results suggesting that autistic children differ from normal children in their temporal and rhythmic organization of speech. Furthermore, the autistic subjects differed from normals in their response to questions with the autistic subjects manipulating intensity more than frequency. An investigation of the intonation contours of three distinct groups - seven normal, seven autistic and seven aphasic children (Baltaxe, Simmons and Zee, 1984) resulted in findings which suggested considerable between-group and within-group variability; however, both language-deficient groups generally showed less facility with the manipulation of intonation.

Investigation into the perception of prosody by autistic subjects was completed by Paccio and Curcio (1982). Using five autistic children ranging in age from six to seventeen years, the authors concluded that the pathological echolalia exhibited by their subjects was not merely mimicry of what they heard, but actually consisted of prosodic restructuring, which the authors interpreted as some degree

of comprehension. The authors inferred that the echolalic child who does not manipulate the prosodic features of speech may be more linguistically impaired than those who frequently restructure their echoic responses.

With regard to listener judgments of prosody in non-autistic, language impaired children and autistic children, von Brenda (1983), as cited by Frith (1989a), found the judges made more negative comments regarding the speech of the autistic children than that of the language impaired group. The judges described the autistic samples as "harsh, contradictory, lacking emotion".

In summary, the research regarding the use of prosody by autistic children and autistic adolescents indicates that the use of pitch is abnormal, either being too high or too low. Furthermore, the studies indicate that the use of intonation by autistic children differs from that of normal children, with the speech of autistic children being described as "monotonous" and "flat". A difference in total utterance duration has been reported in sentence repetition tasks. Previous studies have not identified specific subgroups within the autistic population. The studies have not qualified the nature of observed prosodic differences on different tasks, in that all have used either propositional (meaningful) sentence repetition tasks or conversational samples. Only one of the previous studies included both a propositional repetition tasks and pragmatic, conversational

speech sample. None of the studies to date have included non-propositional (non-meaningful), propositional and conversation tasks.

This study examined factors not previously addressed in past research, specifically the severity of the autistic syndrome as related to the nature of the prosodic deficit by including only high-functioning autistic subjects. Further a nonpropositional repetition task, a propositional repetition task, and a pragmatic, conversational sample were included for examination.

The nonpropositional, nonlinguistic repetition task was included for contrast with the propositional, linguistic repetition task. Performance may differ on the tasks as a result of the propositionality; that is, poor performance on the nonpropositional task and improved performance on the propositional task may indicate that the meaningfulness of the stimuli facilitated performance. The converse may indicate that the meaningfulness of the task confounded performance. Because prosody may serve as a pragmatic skill to facilitate effective communication between speaker and listener, the pragmatic, conversational sample was included to examine possible prosodic differences during a more natural communication exchange.

Research Hypotheses

Based on the review of the literature, the following research questions were proposed:

- (1) Is there a significant difference on accuracy of pattern repetition on:
 - (a) syllable pattern repetition tasks and
 - (b) sentence repetition tasksbetween normal children and high functioning autistic children?
- (2) Is there a significant difference in pitch, loudness and speaking rate on:
 - (a) syllable pattern repetition tasks
 - (b) sentence repetition tasks
 - (c) conversational tasksbetween normal children and high functioning autistic children as determined by subjective, listener judgements?
- (3) Is there a significant difference, in the use of fundamental frequency, intensity, and syllables per second on:
 - (a) syllable pattern repetition tasks
 - (b) sentence repetition tasks
 - (c) conversational tasksbetween normal children and high functioning autistic children as determined by objective,

acoustical measures?

- (4) Is there a significant difference on measures of intonation and stress on conversational tasks between normal children and high functioning autistic children as determined by subjective, perceptual judgements?
- (5) Is there a relationship between listener judgements and acoustic measurements of pitch and fundamental frequency, loudness and intensity, and speaking rate and syllables per second of speech samples of normal and high functioning autistic children?

CHAPTER III

Methods and Procedures

Pilot Study

A pilot study was undertaken to assess the methods and procedures proposed for the study. Four normally developing children and four autistic children served as pilot subjects. All normally developing children were able to repeat all stimuli in a sentence repetition task similar to the task outlined for the current experiment. Only two of the four autistic children were able to repeat the stimuli on the sentence repetition task. These two subjects were rated by the experimenter as mild/moderate autistic children using the Childhood Autism Rating Scale (CARS). The two subjects who were unable to complete the task had been previously rated as severely autistic by the experimenter. These initial data resulted in the elimination of severely autistic children from the proposed investigation. Additionally, observation of the mild/moderate autistic subjects indicated a possible difference in their imitation of prosody relative to their spontaneous use of prosody. This observation confirmed the need for inclusion of a conversational sample for analysis and comparison to the imitated speech sample.

Data from the pilot samples were acoustically analyzed using the VisiPitch. It was determined that the samples should be analyzed for the following: fundamental frequency, intensity, and syllables per second. Furthermore, it was determined that an adaptation of Wilson's voice profile (1979) was most useful in making perceptual judgements.

Subject Selection

Normal Subjects

A group of eight normally developing standard English speakers between eleven and thirteen years of age served as controls for the investigation. All were of similar socioeconomic status (working/middle class) so as to control for possible prosodic differences associated with cultural language differences. Seven subjects were Caucasian and one subject was African-American. The subjects were all males and were found to be free of intellectual impairment and to be average to above average in achievement as judged by teacher report. Furthermore, all subjects had normal hearing acuity as measured by puretone hearing screening at 20 dB at the following frequencies: 1000, 2000 and 4000 Hertz. Using parental report and experimenter observation, all subjects were judged to be free of any physical abnormalities which might interfere with normal speech and

language development. Additionally, a parent questionnaire was completed to rule out previous speech and language difficulties and to obtain information relative to socioeconomic status. The parent questionnaire can be found in Appendix A. All samples were obtained either in the subject's home or school in a quiet setting free of extraneous noise. Summary information can be found in Appendix B, Table B-2.

Autistic Subjects

The experimental subjects for this study included autistic children from eastern Tennessee and central North Carolina. Eight high functioning male children with a mild/moderate autistic syndrome, as measured by the CARS, served as subjects for this investigation. Seven subjects were Caucasian and one subject was African-American. Additionally, a parent questionnaire (Appendix A) was completed to obtain information relative to socioeconomic status and previous speech and language intervention if applicable. All samples were obtained either in the subject's home or school in a quiet setting free of extraneous noise. Furthermore, each subject met the following criteria:

1. Be between the ages of 11-0 and 14-0.
2. Demonstrate normal hearing acuity as determined by puretone hearing screening at 20 dB at the following

frequencies: 1000, 2000, 4000 Hz or previous audiological evaluation within one year of the sampling date.

3. Be diagnosed as autistic by a licensed psychologist, according to criteria outlined in the DSM-III, R.
4. Have a rating on the CARS between 30 and 36 (mild/moderate autism) as determined by the psychologist or the experimenter if not previously rated.
5. Measured verbal and/or performance quotient of 60 or above, obtained by a licensed psychologist, using standardized assessment tools.
6. No physical abnormalities which might interfere with normal speech and language development as determined by parent report and experimenter observation.

Furthermore, the subjects in the groups were matched for age, gender and ethnicity. Summary information regarding the subjects can be found in Appendix B, Table B-1.

Rating of Severity of Autism Using the CARS

As noted previously, any subject who had not been rated by a licensed psychologist was to be rated by the

experimenter using the CARS to determine the severity of the autistic syndrome for inclusion in the experimental group. All subjects from central North Carolina had been rated by a licensed psychologist. The subjects from eastern Tennessee had not been rated previously, therefore the CARS was completed by the experimenter.

Experimental Tasks and Testing Procedures

Syllable Pattern Repetition Task (SPRT)

The syllable pattern repetition task is a non-propositional, non-linguistic task. Each subject was presented with two iterations each of four patterns and was asked to repeat the pattern for a total of eight. Each pattern consisted of four productions of the arbitrarily chosen CV syllable /di/. Stress (manipulation of fundamental frequency, syllable duration, intensity) was placed on either the first, second, third or fourth syllable. As the syllable patterns were presented in live voice, the experimenter practiced the patterns so as to produce syllable patterns with relatively constant pitch, loudness and speaking rate. It was determined that a previously taped presentation of the imitative tasks would not be desirable for use with the autistic subjects as it might serve to alienate the subjects from the task. The syllable patterns can be found in Appendix A.

The experimenter instructed the subject that their responses were to be "just like" the experimenter's. A practice procedure including a syllable different from those to be tested was included. These practice patterns can be found in Appendix A. The syllable repetition task followed the practice procedure. The syllable patterns were presented to each subject via live voice. The subjects were cued, with a finger point, to respond following a one second delay. No patterns had to be presented more than once as each subject responded immediately at the finger point cue. The order of the presentation of the syllable patterns did not vary from subject to subject. Each subject's response, as well as the experimenter's stimulus presentations, were tape-recorded on a Panasonic cassette tape recorder, model number RQ-323AS, with a hand-held Superscope Marantz condenser microphone placed approximately three inches from the speaker's mouth.

Sentence Repetition Task (SRT)

In order to obtain a sample of propositional, linguistic utterances, each child completed a sentence repetition task. This task was comprised of eight sentences. The four patterns presented in the syllable repetition task were used in this task and were as follows: "stress" on the first word; "stress" on the second word; "stress" on the third word; and "stress" on the fourth word.

Simple four-word declaratives were included as this sentence type and length were found to be developmentally appropriate for the age group being examined (Owen, 1986; H.A. Peterson, personal communication, October 1991). The stimulus sentences are listed in Appendix A.

The sentences were presented to each subject via live voice and the subjects were told they would be cued with a finger point when to respond. All subjects were readily able to respond after the first presentation of the sentence, therefore, no repetitions or token reinforcement were necessary. The order of presentation of the sentences did not vary from subject to subject. Each subjects' responses, as well as the experimenter's stimulus presentations, were recorded for later analysis. Recordings were made on a Panasonic cassette tape recorder, model number RQ-323AS, with a hand-held Superscope Marantz condenser microphone placed approximately three inches from the speaker's mouth.

Collection of the Conversational Speech Sample

A sample of each subjects' spontaneous conversational speech was obtained. The experimenter elicited the sample using prompts such as "Tell me about ...". In order to obtain samples of similar semantic content and syntactic complexity, two enlarged photographs depicting children at play were utilized to elicit the language sample. A sample

of at least twenty-five intelligible utterances was obtained according to the methods prescribed by Bloom and Lahey (1978) and Owens (1991). All samples contained more than thirty utterances, therefore the first five utterances were discarded and the following twenty-five sequential, acceptable utterances were used for analysis (Berko-Gleason, 1989; Owens, 1991). The samples were recorded on a Panasonic cassette tape recorder, model number RQ-323AS, with a Superscope Marantz condenser microphone placed approximately three inches from the speaker's mouth.

Procedures for Analysis

Perceptual Analysis

Training of Judges.

A panel of three clinically experienced (>150 clinical clock hours) graduate students in speech-language pathology served as judges for the perceptual analysis. Prior to making judgements regarding the speech samples in the current study, a training procedure for the judges was completed. Training tapes were prepared by the experimenter which directed the judges to attend to each of the parameters examined. The tapes consisted of speech samples demonstrating normal and abnormal variations in pitch, loudness and speaking rate for normally developing children between the ages of eleven and fourteen years. The samples

were obtained from children not included in the present study. Each judge had to attain a criteria of greater than 90 percent consistency on judgements of pitch, loudness and speaking rate during the training procedure.

Following the training procedure, both the syllable pattern samples and sentence repetition samples were presented to the panel of judges. The speech samples of both the control and experimental subjects from both imitative tasks were presented in a random order with the judges being aware of age, gender and ethnicity only. The judges were asked to listen for similarities between the experimenter's production and that of the subject. The first decision required the judges to determine if the pattern had been accurately repeated. Then the judges determined if the specific parameter (pitch, loudness, speaking rate) was normal or abnormal. If found to be normal, a zero was assigned by the judge, while a sample judged abnormal was then rated using the rating scale found in Appendix C. Each judge was asked to make three judgements (pitch, loudness, speaking rate) for each of the syllable patterns and each of the sentences on the sentence repetition task. A total of twenty-four judgements were made for each of the two imitative tasks. While the pitch of the subjects may have been higher or lower than that of the experimenter, the listeners' task was to judge whether the pitch appears to be normal, too high or too low for a

child between the ages of eleven and fourteen. The panel rated all samples using the scale found in Appendix C.

The judges then listened to and rated the randomly ordered conversational samples. Each judge was asked to make three judgements (pitch, loudness, speaking rate) for each conversational sample. If found to be normal, a zero was assigned by the judge, while a sample judged to be abnormal was then rated according to the scale found in Appendix C. To examine listener judgements of the subjective features of prosody on the conversational task, specifically intonation and stress, the scale found in Appendix C was used. These ratings were then compared to the measurements obtained from the acoustic analyses to determine correlations between the two measures.

Reliability of Judgements.

To establish interjudge reliability, one judge was randomly chosen as the standard listener and the other two judges' ratings were compared to the standard. With two judges compared to the standard, the level of agreement was as followed:

- (1) pitch = 66% - 87%
- (2) loudness = 73% - 100%
- (3) speaking rate = 73% - 93%

To establish intrajudge reliability, all three judges rated two randomly chosen samples twice. The agreement levels

ranged as follows:

(1) Syllable pattern task

pitch = 77% - 89%

loudness = 89% - 100%

speaking rate = 77% - 100%

(2) Sentence repetition task

pitch = 77% - 100%

loudness = 77% - 100%

speaking rate = 77%- 89%

(3) Conversational task

pitch = 89% - 100%

loudness = 77% - 100%

speaking rate = 77% - 89%

Acoustic Analysis

All the syllable pattern and sentence repetition imitative speech samples were analyzed using the VisiPitch/IBM Interface Model 6098. The cassette tapes containing the speech samples were placed in the Technics cassette deck, model RS B555. The tape recorder was connected to the VisiPitch via a dubbing cord placed in the tape recorder output jack and the VisiPitch auxiliary jack. Each syllable pattern and sentence was analyzed for fundamental frequency (Hz) and intensity (dB). The duration of each item, in both imitative tasks, was measured in syllables per second, e.g. four syllables/time in seconds.

Settings entered into the VisiPitch for the analysis were as follows:

Frequency display scale = 0 to 400 Hertz

Time display window = 0 to 3 seconds

Pitch/Intensity display = stationary

The spontaneous conversational samples were analyzed for average fundamental frequency and average intensity using the VisiPitch/IBM Interface Model 6098 via the auxiliary input. The samples were analyzed for speech rate using a count of syllables per second obtained from the VisiPitch. All utterances were usable and analyzed.

The fundamental frequency and intensity measurements of the VisiPitch were validated using a Kay Elemetrics Sonograph with live speech samples. Measurements using live voice samples were not found to vary significantly from the VisiPitch analyses to the sonograph analyses with fundamental frequency measurements. The fundamental frequency measurements obtained on both were within +/- five Hertz. Also the fundamental frequency measurements obtained for the experimenter's live voice were consistent with fundamental frequency measures obtained previously. The intensity levels obtained on instruments were consistent with levels expected in typical quiet conversational situations (Moore, 1982). Furthermore, measurements were obtained of both live voice and recorded input from the experimenter to the VisiPitch. The resulting fundamental

frequency measurements and intensity measurements did not differ significantly. The fundamental frequency measurements were within $\pm$ five Hertz (Hz) and the intensity measurements were within $\pm$ five decibels (dB).

Reliability of Measurement Procedures.

To establish intraexaminer reliability, the speech samples, both imitative and spontaneous, of four randomly selected subjects were analyzed twice by the experimenter with a two day lapse between analyses. It was determined that the acoustic analyses would be considered reliable if measurements did not vary by more than $\pm$ two Hz and $\pm$ two dB. The second acoustic analyses were found to be consistent (e.g. within $\pm$ 2 Hz, $\pm$ 2 dB) with the first for measurement of fundamental frequency, intensity and speaking rate and the examiner was judged to be reliable.

Data Analysis

Assumption of Normality

Due to the small number of subjects per group, the normal distribution required for the use of parametric statistics could not be assumed. Therefore, a graphic test for normality (Norusis, 1991) was completed. This test demonstrated that 95 percent of all observations fell within two standard deviations of the mean and 68 percent fell

within one standard deviation for each of the acoustic measures. Based on these findings, the requirement of an assumption of normality necessary for the use of parametric statistics was met.

Accuracy of Pattern Repetition

The total number of correct repetitions was determined to assess the accuracy of pattern repetition in both imitative tasks.

Perceptual Data

For each imitative task (syllable and sentence repetition), the listener's ratings of pitch and loudness were collected across all stimulus items. A rating for speaking rate was also obtained for each imitative task across all stimulus items. Ratings were also determined from the conversational sample for pitch, loudness and speaking rate. The judges' ratings for each subject's individual repetitions were coded as follows: "1", if too little of a particular variable; "2", if considered within normal limits; and "3", if too much of a particular variable. These ratings were employed as dependent variables in several comparisons used to test for significant main effects and possible interactions. The main effects examined included group and task differences on ratings of pitch, loudness and speaking rate. The presence

or absence of group by task interactions was examined. Ratings were also obtained for the subjective aspects of prosody, intonation and stress, in the same manner as pitch, loudness and speaking rate were rated. These measures were employed as dependent variables to test for significant group differences.

Acoustical Data

For each imitative task (syllable and sentence repetition), measures of fundamental frequency and intensity across all eight stimulus items were obtained. A measure of syllables per second was also obtained for each imitative task across all eight stimulus items. These measures were employed as dependent variables in several comparisons used to test for significant main effects and possible interactions. The comparisons included group differences, task differences and group by task interactions on measures of fundamental frequency, intensity and syllables per second.

Correlational Data

The measures from the objective, acoustical analysis (fundamental frequency, intensity, syllables per second) and subjective, perceptual judgements (pitch, loudness, speaking rate) were employed to determine the relationships between the acoustical and perceptual measures. For purposes of

correlational analysis, the judges' ratings for each subject's individual repetitions were coded as follows: "1", if too little of a particular variable; "2", if considered within normal limits; and "3", if too much of a particular variable. These judgements were then compared to the acoustic measurements which were coded in the same way as the perceptual data. In coding the fundamental frequency (Fo) data, it was determined that a range for normal would be from 180 to 220 Hz. The range most accurately reflects the normal range of Fo found in the population of 11 - 14 year old children at large (Hollien & Shipp, 1972; Aronson, 1985). It was then determined that any Fo measurement less than 180 Hz would be coded as "1" representing too low and any Fo measurement above 220 would be coded as "3" representing too high. The intensity data was encoded as follows: 40 to 55 dB = "2" representing normal range; less than 40 dB = "1" representing too low and greater than 55 dB = "3" representing too high. With regard to the measure of syllables per second, an SPS measure between 5.0 and 7.0 was determined to be within normal limits and coded as "2", while any measures less than 5.0 were coded as "1" representing too slow and measures above 7.0 were coded as "3" representing too fast. The encoded data from both the acoustic and perceptual measures were then utilized in the correlational analyses.

CHAPTER IV

Results

The results of the analyses used to explore the five research questions will be presented. The relationship between accuracy of repetition and group membership will be discussed first. The results of the examination of possible differences between groups, across the three tasks, according to the perceptual judgements made by trained listeners will be presented, followed by a presentation of the results of the examination of possible differences between groups, across the three tasks, according to acoustical analyses. Finally, the relationships between perceptual judgements and acoustic measures will be described.

Accuracy of Repetition

The first research question addressed whether group differences existed on the syllable pattern repetition task (SPRT) and the sentence repetition task (SRT) with regard to accuracy of pattern repetition. One aspect of these tasks was the accuracy of the repetition of the pattern. Accuracy data for individuals is presented in Table 1. A 2 (group) by 2 (task) ANOVA (Norusis, 1991) yielded a significant

Table 1

Accuracy of Pattern Repetition for Experimental Subjects
(ES#) and Control subjects (CS#) for Syllable Task
(T1) and Sentence Task (T2)

SUBJECT	T1	T2
ES1	0	0
ES2	4	2
ES3	4	7
ES4	4	4
ES5	8	5
ES6	7	8
ES7	5	5
ES8	6	8
CS1	7	8
CS2	8	8
CS3	8	8
CS4	8	8
CS5	8	8
CS6	8	8
CS7	8	8
CS8	8	8

difference between groups ($F\ 1, 16 = 12.81, p < .01$) with the autistic group demonstrating less accuracy of pattern repetition relative to the control group. No task difference was observed ($F\ 2, 16 = .13, p > .05$). The results appear in Table 2.

Perceptual Analyses

Three separate analyses of variance (ANOVA) were used to examine main effects and interactions of the dependent variables pitch, loudness, and speaking rate. Any significant task effects were examined using a Tukey analysis (Norusis, 1991). The alpha level was set at $p < .05$.

T-tests were employed to examine group differences for the dependent variables intonation and stress which applied only to the conversational task.

Pitch

A 2 (group) by 3 (task) ANOVA yielded a significant main effect for group on the dependent variable pitch ($F\ 1, 16 = 6.24, p < .05$) with the autistic group demonstrating higher pitch. No task effect was observed ($F\ 2, 16 = 1.00, p > .05$). No interaction between group and task was present ($F\ 2, 16 = 1.01, p > .05$). Summary statistics from the ANOVA appear in Table 3. A summary of the data can be found in Table 4.

Table 2

Summary Analysis of Variance for Group and Task Effects for Variable Accuracy.

SOURCE	SS	df	F
Group	78.12	1	12.81**
Task	.123	1	.13
Group by Task	.00	1	.00

* $p < .05$

** $p < .01$

Table 3

Summary Analysis of Variance for Group and Task Effects for
Listener Judgments for Variable Pitch.

SOURCE	SS	df	F
Group	1.02	1	6.24*
Task	.17	2	1.00
Group by Task	.17	2	1.01

* $\underline{P} < .05$ ** $\underline{P} < .01$

Table 4

Coded Individual Perceptual Data for Pitch on Syllable
Pattern Repetition Task (SPRT), Sentence Repetition Task
(SRT) and Conversational Task.

Subject	SPRT	SRT	Conversation
ES1	1	1	3
ES2	3	2	2
ES3	2	2	2
ES4	2	2	3
ES5	3	2	2
ES6	2	2	2
ES7	2	2	2
ES8	2	2	2
CS1	2	2	2
CS2	2	2	2
CS3	2	2	2
CS4	2	2	2
CS5	2	2	2
CS6	2	2	2
CS7	2	2	2
CS8	2	2	2

Note:

1 = too little

2 = normal

3 = too much

Loudness

A 2 (group) by 3 (task) ANOVA yielded a significant main effect for group on the dependent variable loudness ($F_{2, 16} = 7.56, p < .05$) with the autistic group rated as louder relative to the control group. No task effect was observed ($F_{2, 16} = .98, p > .05$). No interaction between group and task was present ($F_{2, 16} = .37, p > .05$). Summary statistics from the ANOVA appear in Table 5. Data summary appears in Table 6.

Speaking Rate

A 2 (group) by 3 (task) ANOVA yielded a significant main effect for group on the dependent variable speaking rate ($F_{1, 16} = 5.97, p < .05$) with the autistic group rated as having a faster speaking rate. No task effect was observed. No interaction between group and task was present. Summary statistics from the ANOVA appear in Table 7. A summary of the data appears in Table 8.

Intonation

A significant difference was observed between groups on listener judgements of intonation during conversation with the experimental group's use of intonation rated as abnormal relative to the control group ($t(14) = 5.46, p < .01$).

Table 5

Summary Analysis of Variance for Group and Task Effects for
Listener Judgements of Variable Loudness.

SOURCE	SS	df	F
Group	1.69	1	7.56*
Task	.54	2	.98
Group by Task	.37	2	.37

* $p < .05$ ** $p < .01$

Table 6

Coded Individual Perceptual Data for Loudness on Syllable Pattern Repetition Task (SPRT), Sentence Repetition Task (SRT) and Conversational Task.

Subject	SPRT	SRT	Conversation
ES1	3	2	3
ES2	3	2	2
ES3	2	2	2
ES4	2	2	3
ES5	1	2	2
ES6	2	2	2
ES7	3	1	2
ES8	2	1	3
CS1	2	2	2
CS2	2	2	2
CS3	2	2	2
CS4	2	2	2
CS5	1	2	2
CS6	2	2	2
CS7	2	2	2
CS8	1	2	2

Note:

1 = too little

2 = normal

3 = too much

Table 7

Summary Analysis of Variance for Group and Task Effects for
Listener Judgments of Variable Speaking Rate.

SOURCE	SS	df	F
Group	4.08	1	5.97*
Task	1.04	2	1.47
Group by Task	1.04	2	1.47

* $p < .05$ ** $p < .01$

Table 8

Coded Individual Perceptual Data for speaking Rate on the Syllable Pattern Repetition Task (SPRT), Sentence Repetition Task (SRT) and Conversational Task.

Subject	SPRT	SRT	Conversation
ES1	2	3	3
ES2	1	1	2
ES3	2	2	2
ES4	1	3	3
ES5	2	2	1
ES6	2	2	1
ES7	1	1	3
ES8	1	2	3
CS1	2	2	2
CS2	2	2	2
CS3	2	2	2
CS4	2	2	2
CS5	2	2	2
CS6	2	2	2
CS7	2	2	2
CS8	3	1	1

Note:

1 = too little

2 = normal

3 = too much

Stress

A T-test comparing group means yielded a significant difference between groups on listener judgements of this variable with the experimental group's use of stress rated as abnormal relative to the control group ($t(14) = 5.55$, $p < .01$). This judgement was only applied to the conversational task.

Acoustical Analyses

Three separate analyses of variance (ANOVA) were used to examine main effects and interactions of the dependent variables fundamental frequency, intensity and syllables per second. Any significant task effects were examined using a Tukey analysis (Norusis, 1991). The alpha level was set at $p < .05$.

Fundamental Frequency

A 2 (group) by 3 (task) ANOVA yielded significant main effects for the dependent variable fundamental frequency (F_0). A significant difference was found between groups with the experimental group demonstrating higher F_0 measurements on all tasks ($F 1, 16 = 8.01$, $p < .05$). A significant task effect was also observed ($F 2, 16 = 5.19$, $p < .05$). No interaction between group and task was present ($F 2, 16 = .27$, $p > .05$). Summary statistics from the ANOVA

appear in Table 9. A summary of the data can be found in Tables 10 and 11.

Means used in the follow-up analysis appear in Table 12. Follow-up analysis indicated that the fundamental frequency measurements obtained on the SPRT task were significantly higher than those obtained on the SRT and conversational tasks.

Intensity

A 2 (group) by 3 (task) ANOVA yielded no significant difference for the main effect intensity ($F_{1, 16} = 4.25$, $p > .05$). While not statistically significant, a trend toward group differences was observed with the experimental group presenting greater intensity. No significant task effect was observed ($F_{2, 16} = 1.52$, $p > .05$). No interaction between group and task was present ($F_{2, 16} = .53$, $p > .05$). Summary statistics from the ANOVA appear in Table 13. A data summary can be found in Tables 14 and 15.

Syllables Per Second (SPS)

A 2 (group) by 3 (task) ANOVA yielded no significant difference for the groups on the dependent variable syllables per second ($F_{1, 16} = 3.48$, $p > .05$). While not statistically significant, the control group demonstrated a tendency toward a faster speaking rate. A significant task effect was observed ($F_{2, 16} = 249.03$, $p < .01$). No

Table 9

Summary Analysis of Variance of Group and Task Effects for
Acoustical Measurements of Variable Fundamental Frequency.

SOURCE	SS	df	F
Group	7254.54	1	8.01*
Task	1398.50	2	5.19*
Group by Task	73.36	2	.27

* $p < .05$

** $p < .01$

Table 10

Individual Acoustic Data for Fundamental Frequency on
Syllable Pattern Task.

Subject	Fo	Fo Range
ES1	187.3	184.1 - 191.2
ES2	285.5	257.0 - 325.1
ES3	221.5	199.7 - 241.3
ES4	219.1	202.6 - 258.3
ES5	221.6	201.9 - 247.0
ES6	220.0	193.1 - 259.5
ES7	210.0	206.2 - 215.3
ES8	254.8	241.3 - 262.1
CS1	216.2	201.0 - 240.5
CS2	203.4	177.2 - 233.0
CS3	188.2	178.3 - 203.8
CS4	212.6	207.2 - 216.3
CS5	198.1	190.1 - 207.1
CS6	175.7	169.3 - 181.3
CS7	211.4	203.7 - 217.6
CS8	189.6	184.3 - 199.2

Note:

Fo - fundamental frequency

Table 11

Individual Acoustic Data for Fundamental Frequency on
Sentence Repetition Task.

Subject	Fo	Fo Range
ES1	184.8	180.1 - 190.1
ES2	214.0	192.3 - 239.8
ES3	216.0	189.2 - 240.1
ES4	180.7	136.0 - 273.8
ES5	236.4	218.8 - 251.0
ES6	225.7	191.8 - 246.8
ES7	210.1	206.2 - 218.1
ES8	237.1	225.6 - 250.1
CS1	198.0	191.0 - 219.9
CS2	181.4	156.4 - 211.2
CS3	176.9	168.6 - 188.6
CS4	206.5	202.6 - 210.1
CS5	196.9	190.1 - 203.1
CS6	178.2	164.3 - 189.9
CS7	204.5	198.7 - 210.4
CS8	180.9	174.9 - 186.9

Note:

Fo - fundamental frequency

Table 12

Cell Means and Standard Deviations for Fundamental
Frequency (Fo).

TASK	M	SD
SPRT	213.438	26.812
SRT	201.725	20.458
Conversation	202.269	21.156

Note:

SPRT = syllable pattern repetition task

SRT = sentence repetition task

Table 13

Summary Analysis of Variance for Group and Task Effects
for Acoustical Measurements for Variable Intensity.

SOURCE	SS	df	F
Group	171.39	1	4.25
Task	16.48	2	1.52
Group by Task	.53	2	.53

* $p < .05$ ** $p < .01$

Table 14

Individual Acoustic Data for Intensity on Syllable Pattern Task.

Subject	dB	dB Range
ES1	65.6	61.3 - 70.1
ES2	52.7	48.3 - 60.2
ES3	48.6	45.0 - 51.4
ES4	53.2	46.0 - 51.2
ES5	47.9	46.6 - 50.2
ES6	49.9	48.0 - 51.8
ES7	54.9	52.3 - 60.2
ES8	56.8	54.3 - 60.1
CS1	46.6	44.7 - 49.1
CS2	43.6	42.2 - 46.0
CS3	49.7	48.6 - 51.4
CS4	56.0	51.1 - 60.2
CS5	57.0	54.2 - 61.2
CS6	51.0	48.7 - 53.1
CS7	51.1	47.7 - 56.1
CS8	45.3	35.5 - 59.2

Note:

dB - decibel level

Table 15

Individual Acoustic Data for Intensity on Sentence
Repetition Task.

Subject	dB	dB Range
ES1	64.9	54.4 - 60.1
ES2	49.3	56.4 - 70.1
ES3	53.6	50.2 - 57.7
ES4	55.0	50.2 - 58.0
ES5	51.7	47.0 - 57.1
ES6	53.5	51.9 - 55.8
ES7	56.5	51.6 - 60.2
ES8	55.9	50.2 - 60.1
CS1	47.9	43.4 - 50.3
CS2	44.8	42.0 - 47.8
CS3	49.5	48.6 - 51.6
CS4	55.4	46.1 - 59.9
CS5	55.4	51.2 - 59.8
CS6	50.7	46.2 - 57.2
CS7	52.3	48.9 - 57.0
CS8	53.8	48.8 - 60.1

Note:

dB - decibel level

interaction between group and task was present ($F\ 1, 16 = 3.21, p > .05$). Summary statistics from the ANOVA appear in Table 16. A data summary can be found in Tables 17 and 18.

Means used in the follow-up analysis appear in Table 19. Follow-up analysis revealed that speaking rate used in the conversational sample was significantly faster than that used in both the SPRT and SRT.

Relationship Between Perceptual and Acoustic Analysis

Nine separate Spearman correlation procedures were completed to assess the relationship between the perceptual judgements (pitch, loudness, speaking rate) and the acoustic measures (fundamental frequency, intensity, syllables per second) across each of the three tasks.

Pitch and Fundamental Frequency

The Spearman Correlation (Norusis, 1991) was completed to assess the relationship between the judgements of pitch and the acoustic measure of fundamental frequency on each of the three tasks. A significant correlation was observed on the syllable pattern repetition task ($r = +.5790, p < .01$). Neither the sentence repetition task nor the conversational task were not found to be significantly correlated.

Table 16

Summary Analysis of Variance for Group and Task Effects for
Acoustical Measurements for Variable Syllables per Second.

SOURCE	SS	df	F
Group	1.40	1	3.48
Task	40.88	2	249.03**
Group by Task	.53	2	3.21

* $p < .05$ ** $p < .01$

Table 17

Individual Acoustic Data for Syllables per Second on
Syllable Pattern Task.

Subject	SPS	SPS Range
ES1	3.5	3.3 - 4.0
ES2	3.0	2.3 - 3.4
ES3	2.8	2.8 - 2.4
ES4	4.4	3.5 - 4.8
ES5	3.4	3.0 - 3.7
ES6	3.7	3.2 - 4.3
ES7	3.4	2.9 - 4.0
ES8	4.0	3.5 - 4.3
CS1	3.2	2.8 - 3.8
CS2	3.4	3.2 - 3.9
CS3	2.9	2.7 - 3.5
CS4	3.7	3.6 - 3.9
CS5	3.9	3.4 - 3.9
CS6	4.0	3.0 - 4.2
CS7	3.8	3.4 - 4.0
CS8	4.0	3.9 - 4.4

Note:

SPS - syllables per second

Table 18

Individual Acoustic Data for Syllables per Second on
Sentence Repetition Task.

Subject	SPS	SPS Range
ES1	3.1	2.8 - 3.4
ES2	3.3	3.3 - 4.3
ES3	3.2	2.9 - 3.6
ES4	3.7	2.7 - 4.9
ES5	3.1	2.4 - 4.2
ES6	3.6	3.4 - 3.9
ES7	3.5	3.1 - 4.0
ES8	3.7	3.4 - 4.3
CS1	3.8	3.4 - 4.2
CS2	3.8	3.6 - 4.8
CS3	3.4	3.1 - 3.6
CS4	3.5	3.3 - 3.7
CS5	3.5	3.3 - 3.7
CS6	3.7	3.6 - 3.7
CS7	3.6	3.4 - 3.8
CS8	3.8	3.6 - 4.0

Note:

SPS - syllables per second

Table 19

Cell Means and Standard Deviations for Syllables Per Second (SPS).

TASK	M	SD
SPRT	3.588	.447
SRT	3.500	.268
Conversation	5.500	.621

Loudness and Intensity

The Spearman Correlation was completed to assess the relationship between the judgements of loudness and the acoustic measure of intensity across each of the three tasks. Significant correlations were identified on the sentence repetition task ($r = +.6547$, $p < .05$), and on the conversational task ($r = +.7125$, $p < .01$). No significant correlation was found on the syllable pattern repetition task.

Speaking Rate and Syllables Per Second

The Spearman Correlation was completed to assess the relationship between the judgements of speaking rate and the measure of syllables per second across each of the three tasks. No significant correlations were identified.

CHAPTER V

Discussion

The purpose of this investigation was to explore prosodic patterns in the speech of high-functioning autistic children in imitative and spontaneous speaking tasks. Furthermore, this investigation analyzed the prosodic patterns using acoustic measures and listener judgements. Previous research has reported differences in the prosody of autistic children and adolescents in various speaking situations. Few studies have used acoustic measures to analyze speech samples, with most investigations relying on listener or perceptual judgements. The results of this study on the use of prosody by high-functioning autistic children will be discussed in terms of: (a) accuracy of pattern repetition, (b) perceptual judgements, (c) acoustical measurements, and (d) the relationship between acoustical and perceptual analyses.

Accuracy of Pattern Repetition

With regard to the accuracy of pattern repetition, the autistic subjects were consistently less accurate on both tasks requiring pattern repetition (SPRT & SRT). There was no difference between the nonpropositional SPRT and the

propositional SRT. These findings are similar to those reported by Pronovost et al. (1966) and Fletcher (1976). One can infer from these studies and the present experiment that autistic children have difficulty with the imitation of intonational patterns regardless of the meaningfulness of the stimuli.

Perceptual Judgements

Pitch

In the present study, listeners were asked to judge speech samples with regard to the appropriateness of pitch. A significant group difference was observed on the variable, pitch. The autistic group was abnormal on the use of pitch with all judges reporting that the pitch was higher than expected. These findings are similar to those reported in previous investigations (e.g., Goldfarb, et al, 1956). While the experimental group and the control group were matched for age and gender, it is likely that pubertal differences may have affected these findings as pitch lowers with the onset of puberty. It should be noted that two of the experimental subjects were not only prepubescent but also shorter in stature relative to all other subjects.

In earlier studies of pitch, loudness and duration, results indicated that autistic and autistic-like subjects demonstrated excessively high pitch with insufficient pitch

change and tended to be monotonous in terms of pitch change (Goldfarb et al. 1956; Pronovost et al. 1966). Baltaxe (1981) reported results suggesting that autistic children demonstrated less facility with the manipulation of pitch.

Loudness

In the current inquiry, the autistic group was also rated as abnormal on loudness with judges determining the loudness level was too loud. These findings may possibly be related to results reported by Baltaxe (1981) which indicated that the autistic subjects included in that study were observed to vary intensity rather than frequency in an attempt to respond to questions.

While nearly all previous studies cite intonational irregularities, few specified intensity as a variable and reported abnormalities in the use of intensity and hence loudness (Pronovost et al. 1966; Baltaxe, 1981). Pronovost et al. (1966) reported the use of intensity to be "monotonous", while Baltaxe (1981) reported that intensity was manipulated more than frequency.

Speaking Rate

In the present study, with regard to speaking rate, the autistic group was judged to speak at a faster rate than the normally developing speakers; however, this perceived difference was not supported by the objective, acoustical

measurements.

While Goldfarb et al. (1956) reported no significant findings with regard to duration, Bagshaw (1978) reported greater variability within the autistic group with regard to total utterance duration.

Intonation and Stress

In the present investigation, significant group differences were noted on judgements of both intonation and stress within the conversational sample. The autistic group was rated as abnormal on the manipulation of both intonation and stress. These findings are similar to those reported by Baltaxe (1981) who found that autistic children, even after speech-language intervention, continue to demonstrate abnormalities in the use of intonation and stress. Rather than producing monotonic speech, Baltaxe found that autistic children tend to use intonation and stress at inappropriately relative to their semantic content.

Acoustical Measurements

Fundamental Frequency

Measurements obtained from the VisiPitch in the present study indicated a significant difference between groups for fundamental frequency, with the autistic group demonstrating a higher average fundamental frequency on all three tasks.

It should be noted that most of the mean fundamental frequencies recorded for subjects in both groups on the sentence repetition task (SRT) and conversational sample were found to be within the range expected for the chronological ages included in the study, 11 to 14 years of age (Hollien and Shipp, 1972; Wilson, 1987).

Further analysis revealed a significant task effect with both groups presenting higher fundamental frequencies on the syllable pattern repetition task (SPRT). This task, while using the same stress patterns found in the sentence repetition task (SRT), utilized the consonant-vowel syllable /di/. Consequently, the constriction needed to produce the consonant-vowel syllable /di/ likely resulted in sufficient laryngeal tension causing an elevation of the larynx as well as an anterior projection of the thyroid cartilage. These physiological adjustments were probably a cause of the elevation of the fundamental frequency (Michel and Wendahl, 1975; E. Stone, personal communication, October 1992; D. Telting, personal communication, October 1992).

Only one previous study used acoustical data gathered from analysis utilizing instrumentation. Bagshaw (1978) reported no significant group differences on measurements of fundamental frequency using spectrographic analyses. Measurements taken at discrete points in repeated sentences did not indicate differences in fundamental frequency between normally developing children and autistic children.

Intensity

In the present research, the autistic group, though not significantly different, demonstrated a tendency toward greater intensity across all tasks. It should be noted that most of the mean decibel levels recorded for both groups were within a broad range of normal (Nerbonne and Schow, 1980). The present study's findings are similar to those reported by Baltaxe (1981). That study found that subjects attempted to respond to questions by increasing their intensity rather than manipulating some other parameter of prosody such as fundamental frequency. It is conceivable then that the subjects in the present study manipulated intensity in order to imitate the stress pattern presented.

Previous studies have included intensity as a variable, however those studies did not measure intensity objectively, but reported that intensity was either monotonic or overused by the experimental subjects (Pronovost et al., 1966; Baltaxe, 1981). The finding of "overused" intensity may be similar to the trend noted in the current investigation.

Syllables Per Second

In the current investigation, a trend for significant group differences across all tasks was noted with the control group tending to produce more syllables per second. This tendency could be due to numerous factors including pause time and perhaps oral-motor sequencing abilities.

Furthermore, a significant task effect was observed with the conversational task resulting in a higher SPS for both groups. This difference may have been due to the instructions given to all subjects prior to the SPRT and SRT to repeat the stimulus exactly as presented. The experimenter presented the stimuli at a rate slower than that used in conversational speech and the subjects imitated that rate. Interestingly, while the autistic subjects had considerable difficulty imitating the pattern in terms of stress pattern, they were relatively similar to their normal peers with regard to speaking rate.

Previous investigations (Bagshaw, 1978; Fletcher, 1976) have addressed duration as a variable, but not in terms of syllables per second (SPS). As mentioned before, these studies indicated that variability was present in the autistic group on measures of total utterance duration. The difference between the groups on the conversational task was likely due to factors influencing total utterance duration such as pause time.

Correlations Between Subjective and Objective Measures

In the present investigation, significant group differences were noted on all three subjective listener measures; however, only one objective acoustical measure, fundamental frequency, yielded significant group

differences. Furthermore, the judges consistently rated the autistic subjects as abnormal compared to the normally developing subjects when group membership was not known. This indicates that listeners may perceive subtle differences which are not captured by the acoustic measurements or that the measurements made were inappropriate for the perceptions of the listeners. For example, maybe pitch range or pitch variation may have been more appropriate measures than pitch per se. Of particular interest was whether any significant correlations existed between the listener judgements and acoustic measures.

Pitch and Fundamental Frequency

A significant correlation was found on the syllable repetition task. This finding is related to the acoustical finding that the fundamental frequency (F_0) was found to be higher on the syllable repetition task as a result of the stimuli utilized, the syllable /di/. The listeners were able to identify the pitch change related to the F_0 change.

Loudness and Intensity

Significant correlations were found on two of the three tasks presented, sentence repetition and conversation. Evidently, the listeners were able to accurately identify increases in intensity/loudness which were demonstrated by acoustic measures.

Speaking Rate and Syllables per Second

No significant correlations were found on any of the three tasks presented. Perhaps it was the nature of the instructions given in the imitative tasks or the encoding of the data which resulted in the lack of significant correlations. Examination of the data indicates that subjects spoke at a slow rate on the imitative tasks relative to the conversational task. This is likely a result of the presentation of the stimuli in the two repetition tasks.

It is noted that some listener judgements can be used to predict objective measures. The lack of correlations between the subjective and objective measures on all variables across the three tasks may be a result of the rating scale utilized for this investigation or the method used for the objective analyses. Perhaps the listeners were perceiving subtle differences in the speech of the subjects which were not captured by the VisiPitch as it was used in this investigation. It may be that the nature of prosody, as a semantic and pragmatic skill, cannot be measured effectively by instrumentation. The appropriateness of one's use of prosody can only be determined by a listener.

Effect of Task on Prosody

Generally, listeners perceived differences in the autistic speakers' pitch, loudness and speaking rate regardless of the task. The autistic subjects were rated as abnormal on all three variables for all three tasks. With regard to the acoustic analysis, task differences were apparent on measures of fundamental frequency and syllables per second. For fundamental frequency, both groups produced a higher fundamental frequency on the SPRT. This difference was likely due to the physiological changes required at the laryngeal level and within the vocal tract for the production of the syllable /di/. The task difference noted on the syllables per second measurement was likely due to the presentation of stimuli in both the repetition tasks as the experimenter presented the stimuli at a slower than normal speaking rate. The fact that the subjects produced the stimuli at a slow rate similar to the experimenter lends support to the notion that the instructions presented prior to the tasks (Say it just like me) were understood by both groups. Even though the autistic subjects understood the directions, they did not accurately reproduce the patterns as presented, but rather, the experimental group placed emphasis on other syllables/words in the stimulus items. This indicates that it was possibly difficulty with pattern repetition rather than a lack of understanding of the

directions that resulted in the group differences on accuracy of repetition. As previously indicated, these findings were found to be in agreement with those presented in previous studies (Pronovost et al. ,1966; Fletcher, 1976).

The task difference expected between the syllable repetition and sentence repetition was not supported by the objective measures. It was expected that accuracy of pattern repetition would have been facilitated by the use of meaningful stimuli (sentences) much in the same way that "meaningfulness" has been found to facilitate memory (McDade & Adler, 1980; McCormick and Schiefelbusch, 1990). Perhaps the difficulty observed on pattern repetition was due to a central auditory abnormality such as those found in split brain patients (Musiek, Pinheiro & Wilson, 1980), patients with both right and left hemisphere lesions (Pinheiro, 1977) and some learning disabled children (Pinheiro, 1981).

Limitations of the Study

Due to the relatively small sample size, caution should be exercised in generalization of the results of the present study. However, the findings of this investigation are similar to those reported in previous studies. Furthermore, the relatively poor performance of the high-functioning autistic children on the two pattern imitation tasks should

not be interpreted as being directly related to a prosodic deficit, but rather a pattern repetition deficit. The conversational sample revealed the use prosodic patterns, albeit, abnormal prosodic patterns as opposed to the monotonic speech reported in previous investigations. As demonstrated in the listener comments, the high-functioning autistic children were observed to manipulate pitch, loudness and speaking rate in a variety of intonational patterns; however, these manipulations did not facilitate communication which is the primary function of prosody.

Implications for Intervention

The results of the current investigation have implications for the speech-language pathologist (SLP) providing treatment services to high-functioning autistic children. The results indicated that this subgroup of the autistic population performed similarly to the autistic population in general on pattern repetition tasks. It would seem that intervention focusing on repetition of prosodic patterns would not be advisable due to the pragmatic nature of prosody. It appears that intervention strategies, based on a pragmatic foundation as in Owen's functionalist model (1991), would facilitate improvement.

The results also indicated that the high-functioning autistic children included in this study were not monotonic

and flat with regard to prosody as had been previously reported. The current investigation indicated that the autistic children sampled were readily able to produce intonated and inflected speech; however, it was noted that the use of prosody was generally inappropriate with regard to the semantic content and pragmatic intent. Therefore, the SLP should endeavor to provide his/her clients, patients and/or students with opportunities to both observe and practice intonations and inflections in a variety of pragmatically appropriate settings. To facilitate treatment, the VisiPitch might prove to be a valuable instrument in that it can provide visual feedback regarding verbal productions, as visual abilities in the autistic population often exceed auditory skills (Frith, 1989a). Other instrumentation is available which could provide similar visual feedback including the Computerized Speech Laboratory designed for use with a Kay elemetrics sonograph. The IBM SpeechViewer II could also be utilized in treatment as it provides visual, as well as auditory feedback.

Implications for Future Research

The findings from this study have implications for future investigations that examine, both subjectively and objectively, the use of prosody by autistic speakers.

The results from this study suggest that differences

exist between high-functioning autistic children and their same-age, normal peers as in previous investigations. It appears that even when intellectual functioning is in the low average to above average range, the autistic speaker is not able to use prosody in a manner similar to normally developing speakers. Studies should be undertaken to compare high-functioning speakers to other lower functioning autistic speakers to determine if qualitative and quantitative differences are present within the population. The present study attempted to include lower functioning speakers; however, during a pilot investigation, the low-functioning subjects were unable to complete the tasks even with numerous adjustments in procedures. As the subjects used in the present investigation were in late childhood/early adolescence, further investigation with older autistic subjects would be of value to determine if facility with prosody changes with age, as well as continued educational and social experience.

The present study used an adaptation of Wilson's voice profile to obtain subjective data and the VisiPitch to obtain objective data. Future investigations might utilize different subjective and objective measures to determine if other measures provide alternative findings including utilization of a different rating systems and instrumentation.

CHAPTER VI

Summary and Conclusions

The purpose of this investigation was to examine the use of prosody in high-functioning autistic children across three tasks including syllable pattern repetition, sentence repetition, and conversation. Subjective, perceptual data (pitch, loudness, speaking rate) were obtained from trained listeners, while objective, acoustic data were obtained using the VisiPitch. Several findings provide insight into the use of prosody by high-functioning autistic children. The major findings are listed below:

1. There was a significant difference between groups with regard to the accuracy of pattern repetition with the autistic group performing less well relative to the normal group. Furthermore, this difference was noted on both the syllable repetition task and the sentence repetition task.

2. There was a significant difference between groups on the perceptual judgements of pitch, loudness and speaking rate with the autistic group being consistently rated as abnormal on all dependent variables. No task effects were observed. No group by task interactions were observed.

3. There was a significant difference between groups on the dependent variables intonation and stress according to the perceptual data with the autistic group rated as

abnormal on both variables during conversation.

4. Significant main effects were observed for both group and task on the variable, fundamental frequency (Fo). The autistic group produced a higher Fo on all three tasks. Both groups produced a higher Fo on the syllable repetition task due to the stimulus items included in that task.

5. No significant group difference was observed on measures of intensity. No task effect or group by task interactions were observed.

6. No significant group difference was observed on the measure of syllables per second (SPS). A significant task effect was observed with the conversational task yielding higher measures of SPS for both groups; however this finding is considered to be an artifact resulting from the research design. No interaction of group by task was observed.

7. There were significant correlations between the perceptual measures and the acoustic measures obtained relative to the pitch and fundamental frequency and the loudness and intensity relationship.

8. Based on the above findings (1 - 7), it was concluded that the prosody in the speech of high-functioning autistic children was perceived to be different from normal peers and that these perceived differences were not consistently captured using the present objective analysis method.

9. Suggestions for intervention planning were discussed and included the utilization of visual feedback in the intervention planning.

10. Suggestions for future research were offered. In particular, studies of subgroups of the autistic population were described. Additionally, it was suggested that the relationship between perceptual judgements and acoustic measures be explored.

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APPENDICES

APPENDIX A

I. Autistic Syndrome

- A. Qualitative impairment in reciprocal social interaction (at least two symptoms)
 - 1. Marked lack of awareness of the existence or feelings of others
 - 2. No or abnormal seeking of comfort in times of distress
 - 3. No or impaired imitation
 - 4. No or abnormal social play
 - 5. Gross impairment in ability to make peer friendships
- B. Qualitative impairment of verbal and nonverbal communication and in imaginative play (at least one symptom)
 - 1. No modes of communication such as babbling, facial expression, gesture, mime or spoken language
 - 2. Markedly abnormal nonverbal communication as in the use of eye to eye gaze, facial expression, body posture, or gestures to initiate or modulate social interaction
 - 3. Absence of imaginative activity such as play acting in adult roles, fantasy characters or animals; lack of interest in stories about imaginary events
 - 4. Marked abnormalities in the production of

- speech including volume, pitch, stress, rate, rhythm and intonation
5. Marked abnormalities in the form or content of speech; use of "you" when "I" is meant; idiosyncratic use of words or phrases; frequent irrelevant remarks
 6. Marked impairment in the ability to initiate or sustain conversation with others, despite adequate speech
- C. Markedly restricted repertoire of activities and interests (at least one symptom)
1. Stereotyped body movements
 2. Persistent preoccupation with parts of objects, or attachment to unusual objects
 3. Marked distress over change in trivial aspects of environment
 4. Unreasonable insistence on following routines in precise detail
 5. Markedly restricted range of interests and preoccupation with one narrow interest
- D. Onset during infancy or childhood

Adapted from the DSM - III, revised (1987).

PARENT QUESTIONNAIRE

Subject# _____

Has your child ever received speech and/or language therapy?

YES

NO

If YES, for how long?

Circle the most accurate description:

Father's education: high school graduate
 some college
 college graduate
 other

Father's employment: manager
 laborer
 professional
 other

Mother's education: high school graduate
 some college
 college graduate
 other

Mother's employment: manager
 laborer
 professional
 other

Tone patterns for presentation in the Tone Pattern Task. Each pattern is to be repeated twice.

-
- | | | | | |
|----|-----------|-----------|-----------|-----------|
| 1. | <u>di</u> | di | di | di |
| 2. | di | <u>di</u> | di | di |
| 3. | di | di | <u>di</u> | di |
| 4. | di | di | di | <u>di</u> |
-

Note:

Underlined syllable will be stressed using pitch change, longer duration and greater intensity.

Training patterns to precede the Tone Repetition Task.

1. pae pae pae pae

2. pae pae pae pae

Note:

Underlined syllable will be stressed using upward pitch change, longer duration and greater intensity.

Declarative sentences for the Sentence Repetition task.
Each sentence is to be repeated twice.

1. The ball is blue.
2. That is my car.
3. He is the clown.
4. The boat is red.
5. Give me the shoe.
6. The water is cold.
7. I saw the dog.
8. We want more juice.

Note:

Underlined word to be stressed with pitch change, longer duration and greater intensity relative to other words in utterance.

APPENDIX B

Table B-1

Individual Demographic Data for Autistic Subjects

Subject	Age	Ethnic Group
ES1	13	Caucasian
ES2	11	Caucasian
ES3	11	Caucasian
ES4	13	African-American
ES5	13	Caucasian
ES6	13	Caucasian
ES7	12	Caucasian
ES8	12	Caucasian

Table B-2

Individual Demographic Data for Normal Subjects

Subject	Age	Ethnic Group
CS1	13	Caucasian
CS2	11	Caucasian
CS3	11	Caucasian
CS4	13	African-American
CS5	13	Caucasian
CS6	13	Caucasian
CS7	12	Caucasian
CS8	12	Caucasian

APPENDIX C

Sample # _____

Your initials _____

Please complete the following for each speech sample.
Circle appropriate response.

- 1). Speaker accurately imitated patterns in task #1.
Yes No
- 2). Speaker accurately imitated patterns in task #2.
Yes No
- 3). After listening to all items in task #1, rate the
sample using the following scale.

Pitch

normal

high

low

1 2 3 4 5 6 7

Loudness

normal

too loud

too soft

1 2 3 4 5 6 7

Rate

normal

fast

slow

1 2 3 4 5 6 7

Circle the appropriate descriptive term under each item. For each item not normal, circle
a number on the scale for that item. Do not mark between numbers.

Key: 1 = slight deviation 4 = moderate deviation 7 = severe
deviation

- 4). After listening to all items in task #2, rate the
sample using the following scale:

Pitch

normal

high

low

1 2 3 4 5 6 7

Loudness

normal

too loud

too soft

1 2 3 4 5 6 7

Rate

normal

fast

slow

1 2 3 4 5 6 7

Circle the appropriate descriptive term under each item. For each item not normal, circle
a number on the scale for that item. Do not mark between numbers.

Key: 1 = slight deviation 4 = moderate deviation 7 = severe deviation

- 5). Listen to the conversational sample task #3 and rate the sample using the following scale.

Pitch

normal

high

low

1 2 3 4 5 6 7

Loudness

normal

too loud

too soft

1 2 3 4 5 6 7

Rate

normal

fast

slow

1 2 3 4 5 6 7

Circle the appropriate descriptive term under each item. For each item not normal, circle a number on the scale for that item. Do not mark between numbers.
Key: 1 = slight deviation 4 = moderate deviation 7 = severe deviation

- 6). Rate the conversational sample using the following scale.

Intonation

normal

abnormal

1 2 3 4 5 6 7

Stress

normal

abnormal

1 2 3 4 5 6 7

Circle the appropriate descriptive term under each item. For each item not normal, circle a number on the scale for that item. Do not mark between numbers.
Key: 1 = slight deviation 4 = moderate deviation 7 = severe deviation

VITA

Lynn Adams was born in Coral Gables, Florida on November 12, 1957. She attended elementary school in the Dade County School District and graduated with honors from South Dade Senior High School in June, 1975. The following September she enrolled in Florida State University and in June, 1979 received the degree of Bachelor of Science in Audiology and Speech Pathology. She continued her educational pursuits at Florida State University and in June, 1980 received a Master of Science degree in Speech Pathology. In January, 1988 she entered the University of Tennessee, Knoxville and in December, 1992 received a Doctor of Philosophy degree in Speech and Hearing Science.

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