Prosodic Characteristics Observed in Verbal Children with Autism

by

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Abstract

Children with autism spectrum disorders (ASD) exhibit difficulties with the suprasegmental aspects of speech production, more specifically, with prosody. However, there is a paucity of research regarding the perception of prosody and if young children with ASD exhibit atypical prosody in their speech. The overall purpose of the current study is to describe the prosodic characteristics (i.e., intonation, stress patterns, pitch and phrasing) of young verbal children with autism who are between the ages of 24 and 66 months. The Prosody-Voice Screening Profile (PVSP; Shriberg, Kwiatkowski and Rasmussen, 1990) will be used to identify and quantify the prosodic characteristics observed. These characteristics will be compared to the prosody of typically developing children to determine whether or not there are similar patterns present. Additional information regarding atypical prosody in young children with ASD would provide clinicians with an additional diagnostic tool to rule out or confirm a diagnosis of ASD. Implications of these findings for understanding prosodic deficits in children with ASD and directions for future research are discussed.

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I. Introduction

Autism spectrum disorders (ASD) encompasses a scope of developmental disorders characterized by impairment in social interaction and communication, and repetitive, restrictive patterns of behavior (DSM-IV-TR, 2000). Kanner's (1943) original description of autism included several features of disordered communication such as echolalia, pronoun reversal, pragmatic difficulties and unusual expressive prosody. While the majority of these aspects of communication have been explored in the literature, prosodic ability in young children with ASD is still considered an under-researched area (McCann & Peppe, 2003).

Expressive prosody plays an important role in a range of communicative functions, serving to enhance or change the meaning of what is said (Couper-Kuhlen, 1986). Specifically, speakers use aspects of speech such as rate, rhythm, intonation and stress in order to better communicate details such as the urgency or emotion of the intended message. Because people with autism are known to exhibit difficulty with emotions, affect and pragmatics, it is likely that they will also have difficulty understanding and using prosody in social communication (McCann, Peppe, Gibbon, O'Hare, & Rutherford, 2007).

The speech of children with ASD has consistently been described in the literature as containing atypical vocalizations and unusual prosody, however studies conflict due to differences in methodology (Baltaxe, 1984; Fosnot & Jun, 1999; Grossman, Bemis, Skwerer, and Tager-Flusberg, 2010; McCann & Peppe, 2003; McCann et al., 2007; Sheinkopf, Mundy, Oller & Steffens, 2000; Shriberg, Paul, McSweeny, Klin, Cohen, & Volkmar, 2001). Additionally, research has typically focused on older age groups with wide age ranges (Fosnot & Jun, 1999; Hubbard & Trauner, 2007; Shriberg et al., 2001). To date, studies have not yielded findings that are consistent enough to have clear theoretical or clinical implications. Due to the inconsistencies in the data within this area of research, the present study was undertaken in order to better understand the prosodic patterns of young verbal children with ASD. This study will also investigate whether group differences exist with regard to prosodic characteristics of children with ASD when compared to those present in children with typical development.

II. Literature Review

This chapter describes literature relevant to the research purpose of this thesis. It is organized into five sections: a) classification and characteristics of Pervasive Developmental Disorders, b) social communication deficits in children with ASD, c) suprasegmental aspects of speech, d) prosodic characteristics observed in children with HFA and AS and e) Prosody-Voice Screening Profile (PVSP): An assessment of prosody.

Classification and Characteristics of Pervasive Developmental Disorders

Pervasive developmental disorders (PDDs) are a group of disorders characterized by patterns of delay that affect areas of social, communicative and affective development. These disorders typically have their onset in infancy or early childhood and include disorders such as Autism, Asperger Syndrome, Childhood Disintegrative Disorder, Rett's syndrome and PDD Not Otherwise Specified (PDD NOS) (DSM-IV-TR, 2000; Graziano, 2002; Klin and Volkmar, 1997). PDDs are characterized by similar core clinical features, but vary with regard to symptomatology and course of development (see Appendix A for the complete DSM-IV TR criteria used to define PDDs).

Autism was first identified by Leo Kanner in the 1940's. Kanner's three core diagnostic features of autism became known as the triad of impairment (Kanner, 1943; Kanner, 1971; Wing and Gould, 1979), and include a) impairments in social interaction, b) impairments in communication, and c) repetitive, restrictive patterns of behavior

(DSM-IV-TR, 2000). In addition to the three core characteristics, the diagnostic criteria listed in the DSM-IV-TR specify that delays or abnormal functioning be observed prior to the age of 3 years, in at least one of the following areas: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play. Autism ranges from low-functioning, where individuals may be non-verbal, to high-functioning autism. Autism is one of three disorders recognized in the autism spectrum (ASD). The remaining two include Asperger Syndrome (AS), which lacks delays in cognitive development and language, and PDD-NOS, which is diagnosed when the full set of criteria for autism or Asperger syndrome are not met.

The features used to describe Asperger syndrome include a) significant impairment in social interaction, b) restricted repetitive and stereotyped patterns of behavior and interest, c) engaging in inappropriate or one-sided interaction, d) paucity of empathy, e) speech that is monotonous, rigid or unusually fast and f) poor nonverbal communication displayed by poor eye contact, few facial expressions or awkward body postures and gestures. As stated above, AS differs from autism in that linguistic and cognitive development is relatively preserved. (DSM-IV-TR, 2000; Klin and Volkmar, 1999).

The clinical features of PDD-NOS are severe and pervasive impairment in the development of social interaction or verbal/nonverbal communication skills, as well as stereotyped behaviors, interests, and activities. PDD-NOS differs from the criteria for atuism and Asperger Syndrome in that individuals with PDD-NOS exhibit impairments later in development and symptoms are either atypical or do not meet all criteria necessary to be classified as autism. (DSM-IV-TR, 2000).

In contrast to the PDDs described above, Rett's Disorder and Childhood Disintegrative Disorder are marked by typical early development, followed by behavioral and developmental deterioration with minimal recovery following at least two years of normal development. The essential feature of Rett's Disorder is a loss of purposeful hand movements and the subsequent development of stereotyped hand movements, as well as deceleration of head growth and poorly coordinated trunk and gait movements. Interest in the social environment diminishes in the first few years following onset. There is also significant impairment in expressive and receptive language development (DSM-IV-TR, 2000). Similarly, children with Childhood Disintegrative Disorder exhibit regression in multiple areas of functioning following at least two years of typical development. After the first two years of life, the child has a clinically significant loss of previously acquired skills in at least two of the following areas: a) expressive or receptive language, b) social interaction, c) bowel or bladder control, d) play or e) motor skills. While children with Rett's Disorder and Childhood Disintegrative Disorder exhibit the communicative impairments and behavioral features generally associated with ASD, they differ in these children do not exhibit delays during the early years of development (DSM-IV-TR, 2000).

Social Communication Deficits in Children with ASD

As stated above, one of the key features of ASD is a marked impairment in social communication. Young children with ASD exhibit deficits in areas such as joint attention, the ability to use conventional and symbolic gestures, symbolic play and vocal communication (DSM-IV-TR, 2000; Tager-Flusberg, Paul & Lord, 2005; Klin & Volkmar, 1999; Wetherby, Woods, Allen, Cleary, Dickinson & Lord, 2004).

Deficits in joint attention are manifested by difficulty in using eye gaze to coordinate attention, drawing another's attention to an object of interest and following the attentional focus of another individual. Findings from longitudinal research studies suggest that failure to acquire joint attention may be a core deficit in ASD (Mundy, Sigman & Kasari, 1990; Wetherby & Prutting, 1984; Wetherby et al., 2004). Additionally, because joint attention is a critical developmental milestone, deficits within this area result in a significant impairment in communication and language development.

Impairments in the ability to use conventional and symbolic gestures have been documented by numerous studies (Loveland & Landry, 1986; McHale, Simmeonsson, Marcus & Olley, 1980; Stone & Caro-Martinez, 1990; Wetherby et al., 2004). Children with ASD lack the use of many conventional gestures, such as showing, waving and pointing, as well as symbolic gestures such as depicting actions and head nodding. Instead, they predominantly use primitive gestures, such as manipulating, pulling or leading another's hand to communicate. In lieu of developing conventional communication skills, children with ASD often develop idiosyncratic or inappropriate behaviors to communicate, such as aggression, self-injurious behavior or tantrums.

Children with ASD exhibit significant deficits in symbolic or make-believe play, that is, the ability to use pretend actions with objects. They also demonstrate limited abilities to use objects functionally (i.e. driving a toy car, using a spoon to feed a doll). A lack of varied, spontaneous symbolic play is one of the core features of impairments in communication used to identify young children with ASD (DSM-IV, 2000). Symbolic play has a significant correlation with the development of receptive and expressive language. Therefore, deficits within this area result in delays in the development of language and communication (Dawson & Adams, 1984; Wetherby & Prutting, 1984; Wetherby et al., 2004).

Lastly, children with ASD demonstrate variability in the use of vocal communication. This contributes to the wide range of speech and language skills exhibited by this population. Some children with ASD use a limited consonant inventory, while others show more complex vocalizations (McHale et al., 1980; Wetherby et al., 2004). Although some children with ASD are able to produce more complex utterances than children with low-functioning autism, the speech patterns produced by this population have been shown to differ from their typically developing peers. Differences noted in observational studies include deficits in the use of pitch, voice quality and volume control, monotonic intonation and abnormal stress patterns (Klin & Volkmar, 1999; Lord & Paul, 1997; Shriberg, Kwiatkowski & Rasmussen, 1990). These affected areas are known collectively as the suprasegmental aspects of speech. Deficits within this area of communication greatly interfere with the ability to functionally communicate through expressive language.

Suprasegmental Aspects of Speech

Speech is divided into two domains, segmental and suprasegmental. Segmental aspects include the phonological organization of speech sounds and the production of these sounds by the speech mechanism (Shriberg, Kwiatkowski & Rasmussen, 1990). Suprasegmental aspects, or prosody, are defined as the characteristics of speech that enhance and regulate the meaning of what is said (Paul, Augustyn, Klin, & Volkmar, 2005). Information regarding the speaker's intent, feelings or speaking style are all conveyed through prosody.

Prosody is a collective term used to refer to three features of language; phrasal stress, boundary cues and meter. Phrasal stress occurs when a word in a phrase is made more prominent by making it louder, longer in duration or higher in pitch. Boundary cues consist of pauses, as well as changes in pitch or duration that occur at the end of a phrase or utterance. Meter, also known as rhythm, is the relationship between the use of stressed and unstressed syllables in words and phrases to convey meaning (Gerken & McGregor, (1998). The three features of prosody have been subdivided into three categories: grammatical, pragmatic and affective prosody.

A speaker uses grammatical prosody to clarify the communicative intent of a message, and includes aspects of speech such as meter, lexical stress and pitch. Meter, or rhythm, refers to the regular pattern of stressed and unstressed syllables used in words and phrases (Gerken & McGregor, 1998). There are two types of meter used in speech: lexical meter and phrasal meter (Gerken & McGregor, 1998; Hayes, 1982). Lexical meter is used to describe the patterns of weak (unstressed) and strong (stressed) syllables used in English (i.e.,AriZOna versus aMERiCAna). Phrasal meter is used to describe the way in which grammatical morphemes in phrases are grouped so that no more than two unstressed syllables occur in a sequence. For example "he COULD have BEEN a contender" versus "he COULD have been PRESident." In the first sentence, the words "could" and "been" are both stressed in order to avoid a long sequence of unstressed syllables. In the second, the first syllable of "president" is stressed, therefore "been" is not stressed in order to avoid a sequence of stressed syllables. Lexical stress is similar to meter, but differs in that it is used to indicate syntactic information, such as whether a word is being used as a noun or verb. For example, a speaker will place stress on the first syllable of the word ‘present’ to indicate it is being used as a noun, versus placing stress on the second syllable to indicate the word is being used as a verb. This particular type of stress is also known as a pitch accent, because the emphasized or stressed syllable is usually pronounced at a higher pitch than surrounding, unstressed syllables. Speakers also use pitch to indicate phrase boundaries. Phrase boundaries denote the end of a sentence, and signal whether a given utterance is a question or statement (Gerken, 1996; Shriberg et al., 2001).

Pragmatic prosody is used by a speaker to relay social information beyond that conveyed at the syntactic level. Through the use of contrastive stress, pragmatic prosody draws attention to certain elements within a sentence, separating the presentation of new information from old information in a given conversation (Paul et al., 2005). For example, “the boy PUSHED Sarah,” versus “the boy pushed SARAH.” In the first sentence, the speaker is emphasizing the action performed by the boy; in the second sentence, the speaker is emphasizing who was pushed by the boy.

Affective prosody serves more broad communicative functions than the two previous prosody types. It includes the modal register or habitual pitch used by the speaker, and differences in speaking style depending on the speaker’s audience. For example, a child will use a more formal speaking style with an authority figure versus a fellow student. Affective prosody is also used to convey a speaker’s emotional state, such as feelings of agitation versus relaxation (Bolinger, 1989; McCann, Peppe, Gibbon and

O'Hare, 2007). Together, the characteristics of prosody function to convey different aspects of a speaker's message, which include the speaker's intent, emotions and/or speaking style.

Together, these aspects of prosody function as a link among lexical, phonological and syntactic variables used during communicative exchanges. Though the prosodic system is complex, research has shown that sensitivity to prosodic cues such as pitch and boundary cues begins as early as infancy (Cooper & Aslin, 1990; Gerken, 1996). Research further suggests that young children learn to organize their own speech and language by experimenting with prosodic cues (Allen & Hawkins, 1980; Demuth, 1996; Fee, 1997; Snow, 1997). While there appears to be a relationship between the development of prosody and language, the exact role that prosody plays is unclear. To date, several theories have been developed in an attempt to better explain the correlation between the two variables.

Theories of Prosodic Development

Concerning the acquisition of prosody, two general theories exist in the language development literature: the stressed and final syllable account (Echols & Newport, 1992; Gerken, 1994; Snow, 1997) and the prosodic hierarchy (Demuth, 1996; Demuth & Fee, 1995; Fikkert, 1994). The theories are similar in that each recognizes that prosody develops as children learn how to manipulate and expand upon the many facets of prosody in speech. In spite of this agreement, the details of each theory differ. Because there are slight variations among the particular theories, one specific theory for each group will be discussed.

Gerken's (1994) stressed and final syllable account is based on analysis of speech samples of two-year old children. The author states that children early in language development apply a trochaic foot, or strong-weak metrical template to their productions of adult target words. For example, when children are asked to imitate a four-syllable word with a weak-strong-weak-strong (WSWS) metrical pattern, such as phoTOgraPHY, they are more likely to omit the first weak syllable than the second because it does not coincide with the metrical template. That is, the second weak syllable is produced because it forms a trochaic foot (S-W) with the strong syllable TO; the first weak syllable cannot form a trochaic foot with any other syllable and is therefore, omitted with a higher frequency. While children at this age are omitting prosodic units of speech, it is important to note that they seem to have an understanding of stress patterns used in language and are beginning to assign stress appropriately in their early productions of multisyllabic words.

Demuth (1996) offers a theoretical framework for the acquisition of prosodic structure using child productions taken from Fikkert (1994). Demuth's prosodic hierarchy suggests that children are working simultaneously at the segmental and prosodic levels to develop language. Additionally, the author suggests that at a young age, correct language production is limited due to grammatical constraints, and that these constraints lessen as productions mature. Examples of grammatical constraints include omission of vowels and consonants, substitution of consonants and weak syllable deletion. Demuth's four stages in the development of prosody are outlined below:

1. Stage I: Children are 1:4-1:5 years old. Children use core syllables in the production of intended words. Word shapes are limited to CV productions ("gu" for "juice") and children's productions are approximations of the adult form of the word. At this early stage, children do not distinguish vowel length (i.e., they use short and long vowels interchangeably) and lack the use of contrastive vowels in their productions. That is, a child may use one vowel in all word productions instead of using a variety of vowels.
2. Stage II: Children are between the ages of 1:6 and 1:10. During this stage of prosodic development, the child begins to use a variety of word shapes in speech production, including CVC, CVCV and CVV. Initially, children delete final consonants (i.e., "/ba/" for "ball") or substitute final consonants (i.e., "baf" for "ball"). As children prepare to transition to Stage III, they begin to show variations in the use of vowels and length of vowels.
3. Stage III: This stage begins around age 2:3. Children at this stage begin to develop a better understanding of the prosodic structure of words and the use of prosody in speech. Children tend to either delete weak syllables but keep the primary stress of the word (i.e., "mado" for "tomato") or substitution of consonants ("domado" for "tomato"). Although productions still contain errors, children in stage III exhibit the use of primary stress in their productions.
4. Stage IV: Children are 2:3-2:4 years old. Children begin to use the adult forms of words. Extra syllables may be added to words (i.e., "ele-ma-phant" for "elephant").

Demuth states that during the later stages of prosodic development, children's productions either satisfy syllabic requirements (i.e., "domado" for "tomato") of words or the prosodic structure of words (i.e., "MAdo" for "toMAto"), but rarely satisfy both. Furthermore, the author explains that variations in the shape of the prosodic structure of words can be accounted for in terms of the grammatical constraints that are present during each stage of development. These constraints will change as grammar improves and becomes more representative of adult models.

These two models, although offering differing explanations, share the common view that prosodic development begins shortly after children begin to develop language. Furthermore, research from both authors indicates that by age 2, children appropriately integrate prosodic cues into their language productions. This would suggest that although prosody is complex, typically developing children comprehend and use prosody automatically from an early stage in development. In addition to the studies conducted by Gerken (1994) and Demuth (1996), a body of research exists that supports aspects of both theories discussed. More importantly, the research confirms that children master basic aspects of prosody at a young age (Allen & Hawkins, 1980; Gerken & McGregor, 1998; Klein, 1981; Snow, 1994).

Prosodic Characteristics of Children with Typical Development

Several research studies have been conducted in order to determine the role prosody plays in the organization of early language production in typically developing children (Allen & Hawkins, 1980; Gerken & McGregor, 1998; Klein, 1981; Snow, 1994). The majority of research studies that have examined prosodic development have looked at children between the ages of 18 and 30 months. Studies regarding the prosody of typically developing (TD) children can be separated into two main groups: a) omissions of unstressed syllables as well as b) perceptual and acoustic measurements. These studies will be reviewed according to each type in the following sections.

Omissions of Unstressed Syllables in Children with TD.

Several studies suggest that children's omissions of unstressed syllables play a considerable role in language development (Allen & Hawkins, 1980; Gerken & McGregor, 1998; Klein, 1981). Results from these studies indicate that young children are more likely to omit unstressed or weak syllables than stressed or strong syllables in their utterances. Omissions include syllables in multisyllabic words as well as syllabic grammatical morphemes from phrases and sentences (i.e., "banana" → "nana" or "she PETS the DOG" → "PETS DOG").

This research supports Gerken's (1994) model of prosodic development, earlier defined as the stressed and final syllable account. In addition to the explanation of the metrical template offered by Gerken (1994), several researchers have stated that children exhibit this prosodic pattern because stressed syllables tend to be longer and higher in amplitude and pitch than unstressed syllables (Echols, 1993; Kehoe & Stoel-Gammon, 1997; Snow, 1997). Additionally, final syllables are usually longer in duration than non-final syllables. Together, these characteristics make stressed syllables more salient perceptually than unstressed syllables and therefore, are omitted less frequently than unstressed syllables.

Allen and Hawkins (1980) examined this account in five children between the ages of 2:2 and 3:9. The purpose of the study was to a) determine the degree to which children use weak syllables appropriately in their utterances and b) determine whether there was a pattern of occurrence for weak syllable deletions. Conversations were recorded with each child and were used for further analysis. In relation to the degree to which children used weak syllables appropriately, results showed that the children differed greatly in their ability to produce weak syllables, ranging from 65% for the child that used weak syllables most frequently to 35% for the child who used weak syllables the least. The authors compared patterns of weak syllable deletion to chronological age for each participant and found the two variables were only weakly correlated. This finding suggests that there is substantial variation in the development of prosody in typically developing children. In relation to a pattern of occurrence, the authors found that weak syllables were deleted in two specific environments: a) in the word initial position (i.e., "WAY" for aWAY) or b) when two weak syllables appeared in succession (i.e., "SOMEBA" for "SOMEbody"). This observation confirms Gerken's (1994) view that children's speech tends to follow a trochaic metrical template in which weak syllables that stand alone are omitted, and weak syllables that follow a strong syllable are produced.

Results indicate that prosody plays a critical role in early language development. The emergence of prosodic features such as lexical stress appears to serve as a guide for the development of more complex language productions. That is, as children begin to integrate prosodic cues into their speech, they begin to use utterances that are more lexically and syntactically complex. These predictions concerning the relationship between prosodic acquisition and language development remain untested. Therefore, there is a need for empirical research within this area.

Perceptual and Acoustic Assessment of Prosody in Children with TD.

Research regarding the perceptual and acoustic characteristics of prosody in typically developing children has examined topics such as the acoustic properties of early utterances as well as the development of phrasal stress, boundary cues and final utterance lengthening (Allen & Hawkins, 1980; Carter, 1996; Klein, 1981; Snow, 1994). Although the amount of literature within this area is small, results of studies conducted have shown that typically developing children tend to master these aspects of prosody by 30 months of age.

Carter (1996) conducted a study to determine whether or not children who omit weak syllables leave an acoustic "trace" of the omitted syllable in their utterances. Carter proposed that children who omit weak syllables demonstrate an understanding that the syllable should exist in their production. Two explore this hypothesis, two-year olds were introduced to dolls whose names contained a strong-weak stress pattern (i.e., SANdy) and a weak-strong-weak pattern (i.e., caSANdra). The children were then asked to produce sentences containing the names of the dolls. Results showed that the participants frequently omitted the initial weak syllable of "Casandra." The sentence productions were then examined acoustically to determine whether or not the children left a "trace" of the omitted syllable. It was determined that the duration from the onset of the verb to the onset of the name was longer in duration for sentences in which the syllable was omitted (i.e., He pushed ~~Ca~~sandra) than when the syllable was preserved (i.e., He pushed Sandy).

Therefore, Carter concluded that although children omit the first syllable of words with a weak-strong-weak syllabic structure, they seem to maintain a place for the omitted syllable in their productions. This would suggest that at a young age, children conceptually understand prosodic cues in speech, but are not necessarily able to formulate these cues in their own speech.

With regard to studies using perceptual or acoustic measures to determine children's mastery of prosodic cues, features such as phrasal stress and boundary cues have been studied (Klein, 1981; Snow, 1994). Klein (1981) perceptually examined the phrasal stress patterns of a child approximately 2 years of age. Results from the study indicated a correlation between familiarity of words and the child's ability to correctly use primary stress. Familiar words were judged to be those words that the child produced with a higher frequency spontaneously than imitatively and were used multiple times throughout the speech sample. Data showed that the child did not misassign stress to any of these familiar words (i.e., A-pple, HOR-sie) across several productions. For words that the child was less familiar with and were produced imitatively, correct stress was exhibited less often. For unfamiliar words, the child used primary stress correctly 24% of the time, misplaced stress 13% of time (i.e., stress was consistent but inappropriate) and used level stress (i.e., equally stressed two or more syllables of a word requiring only primary stress) 63% of the time. Examples of misplaced stress include (paPER) instead of (PAper); examples of level stress include (BRO-KEN) instead of (BROken). Klein concluded that the child's use of stress at his current stage of language development appeared to be lexically based. Therefore, he demonstrated more consistent stress placement for words that were part of his spontaneous repertoire than those that were primarily imitative. Klein also found that as words became more familiar to the child, productions were produced with more consistent primary stress placement.

Snow (1994) described the development of intonation and phrase-final lengthening in nine typically developing children. Intonation was examined with regard to the fall in fundamental frequency that occurs in the final syllables of utterances to indicate the end of an utterance. Phrase-final lengthening is a timing feature used to indicate syntactic boundaries in speech by lengthening the last syllables of phrases. It was examined by measuring the length of the final syllable of an utterance in comparison to non-final syllables. Data collection began when the participants had a vocabulary consisting of at least 30 words. Although participants were at the same point in linguistic development, they differed in age from 12 to 20 months. Collection of speech samples took place over a period of nine months. Over this nine-month period, all participants transitioned from single-word utterances to combinatorial speech. Speech samples were elicited in semi-structured play activities involving the child, caregiver and investigator. A total of four sessions were carried out; each session was 30 to 45 minutes in length. With regard to intonation, results showed that this prosodic feature was present early in the study when children were still using one-word utterances. With regard to phrase-final lengthening, analysis indicated that this prosodic feature was present during the first session, disappeared, and reappeared during the third or fourth session. Snow concluded that this prosodic cue was initially present because the children were imitating adult models and then later acquired independent use of this prosodic cue, usually within 3 months after the development of combinatorial speech. Results from the study also showed that although intonation and phrase-final lengthening are correlating features of prosody, children master use of intonation several months before they master phrase-final lengthening. Both features are not used in combination until children transition to combinatorial speech. This finding supports the evidence suggesting that prosodic development is a gradual process, and that prosody becomes more adult-like as lexical and syntactic complexity increase.

In summary, studies that have examined children's early uttterances suggest that prosody greatly influences the speech productions of typically developing children. Results from each study discussed indicate that use of prosody becomes apparent following onset of first words and continues to develop into early preschool years. While some variability exists with regard to age of mastery, studies within this area indicate that typically developing children independently and consistently use prosodic cues such as phrasal stress, intonation and boundary cues by around 30 months of age. These findings are important because they have provided both researchers and clinicians with a comparative measurement with which to assess the presence of abnormal prosody in children with language deficits, such as children with language impairments (LI) and children with autism. Although research concerning prosodic development within these two populations is limited, results indicate that young children with LI and autism have difficulty recognizing and using certain aspects prosody in their speech.

Prosodic Characteristics Observed in Children Speech and Language Impairments

The American Speech-Language-Hearing Association (ASHA) has defined a speech and/or language impairment as a communication disorder, such as stuttering, impaired articulation, language impairment or a voice impairment that adversely affects a child's educational performance. More specifically, ASHA has defined language disorder as an impairment in "comprehension and/or use of a spoken and/or other symbol system. The disorder may involve a) the form of language, b) the content of language, and/or c) the function of language in communication in any combination" (ASHA, 1993). Several types of language disorders have no known concomitants. These disorders are typically defined by exclusion, that is, in absence of factors such as sensory disorders, neurological damage, emotional problems or environmental deprivation (Paul, 2007). Such disorders are categorized as specific language impairment (SLI). SLI is a form of developmental language impairment in which children demonstrate difficulties in language comprehension and/or production, despite showing normal development in all other areas. For example, a 7-year old child with SLI may exhibit the speech of a typically developing 3-year old, using short, ungrammatical utterances with simplified speech sounds (i.e., "me go there"). SLI is a heterogeneous disorder, varying in both severity and profile of the disorder. However, in most cases children with SLI demonstrate problems with both understanding and producing spoken language (Leonard, 2006).

Recent studies suggest that children with LI, including those with SLI, display subtle differences in their prosodic abilities. Since prosody seems to play a large role in language development, it serves to follow that children with deficits in language may also have difficulty with prosody. Difficulties include the perception and understanding of prosodic patterns and incomplete control over phrasal stress (Crary & Tallman, 1993; Hargrove, 1997; Goffman, 2004; Wells & Peppe, 2003). With regard to this area of research, studies used either acoustic or perceptual methods to assess prosody. These two types of research will be addressed accordingly in the following sections.

Acoustic Assessment of Prosody in Children with LI.

Crary and Tallman (1993) investigated the intonation abilities of seven children with speech disorders and seven children with age-appropriate language abilities. The children with speech disorders demonstrated multiple articulation errors, poor expressive syntactic abilities and poor motor-speech performance. Each group contained five boys and two girls. The average age for each group was 5:7. All participants were required to imitate 40 stimuli containing either a rising or falling intonation pattern. Half of the stimuli were repetitions of the sentence, "That's a bee," the other half were nonmeaningful repetitions of the syllable "/bi/." The authors contrasted the children's linguistic productions of /bi/ at the sentence level versus production at word level. Recording of the speech samples were analyzed acoustically for measures such as fundamental frequency sentence productions, fundamental frequency of the peaks of the three syllables (/bi/ /bi/ /bi/), sentence slope and duration of sentence productions. Analysis of these variables showed that the two groups' sentence productions did not differ significantly with regard to mean fundamental frequency or sentence slope. The sentence slope is perceptually judged as whether an utterance is a statement or a question. Acoustically, statements are expected to show a negative slope, which indicates a decline in the fundamental frequency. In contrast, questions are expected to demonstrate a positive slope. For both groups, the sentence slopes were indicative of the type of sentence they were producing. However, there were slight group differences in the degree of rise or decline in sentence productions between the two groups. Specifically, the slope of children with speech disorders showed less rise or decline in the fundamental frequency than the children with typical development. Finally, analysis of sentence duration indicated that sentences of children with speech disorders were significantly longer. The authors also found that children with speech disorders had longer pauses in between repetitions of the syllable /bi/ than the children with typical development. Based on the results from the study, the authors concluded that children with speech disorders do not differ from children with typical development with respect to the production of intonation. They did, however, produce significantly longer productions than the children with typical development. The authors concluded that children with speech disorders may have difficulty with the timing and rhythm of speech, but do not seem to exhibit difficulties in the comprehension or production of intonation. The children with speech disorders also may have had difficulty processing the adult models, which would contribute to differences in performance between groups.

Snow (2001) conducted a study to investigate a) the expressive intonation patterns of children with specific language impairments (SLI) and b) if phonological impairments often present in children with SLI contribute to errors in prosody. Eleven children with SLI between the ages of 4:0 and 5:1 were age-matched to eleven children with normal language development. Both spontaneous and imitative speech samples were collected from each child. For the imitative task, children repeated different types of sentences modeled by the experimenters. Several combinations of intonation were elicited, including statements, questions and commands. Intonation was elicited in both the final and non-final position (i.e., “go HOME pig” versus “go home PIG”) and tone switched between rising and falling (i.e., “did you take your SOCKS?” versus “this is a PIG”). Acoustic analysis indicated that children in both groups imitated falling tones more accurately than rising tones and that no significant group differences were present regarding intonation skills. Analysis of phonological errors, determined by percent consonants correct (PCC), indicated that the children with SLI had mild to moderate phonological impairments. However, because the children with SLI demonstrated intonation skills that were comparable to children with typical development, Snow concluded that the presence of phonological impairments does not affect a child's ability to correctly use prosody in speech.

Goffman (2004) evaluated the speech productions of children with SLI, children with typical development, and adults to determine differences among the groups with respect to the amplitude and duration of movement in weak versus strong syllables. These aspects of prosody were examined in both content and function words using acoustic analysis. Each group contained nine participants. Children in both groups ranged in age from 4:2 to 7:1. The adults ranged in age from 20 to 28 years. Children and adults participated in sessions designed to elicit function + content words (i.e., Sam's a DOG) and content words only (i.e., aTTEMPT). Results indicate that both children with typical development and children with SLI produced movement sequences that do not differentiate between syntactic contexts. Measures of the amplitude and duration of weak syllables in both contexts described above showed no significant differences in rhythmic structure. In contrast, adult productions showed significant differences between the syntactic contexts. These findings indicate that children with SLI exhibit prosodic abilities similar to children with typical development. Furthermore, results show that young children rely on a condensed set of prosodic rules until linguistic abilities mature.

Perceptual Assessment of Prosody in Children with LI.

Van der Meulen, Janssen and Den Os (1997) compared the receptive and expressive prosodic abilities of children with SLI to those of age-matched children with typical development. Each group consisted of ten 4-year-olds, ten 5-year-olds and ten 6-year-olds. Two tasks were presented to the subjects in order to test both receptive and expressive aspects of prosody. To investigate receptive prosody, subjects were required to identify recordings of emotionally intoned sentences that were representative of four emotions: happy, sad, angry and afraid. To investigate expressive prosody, subjects were required to imitate ten sentences with different linguistic and affective intonation patterns. Subjects were also required to imitate the speech rate of each stimulus sentence. The linguistic and affective intonation patterns of expressive prosody were perceptually judged by all three authors to determine whether or not it resembled the adult production. Responses were rated independently on a scale of 1 to 5, with 1 being very poor resemblance and 5 being very good resemblance. Ratings were then averaged to obtain mean scores. The speech rate of each sentence was judged by measuring the duration of each child's sentence in terms of syllables per second. Duration of the children's productions was compared to that of the experimenter. Results indicated that the children with SLI performed significantly less accurately on the imitation of intonation than children with typical development, but were similar in their imitation of the speech rate. For the emotion identification task, the authors did not find any significant differences between the groups. For both tasks, the authors found a significant correlation between chronological age and performance; the older children within each group performed better than the younger children. Although the children with SLI demonstrated more incorrect imitations of sentences, the authors noted that the task required subjects to attend to both the prosodic cues of a stimulus sentence as well as its linguistic forms. Therefore, syntactic complexity of the stimulus sentences may have contributed to prosodic errors produced by the children with SLI.

Wells and Peppe (2003) used a nonstandardized assessment, the Profiling Elements of Prosodic Systems in Children (PEPS–C), to measure receptive and expressive prosody abilities in eighteen children with speech and/or language impairments. Specifically, this group included children with language delays, speech disorders and pragmatic language impairments. Several participants had additional diagnoses of hearing impairments and attention deficit hyperactivity disorder. Participants ranged in age from 8:0 to 8:11. The control group consisted of 45 typically developing children of the same age range who had participated in a normative study using the PEPS-C two years previously. The PEPS-C is based on a psycholinguistic framework, incorporating parallel expressive and receptive tasks. It assesses the ability to discriminate between prosodic forms and to understand and express prosodic functions. The procedure for the PEPS-C is computerized but is also available in paper format. The assessment evaluates prosodic usage over 12 different tasks: 1) short-term auditory discrimination (single words), 2) long-term auditory discrimination (short phrases), 3) short-term imitation (imitation of single words), 4) long-term imitation (imitation of phrases), 5) receptive understanding of whether a an utterance is a question or statement, 6) expressive understanding of intonation to suggest a question or statement, 7) comprehension of affect to suggest like or dislike, 8) production of affect to suggest like or dislike, 9) comprehension of prosodic phrase boundaries, 10) production of prosodic phrase boundaries, 11) comprehension of contrastive stress, and 12) production of contrastive stress. With regard to the receptive measures of prosody, the children with language delays performed significantly poorer than the control group on two tasks. These include short-term and long-term auditory discrimination of pitch patterns. The two groups performed similarly when required to determine whether affect suggested like or dislike. With regard to the expressive measures, the children with language delays scored lower for tasks that required participants to imitate numbers and words that varied with regard to placement of contrastive stress. However, there were no significant differences between the two groups on the remaining measures of expressive prosody. Based on these results, the authors suggested that for children with speech and language impairments, intonation to express grammatical, affective and pragmatic meaning is fairly intact. Overall, results from the study indicate that children with language delays may have difficulty retaining information in which multiple prosodic features, such as phrasal boundaries and phrasal accents, are implemented. While the group performed poorly on several receptive language tasks, they performed relatively well on the expressive prosody tasks. The authors contributed areas of poor performance on the expressive tasks to difficulties in understanding pragmatics.

Overall, the literature concerning prosody in children with LI suggests that they experience some difficulty with prosody, however their prosodic systems seem relatively intact, with only mild impairments. Areas of difficulty seem to lie mainly within aspects of retaining or imitating larger amounts of prosodic information. As many researchers stated, the amount of information could have influenced poorer performance in children with LI. This conclusion is further supported by research conducted by Marton and

Schwartz (2003), who found that children with SLI have difficulty performing tasks involving verbal working memory. Additionally, the majority of studies conducted have used imitative tasks to determine the expressive prosodic abilities of children with LI. More research is needed that focuses on spontaneous prosody production in order to get a true picture of the population's abilities.

Prosodic Characteristics Observed in Children with HFA and AS

In contrast to children with LI, individuals with autism display deficits in many aspects of prosody including rhythm, stress, fluency, phrasing, intonation and affect. Although abnormal prosody has continuously been identified as one of the core features of children with autism, there is a limited amount of research within this area that explores the relationship between the prosodic characteristics of children with autism and how these characteristics influence communication. To date, the majority of studies have concluded that individuals with autism encounter the most difficulty with the receptive and expressive aspects of pragmatic and affective prosody (Baltaxe and Guthrie, 1987; McCann et al., 2007; Paul et al., 2005).

McCann and Peppe (2003) conducted a critical review of research documenting specific prosodic errors of children with autism compared to typically developing children and children with other developmental disabilities. They found that many of the studies in this area tend to focus on two different measures of prosody; acoustic or auditory-perceptual. Acoustic measures include amplitude, frequency and duration. Auditory-perceptual measures include intonation patterns, the placement of accent and stress, or boundary and phrasing placement in speech. McCann and Peppe noted that the majority of research in this area has been subjective, that is the studies examined the auditory-perceptual aspects rather than measuring the acoustic aspects of prosody. The lack of objective research makes it difficult to quantify what constitutes as typical or atypical prosody in individuals with autism. The following four studies are the only studies to date that have explored the acoustic differences in the speech of children with autism.

Acoustic Assessment of Prosody in Children with HFA and AS.

Fosnot and Jun (1999) studied the intonation and timing patterns of four children with autism, and four children who stutter, ages 7-14. The prosodic characteristics of these two groups were compared to four typically developing children of similar ages to determine both quantitative and qualitative differences in prosody. The children were asked to read eight sentences with and without question marks aloud, and then imitate the same sentences as spoken by an adult. Fosnot and Jun found that the speech of children with autism was most deviant from the control group in terms of duration, intonation and pitch for both the reading and imitative tasks. The declarative and question sentences read by children with autism were longer in duration, around 1600 ms, than children who stutter and typically developing children, who both averaged 1200 ms. The same results were found for the imitative tasks. Fosnot and Jun also reported that the children with autism did not use proper intonation patterns, making it difficult to distinguish declarative sentences from interrogative sentences during the reading task. That is, the children with autism were unable to produce the high frequency boundary tone that alerts the listener to the fact that the speaker is asking a question. Minimal improvements were made when they imitated an adult. Lastly the children with autism used a greater number of pitch accents than the other groups, and they had a tendency to use pitch accents inappropriately. For example, instead of stressing the first syllable in the word ‘rhino,’ the authors reported instances where the second syllable was stressed. The authors concluded that these prosodic differences contribute to the perception that the speech of children with autism is abnormal and disconnected.

Hubbard and Trauner (2007) also examined the intonation patterns of children with autism and compared them to children with AS and children who are typically developing. More specifically, the authors were interested in the correlation between prosody and emotional content. Participants included nine children with autism, nine children with AS, and ten children with typical development. Participants were between the ages of 6 and 21. Prosodic characteristics such as pitch, loudness, and duration of speech sounds (i.e. phonemes) were analyzed and compared to subjective ratings of emotions during repetition tasks and a free-response task. In the repetition task, the child listened to a tape recording of an actress speaking in one of three emotional intonations (happy, sad and angry) and was instructed to repeat the phrase. In the free-response task, the child listened to a short story read by the examiner. The child was then instructed to complete the story in one sentence while pretending to be one of the characters from the story. The authors hypothesized the children with autism would have a decreased pitch range; however, the children with autism actually demonstrated a wider pitch range than the other groups during the repetition task. They found that the children with autism tended to misplace pitch peaks more often than the other two groups. Hubbard and Trauner also found that the children with autism missed amplitude and duration cues that correlate with differing emotions during the repetition task (i.e. using intensity as a component of encoding anger and using a slower rate to indicate sadness). The authors noted that the variability in pitch range disconfirms previous conclusions that children with autism have monotonous intonation, although results did confirm previous findings that children with autism have atypical prosody.

Diehl, Watson, Bennetto, McDonough and Gunlogson (2009) examined the fundamental frequency in narratives of individuals with high-functioning autism (HFA) to determine whether or not children and adolescents with HFA exhibit differences in pitch range compared to typically developing controls. Two studies were conducted using acoustic analyses to examine the fundamental frequency range of naturalistic speech samples taken from narratives. Participants in Study 1 included 21 adolescents with HFA ages 10-18 and 21 typically developing controls matched on age, IQ and verbal abilities. Participants in Study 2 included 17 children with HFA ages 6-14 and 17 typically developing controls matched on age, IQ and verbal abilities. Study 2 was conducted in an attempt to replicate results from Study 1 in a younger sample of children whose IQ scores were slightly lower yet still within the normal range for cognitive functioning. The results of Study 1 indicated an increased fundamental frequency variation and a higher fundamental frequency average in the HFA group when compared to 21 typical controls. Specifically, the average fundamental frequency used by males and females in the HFA group were 187.5 and 213.2 respectively, while the average fundamental frequency used by males and females in the TD group were 169.6 and 183.7 respectively. Study 2 replicated these findings in younger children with HFA. Similarly, the average fundamental frequency used by males and females in the HFA group were 206.9 and

229.8 respectively, while the average fundamental frequency used by males and females in the TD group were 209.9 and 202. 8 respectively. Additionally, Study 1 found evidence that acoustic measurements of prosody were related to clinical judgments of autism-specific communication impairments. However, these results were not replicated in Study 2. Together, these studies provide evidence for differences in expressive prosody in individuals with HFA that can be measured objectively.

In one of three experiments, Grossman, Bemis, Skwerer and Tager-Flusberg (2010) evaluated the production of lexical stress of 16 children with HFA and 15 children with TD between the ages of 7 and 18. The experiment expanded on earlier research by using objective measures of prosody instead of subjective ratings. Grossman et al. hypothesized that the participants with HFA would exhibit differences in acoustic measures of whole-word duration. They found that the HFA group produced longer word productions than the TD group, although there were no significant differences in pitch or loudness. Listeners noted that participants with HFA produced more pauses between syllables than the TD group, making word production sound awkward and disfluent.

Although the objective studies described above provide important information regarding the acoustic measures of prosody, they lack cohesion in terms of the aspects of prosody analyzed because each study examined different aspects of prosody. Additionally, they differ in the number and age range of participants. The disparity among these variables continues to make it difficult to define those characteristics of prosody that are typical from those that are atypical. As earlier discussed, the majority of studies involving the prosodic characteristics of autism have been perceptual, subjective studies.

Perceptual Assessment of Prosody in Children with HFA and AS.

The following eight studies, discussed in chronological order, investigated several aspects of prosody, including intonation patterns, lexical stress, contrastive stress and use of phrasing. Although the studies used differing methodologies, each study used perceptual measures to determine differences that exist between children with HFA and children with TD.

Baltaxe (1984) studied the contrastive stress patterns of seven children with autism, seven aphasic children, and seven typically developing children ages 2-12. Participants were asked yes/no questions regarding a play situation. Contrastive stress was examined in the subject, verb and object positions. For example, to prompt the use of contrastive stress, the participant was shown a picture of a doll named Pat sitting in a chair and asked “Is Mike sitting on the chair?” Therefore, the expected response was, “No, PAT is sitting on the chair.” Two listeners perceptually analyzed the responses for instances of contrastive stress and found that the children with autism were twice as likely to misassign contrastive stress than the two other participating groups. Of the three groups, typically developing children produced the greatest percentage of prosodically correct utterances, followed by the aphasic children, and then the children with autism. Baltaxe also noted that the children with autism tended to stress more than one stressable syllable, an error type not produced by the other children and which accounted for 36.8% of their errors. Of note however, is the fact that all groups only provided full responses 60% of the time. The remaining responses were simply yes or no, with a bias towards yes responses. This bias indicates that the task may have been too complex or abstract for the participants, and results may not be indicative of stress used in spontaneous conversation.

In a sister study to Baltaxe (1984), Baltaxe and Guthrie(1987) investigated the ability of the same participants to use default stress. Researchers used an elicited production task in which the examiner manipulated materials while asking, “What’s happening?” in order to obtain subject-verb-object (SVO) and subject-verb-preposition (SVPrep) sentences containing default stress. A total of sixteen utterances consisting of eight nouns and four verbs were obtained. A correct response was an utterance with stress on the last stressable syllable (i.e., the baby is sleeping on the BED). Results were similar to that of the 1984 study in that the children with typical development scored highest, followed by the children with aphasia and then the children with autism. However, it should be noted that all groups made more incorrect than correct responses; the children with typical development assigned stress correctly in only 20% of their responses, and the children with autism made no correct responses. The authors found that stress was misassigned to the first stressable syllable (i.e., the subject noun) in approximately 87% of all the participants’ utterances. Based on the results of the study, the authors concluded that default stress may not have been established for any of the participants at the time of the study, which would account for the high percentage of incorrect responses.

McCaleb and Prizant (1985) investigated the use of contrastive stress in four male children with autism ages 4:8-14:10. The study described the participants’ pragmatic ability to encode new versus old information. Each participant was videotaped for one 20 to 30 minute session in interactions with their teacher and one session of similar length with his speech-language pathologist. Teachers were directed to select materials that would best initiate verbal interactions. Each utterance produced by the participant was categorized as the delivery of either new or old information. Two means of encoding new versus old information were examined: a) encoding new information through single word utterances, known as a lexicalization strategy (i.e, PREsent versus preSENT) and b) using contrastive stress to emphasize new information in a multiword utterance (i.e., SHE ran versus she RAN). Results indicated that all four children demonstrated the ability to encode new information using the lexicalization strategy as well as through contrastive stress in relatively equal proportions. Specifically, the range of percentage of utterances encoding new information through single-word utterances yielded a range of 45.3-68.3% while encoding new information using contrastive stress yielded a range of 47.9-55.8%. However, researchers found that the participants encoded old information almost as frequently as they encoded new information. That is, in approximately 47% of their utterances, the participants provided information that had already been stated during the communicative exchange. The encoding of a new action or state change (i.e., I'm HUNGRY) was marked relatively infrequently by the participants, and they consistently produced repetitions of previously encoded information when they failed to offer new information to their listeners. Based on the results of the study, the authors concluded that the participants were not consistently using stress in a typical way. However, McCaleb and Prizant did not have a control group for the study; therefore, it is difficult to draw conclusions as to whether or not the participants' use of stress was appropriate or inappropriate.

Fine, Bartolucci, Ginsberg and Szatmari (1991) investigated the intonation patterns of 23 individuals with AS between the ages of 7 and 18, 19 with HFA between the ages of 7 and 32, and 34 psychiatric outpatients ages 7-18 who acted as controls. A 10-minute speech sample was collected from an interview between one of the researchers and each participant. Participants were interviewed on topics such as family and school. Each speech sample was coded by perceptually marking tone boundaries and stress assignments and were then judged as appropriate or inappropriate. Results indicated that the participants with HFA did not use intonation cues such as stress and tone boundaries as effectively in conversation as the other two groups. However, the participants with AS performed on an equal level with the controls. Based on these results, the authors suggested that disordered intonation co-occurs with disordered language. This conclusion stems from the fact that children with AS do not display deficits in language, while children with HFA often exhibit impairments in language.

Thurber and Tager-Flusberg (1993) investigated the production of different types of speech pauses and repairs of 10 children with autism with a mean age of 12;1, 10 children with learning difficulties with a mean age of 11;3 and 10 children with typical development with a mean age of 7;9. Each participant was asked to tell the story depicted in a wordless picture book. The narratives were analyzed for frequency of grammatical (between phrase) and nongrammatical (within phrase) pauses as well as for measures of story length and complexity. Results indicated that there were no significant differences among groups in the number of repetitions, false starts and silent grammatical pauses. However, there were significant differences in the number of nongrammatical pauses in that the children with autism produced significantly fewer nongrammatical pauses than the children with learning difficulties and children with typical development. Specifically, the children with autism produced a mean frequency of 2.7 nongrammatical pauses, compared to 5.4 produced by the children with learning difficulties and 4.3 produced by the children with typical development. There were also significant differences between groups in the lengths and complexities of their narratives. The children with autism had significantly shorter MLU than the other groups. That is, the average MLU for the children with autism was 7.3, whereas the average MLU for the children with learning difficulties and children with typical development was 12.5. Additionally, the children with autism produced an average of 220 words in their speech sample, compared to 317.1 produced by the children with learning difficulties and 292.7 produced by the children with typical development. The authors concluded that the reduced frequency of nongrammatical pauses was correlated to narratives of reduced complexity and story length.

A study conducted by Shriberg et al. (2001) documented the speech profiles of fifteen males between the ages of 10 and 49 with HFA, 15 males of similar age with AS, and 53 similar-aged males with normal speech development using the Prosody-Voice Screening Profile (PVSP; Shriberg, Kwiatkowski & Rasmussen, 1990). Results from the study revealed that individuals with HFA and AS used excessive or misplaced stress in their speech, as well as inappropriate phrasing. For the purposes of the study, inappropriate phrasing was defined as utterances that contained sound, syllable or word repetitions, or part word revisions. Out of the 30 individuals with ASD, Shriberg et al. found that 53% of individuals with HFA and 26.7% of individuals with AS used stress improperly and 66.7% with AS misused phrasing. In comparison, only 5.7% of the control group misassigned stress, and 26.4% used incorrect phrasing in their speech. Shriberg et al. noted that the majority of inappropriate stress produced by the HFA and AS speakers involved the pragmatic use of stress, which is consistent with findings by Baltaxe (1984).

Paul et al. (2005) expanded on the Shriberg (2001) study, examining the perception and production of prosody in 27 individuals with ASD with an average age of 16;8, and 13 typical peers with an average age of 16;7. Individuals participated in 12 experimental tasks designed to examine the perception and production of three aspects of prosody, including intonation, stress and phrasing. Tasks included: 1) grammatical perception of stress, 2) grammatical production of stress, 3) grammatical perception of intonation, 4) grammatical production of intonation, 5) grammatical perception of phrasing, 6) grammatical production of phrasing, 7) pragmatic perception of stress, 8) pragmatic production of stress, 9) pragmatic perception of intonation, 10) pragmatic production of intonation, 11) pragmatic perception of phrasing and 12) pragmatic production of phrasing. For five of the twelve tasks (grammatical perception of intonation, grammatical production of intonation, pragmatic perception of phrasing, pragmatic production of phrasing and pragmatic perception of intonation) performance for both groups was near 100%, indicating a ceiling effect. These results indicate that the tasks were too easy for subjects in both groups. In order to determine the presence of between-diagnostic group differences, post-hoc tests were used. They found significant differences between the two groups in the grammatical production of stress, as well as the pragmatic perception and production of stress. Paul et al. concluded that individuals with ASD have difficulty understanding how to properly utilize stress in their speech, which hinders their ability to produce affective and appropriate stress patterns. However, no significant differences were found between the two groups regarding intonation or phrasing, which may indicate that speakers with ASD encounter the greatest difficulties when utilizing stress that serves pragmatic or affective functions in communication.

McCann et al. (2007) evaluated the receptive and expressive prosodic abilities of 31 children with HFA compared to 72 typically developing children (TD). The children ranged in age from 4-13. Similar to the study by Wells and Peppe (2003), investigators used the PEPS–C to measure the perception and production of affective and grammatical prosody. McCann et al. found that the children with HFA performed poorer on 11 of the 12 tasks in the PEPS-C than the TD group. Specifically, the children with HFA had the most trouble with the receptive and expressive affective prosody tasks, as they were unable to discern or express liking from disliking given food items. They also found that the HFA group misassigned accent placement, often accenting or stressing the first syllable. This confirms earlier findings that children with ASD encounter difficulties with the production of contrastive stress (Baltaxe, 1984; Shriberg et al., 2001). Overall, McCann and Peppe noted that all children in the HFA group showed difficulty with at least one aspect of prosody, and the scores of the TD group were significantly better than the HFA group. The authors also observed a strong correlation between prosody skills and receptive and expressive and language scores for both groups, indicating that children must understand and master prosody in order to communicate effectively. While the PEPS-C provides a comprehensive assessment of the receptive and expressive aspects of prosody, data for expressive prosody is based on elicited utterances and structured conversation rather than spontaneous conversation, reducing the likelihood of obtaining a realistic picture of a child’s natural speech.

Similar to the acoustic studies previously discussed, the perceptual studies provide pertinent information regarding atypical prosody, yet they do not provide conclusive evidence due to differences in sample sizes, age ranges, and type of investigative method utilized. No study includes a large number of subjects matched with typically developing children or adults based on linguistic and non-verbal abilities. Those studies that do include more than 20 individuals with autism or AS (Fine et al. 1991, Shriberg et al. 2001) include groups with wide age ranges and more than one diagnosis. Moreover, only four studies (Diehl et al., 2009; Fosnot and Jun 1999, Grossman et al. 2010, Hubbard and Trauner, 2007) use acoustic analysis to quantify expressive prosody; the remaining studies rely on perceptual judgments. Of these studies, only one (Shriberg et al. 2001) used a published and readily available prosody assessment, the PVSP. Due to significant differences in the method of collecting and analyzing data within this area of research, an assessment such as the PVSP proves useful in the sense that it provides researchers with a single method of assessment that can be used to determine the typical and/or atypical prosodic characteristics present in children with ASD. Since the PVSP will be used in the current research study, a detailed description regarding the development, purpose, reliability and validity of the PVSP is provided in the following sections.

Prosody-Voice Screening Profile (PVSP): An Assessment of Prosody

The Prosody-Voice Screening Profile (PVSP) was developed as a research tool by Shriberg, Kwiatkowski & Rasmussen (1990) in order to provide researchers and clinicians with a comprehensive assessment for determining inappropriate aspects of prosody used by a speaker. It has been used with a variety of children and adults; however, it was specifically designed for young children with a variety of speech disorders.

The PVSP is divided into two subcategories: prosody and voice. Shriberg et al. (1990) chose to separate prosodic aspects, which reflect errors in linguistic processing, from vocal aspects of speech, which reflect errors in vocal function. Three suprasegmental areas, including phrasing, rate, and stress, are categorized under the prosody domain, while loudness, pitch and quality are categorized under the voice domain.

The PVSP uses conversational speech samples to analyze the suprasegmental aspects of speech instead of using elicited sentence production or standardized tests. While elicited sentences and standardized tests provide useful information regarding speech characteristics such as fluency and voice, judgments regarding the suprasegmental aspects should reflect the speaker's natural, uninhibited conversational patterns. Additionally, data from studies conducted by McSweeny and Shriberg (2001), Morrison and Shriberg (1992) and Shriberg and Kwiatkowski (1983) indicate that certain word forms and parts of speech are not always present in standardized test stimuli. More specifically, standardized tests lack variety in the number and type of function words, word shapes such as CVC and CVCV, as well as percentage of occurrence of consonants, vowels/diphthongs and consonant clusters. For example, Morrison and Shriberg (1992) found that simple word shapes are underrepresented in standardized articulation tests, whereas they account for over 22% of words in continuous speech samples. Overall, these studies indicate that continuous speech samples are the best form of data collection when analyzing speech for structural, linguistic and pragmatic characteristics.

The use of spontaneous speech samples results in optimal validity, however it often results in lower reliability. In order to improve validity and reliability, Shriberg et al. have developed comprehensive procedural guidelines for obtaining and interpreting speech samples. These guidelines contain information regarding proper glossing and segmentation of utterances, as well as types of utterances that should be eliminated from the speech sample due to the possibility of obtaining biased results. Additionally, instead of requiring examiners to rate participants on a severity scale, the PVSP only requires an examiner to judge whether an utterance is appropriate or inappropriate. Together, these methodological decisions maximize the reliability and validity of PVSP scores.

In order to use the PVSP to score an individual's speech, Shriberg et al. have set minimum requirements for standardization purposes. As stated above, the speech sample should reflect the speaker's natural speaking style. Therefore, it should contain utterances that vary in terms of length, emotional content and linguistic construction. Once the speech sample is obtained, it must be glossed and segmented according to specific guidelines. A total of fifteen segmentation rules have been developed to ensure consistency in defining and separating utterances. Examples of segmentation rules include how an utterance is defined, how to segment utterances that include conjunctions, and how to separate a run-on string of words or ideas. Once the sample has been segmented, certain utterances are excluded in accordance with a set of exclusion codes. The remaining utterances are used for analysis using the prosody-voice codes.

The overall goal of the PVSP is to aid in the identification of individuals who exhibit inappropriate prosody-voice characteristics on more than 10% of their utterances. It is important to note that the scores from the PVSP are meant to be descriptive rather than diagnostic. Therefore, a child's summary score could reflect delays in one area or in several areas including cognitive, linguistic, psychosocial, or motor-speech. Additionally, prosody-voice scores may reflect compensatory or facilitating behaviors associated with other disorders, such as fluency, or prosody-voice may be judged as the primary disorder of an individual.

Validity Studies.

Several types of validity were obtained for the PVSP. Specifically, Shriberg, Kwiatkowski, and Rasmussen examined face, content, consensual, criterion, concurrent and instrumental validity. Validity for the PVSP was established and supported by a number of studies, including critical reviews and journal articles on prosody and voice used to identify categories by which to classify disordered or atypical prosody and voice for the PVSP (Shriberg et al., 1989) (Shriberg, Kwiatkowski, and Rasmussen, 1989; Shriberg, Kwiatkowski, & Rasmussen, 1990; Shriberg, Kwiatkowski, Rasmussen, Lof, & Miller, 1992; Shriberg & Widder, 1990). Categories and terms were discussed with researchers whose primary area of focus is speech, language, fluency, voice and hearing disorders. Additionally, Shriberg, Kwiatkowski and Rasmussen listened to several hundred speech samples in order to capture all perceptual aspects of voice and prosody. The claim for consensual validity stems from discussions with clinical-research colleagues of the authors on the adequacy of the codes developed for inappropriate prosody-voice (Shriberg et al., 1992)

Criterion and concurrent validity were assessed in acoustic studies for five of the seven prosody-voice variables, including instrumental studies of rate, stress, pitch, laryngeal quality and resonance quality (Shriberg et al., 1992). For criterion validity, data showed that 78% of the examples used to teach inappropriate laryngeal quality, resonance quality or voice quality were judged correctly. Criterion validation was highest for larygneal quality exemplars, with an average agreement of 86.4%, less for inappropriate pitch, 77.1% and least for resonance quality exemplars, 74.5%. Concurrent validity was assessed by comparing data from prior studies that used the first version of the prosody-voice coding procedure to estimates obtained using the present version of the PVSP. Compared to data from prior studies using the earlier version of the procedure, current estimates of involvement are reasonably similar for four of the six prosody-voice domains: Phrasing, Stress, Loudness, and Quality. Differences were apparent for the remaining two domains, Rate and Pitch. Inspection of both data sets suggests that these differences stem from the participants involved in each study (i.e. participants in the earlier study appeared to have more prosody-voice involvement. Additionally, the current version of the PVSP has more stringent criteria for coding pitch and rate, which may also account for differences in study outcomes.

Instrumental validity of perceptual decisions was used for rate, stress, pitch, and two of the descriptors for inappropriate quality. *CSpeech* (Milenkovic, 1991) and *VOCAL* (1989) were used for the comparative analyses in the suprasegmental domains listed above. Overall, comparisons yielded 71-92% exact confirmations of a given categorization (i.e. PV2: Sound/Syllable Repetition). This indicates that the perceptual decisions used to determine whether prosody was appropriate or inappropriate agree with results of acoustic instrumentation used to determine the same variables.

Reliability Studies.

The reliability and stability of PVSP speech samples has been assessed and supported in studies concerning collection and analysis of continuous speech (McSweeny and Shriberg, 2001; Morrison and Shriberg, 1992; Shriberg and Kwiatkowski, 1983; Shriberg and Lof, 1991; Shriberg and Widder, 1990). Two measures were used to determine the reliability of the PVSP: internal consistency studies as well as interjudge and intrajudge agreement. Studies and methods used to establish these two measures of reliability are discussed below.

Two studies support the internal consistency of the PVSP (Shriberg et al., 1992). The first study compared the first 12 utterances to the second 12 utterances in the speech samples of 64 children with developmental phonological disorders. It was determined that 80-100% of the retest decisions were similar for those speakers that passed based on the first 12 utterances. A second study divided speech transcripts into odd and even utterances. Similar scores of 80-100% were obtained when the odd and even utterances were compared.

With regard to interjudge and intrajudge agreement, estimates for segmenting conversational speech into utterances based on these rules range from 90-100% (Shriberg, Kwiatikowski and Rasmussen, 1989; Shriberg & Widder, 1990). Therefore, it is determined that the segmentation rules provided are detailed enough for users to obtain high reliability when segmenting conversational speech samples for prosody-voice coding. Following segmentation of utterances, certain utterances are excluded according to the exclusion codes provided in the PVSP. Estimates of intrajudge agreement for exclusion coding range from 71-100% and estimates of interjudge agreement range from

76-100% (Shriberg et al., 1989; Shriberg et al., 1992). After utterances have been excluded, the remaining utterances are used for PV coding and analysis. For prosody-voice coding, estimates for intrajudge agreement in development studies range from 85-99% and interjudge agreement range from 78-96%. Estimates from clinical studies range from 74-99% for both intra- and interjudge agreement. It should be noted that these estimates reflect agreement only within a class (i.e. rate codes) across the six prosody-voice variables. Agreement for the use of inappropriate codes within each variable is lower, depending on the severity of the speaker.

III. Justification

Currently, variations exist in the literature with regard to the investigative method used when collecting and analyzing prosody data in children with ASD. Differences also exist with regard to the age ranges of the participants included in the studies. To date, no studies have specifically investigated the prosodic characteristics of preschool-age children. All studies that have included young children have also included children as old as 14 in the sample (Baltaxe 1984; Baltaxe & Guthrie, 1985; McCaleb & Prizant 1985, McCann et al., 2007). Due to the lack of conclusive evidence concerning the prosody of children with ASD, the present study was undertaken to provide a perceptual analysis of the prosody components of young children diagnosed with ASD.

The primary purpose of this study was to evaluate the prosodic characteristics of young verbal children with autism between the ages of 24 and 68 months. Specifically, this study explored characteristics such as loudness, pitch and quality of individuals with ASD and TD. The PVSP (Shriberg, Kwiatkowski and Rasmussen, 1990) was used to evaluate the degree to which atypical prosodic characteristics appear in the speech of young children autism. These characteristics were then compared to the prosodic characteristics of typically developing children to determine whether or not differences exist. This study also explored the number and type of exclusion codes that were most frequently used for the ASD group versus the TD group. The speech of children with autism has been described as echolalic and sometimes more unintelligible than children with typical development (Leary & Hill, 1996). Therefore, exclusion codes such as C4 – Imitation and C12 – Too many unintelligibles should be used more frequently for the ASD group because they reflect characteristics often observed within this population.

The PVSP is a nonstandardized assessment designed to evaluate the prosody of individuals of all ages with a variety of primary disorders. However, it was specifically designed for young children with more severe speech disorders. Prosody is of clinical significance because it serves to modulate and enhance the meaning of the speaker's intended message. Additionally, information regarding prosody can provide clinical insight into a child's expressive language skills. Specifically, atypical prosody can indicate deficits in pragmatics and the social communication abilities of a child (Shriberg et al., 2001; Wetherby et al., 2004). Additional information regarding atypical prosody in young children with ASD would provide clinicians with an additional diagnostic tool to rule out or confirm a diagnosis of ASD. This is of clinical relevance because the screening and diagnosis of ASD must be based on behavioral features such as social communication abilities (Filipek et al., 1999; Wetherby et al., 2004). Since there is a lack of research within this area, the data will help provide a foundation for future studies.

Therefore, there are three specific questions that were addressed in this study:

(1) Do children with ASD differ from children with TD with regard to type or number of utterances related to content and context that must be excluded from the speech sample?

(2) Does the number of prosodic characteristics present in children with ASD differ from those present in the speech of typically developing children?

(3) Are the types of prosodic characteristics present in the speech of young children with autism different from those in typically developing children?

IV. Method

Participants

The participants in this study included two groups of children between the ages of 24 and 68 months: verbal children with autism (ASD) and typically developing children (TD). These children were selected from an ongoing research study being conducted at The University of Memphis and Auburn University investigating early markers of ASD in young children. To be included in the ASD group, the children had to meet the following criteria: 1) a diagnosis of ASD within the previous 6 months, 2) no known hearing or visual impairments or comorbid diagnoses, 3) monolingual, English speakers, 4) no prematurity, 5) no low birth weight, and 6) self-identified as either AA or Caucasian race when provided with the race options defined by the U.S. Census (i.e., White, Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, Other Race) (U.S. Census, 2000). To be selected for the current study the children were also required to be verbal communicators (i.e., producing at least 2 word combinations). To be included in the TD group, the children had to meet the following criteria: 1) no known hearing or visual impairments or comorbid diagnoses, 2) monolingual, English speakers, 3) no prematurity, 4) no low birth weight, and 5) self-identified as either AA or Caucasian race when provided with the race options defined by the U.S. Census (i.e., White, Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, Other Race)

(U.S. Census, 2000), 6) receive a raw score of <15 as specified by the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003) and 7) receive scores within 1.5 standard deviation of the mean for receptive and expressive language scores as specified by The Mullen Scales of Early Learning (MSEL; Mullen, 1995).

Fourteen participants met the criteria and were selected for inclusion in this study. The participants for the ASD group consisted of 6 males and 1 female between the ages of 38 and 62 months (M = 47.57; SD = 8.73). Participants for the TD group consisted of 5 males and 2 females between the ages of 30 and 64 months (M = 44.14; SD = 13.26). All participants were Caucasian and were recruited from communities in the Southern region of the United States (see Table 1 for demographic information).

Table 1

Summary of Participant Demographics

Group	ASD	TD
Sample Size	7	7
Child's Age at Initial Evaluation in Months (*M, SD*)	47, 8.73	44.14, 13.26
Gender		
Female (*n, Percent)*	1, 14	2, 28
Male (*n, Percent)*	6, 86	5, 72
Parents' Education in Years Completed		
Mother *(M, SD)*	16, 2.23	17, 2.69
Father *(M, SD)*	16, 2.15	17, 2.27
Parents' Age at Child's Evaluation in Years		
Mother *(M, SD)*	33, 3.68	34.44, 3.84
Father *(M, SD)*	41.41, 7.73	35.79, 4.52

A diagnosis of ASD was confirmed through administration of the Autism Diagnostic Interview – Revised (ADI-R; Rutter, LeCouteur, & Lord, 2003), and the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999).

The ADI-R is a comprehensive, standardized interview with the caregiver that is used for assessing autism in children and adults. It evaluates caregivers' responses to questions focused in three main behavioral areas: reciprocal social interaction, communication and language, and restricted and repetitive, stereotyped interests and behaviors. The ADI-R is appropriate for children and adults with mental ages of 18 months and above. The ADOS is a semi-structured assessment of social interaction, communication, and play or imaginative use of materials for individuals suspected of having ASD. Results from the ADOS were used to separate the ASD group from the TD group. The diagnostic criterion established by the DSM-IV-TR (American Psychological Association, 2000) was also adhered to when confirming or disconfirming a best diagnosis of ASD.

Procedure

After receiving permission from the University of Memphis and Auburn University's Institutional Review Board (IRB authorization number 09-099MR0905, approved May 13, 2011), children between the ages of 24 and 68 months were recruited to participate in this study (see Appendix B for telephone screener). The recruitment process is ongoing and consists of one of the investigators reading a script either over the phone or in person to a parent who expresses interest in the study. Participants could also learn about the study from flyers posted in public areas (see Appendix C for flyer).

When the parent and child arrived for the evaluation, the parent was given the appropriate consent form before providing any information or participating in procedures (see Appendix D for consent forms). Parents were allowed time to review each section of the consent form. After the parent finished reading the form, the investigator reviewed the form with the parent, asked the parent if he/she has any questions, and gave the parent the opportunity to withdraw from the study. The parent of each participant was then asked to initial and sign the consent form, which was witnessed by the investigator. By signing the consent form the parent agrees that his/her child has met all the inclusionary criteria discussed above.

Before the evaluation began, the participant was assigned a participant code to ensure that all the information and data collected is anonymous. The parent of each participant also provided demographic information by completing a demographic form. The demographic form asks parents to provide information such as the age, race and gender of the participant, age and gender of siblings of the participant as well as age, race and education completed by both parents (see Appendix E for demographic information form). The parents were reminded at this time that information collected and all successive information was anonymous as the standardized test forms used for the evaluation were labeled using the participant number and stored separate from the consent form.

Once it was determined that the participant met the inclusionary criteria of the study, he or she was seen individually at The University of Memphis or Auburn University for an evaluation session that included The Mullen Scales of Early Learning (MSEL; Mullen, 1995), Communication and Symbolic Behavior Scales Developmental Profile (CSBS DP; Wetherby & Prizant, 2002), and an informal play sample. The MSEL is used to evaluate the cognitive skills of children through motor, visual reception, and expressive and receptive language subscales. The MSEL can be administered to infants and children up to 68 months of age. The ASD group was 1.5 SD below the mean on fine motor and receptive language. However, the ASD group was within 1 SD of the mean on visual reception and expressive language. Conversely, the TD group was above the mean on visual reception and receptive language, and within 1 SD of the mean on fine motor and receptive language (see Table 2).

The CSBS DP is used to determine a child's communicative competence through the use of eye gaze, gestures, sounds, words, understanding, and play. It is designed for children with a functional communication age between 6 and 24 months. However, it may be used for children up to 6 years of age whose functional communication skills are below 24 months (Wetherby & Prizant, 2002). For the current study, administration of the CSBS DP allowed for a structured context for sampling communication behaviors, regardless of the child's language level.

The informal play sample is used to evaluate a child's communicative behaviors during interactions with his/her parent or caregiver. During the assessment, novel toys were arranged within and outside of the child's reach in a clinical evaluation room. Caregivers and their children were asked to play as they typically would with toys and during social games.

The parents or legal guardians of children who demonstrate language delays on the previous diagnostic measures (i.e., CSBS or Mullen) were asked to participate in two more assessment sessions. The second session consisted of an interview (i.e., ADI-R) with the parent or legal guardian. Administration time was approximately 1-2 hours. Following administration of the ADI-R, a final visit was required for the third evaluation session in order to confirm or rule out a best estimate diagnosis of ASD. During this session, the ADOS was administered to the child. This evaluation session took approximately 30-45 minutes.

Table 2

Descriptive Statistics of Standardized Language Measures

Measure	M		Range		SD	
	ASD	TD	ASD	TD	ASD	TD
Mean Length of Utterance	3.06	3.45	2.11-4.34	2.13-4.81	0.87	0.98
Mullens Scales of Early Learning						
Visual Reception[a]	40.71	52.29	20-58	40-63	12.93	6.7
Fine Motor[a]	32.14	47.14	20-45	35-58	9.75	8.47
Receptive Language[a]	32.71	57	24-49	48-80	9.66	11.17
Expressive Language[a]	42	48	33-48	44-54	6.43	3.7
Developmental Quotient[b]	87.64	92.96	73.6-97.7	79.7-102	10.1	7.43

Note: [a] Mullens Scales of Early Learning scale standard scores based on M=50 and SD=10. [b] Mullen Scales of Early Learning Developmental Quotient is based on Expressive Language Age Equivalent divided by Chronological Age times 100.

Participants were matched based on MLU scores and developmental quotient scores. MLU scores were obtained by entering the transcribed speech samples into the Systematic Analysis of Language Transcripts program (SALT; Miller & Iglesias, 2008). Results from two-tailed tests showed no significant difference between the two groups with regard to developmental quotient scores (p = .365) or MLU scores (p = .498). Charman (2004) suggests combining measures of language from more than one source provides a more global assessment of language competence than a single measure. Charman (2003) compared raw scores from a formal language measure produced as to number of words produced as reported by parents on the MacArthur Communicative Development Inventory (Infant Form). Charman found agreement between formal test measures and parental report with regard to language production (N =15, r=0.66, p<0.01).

Recording of Speech Samples

All of the evaluations were audio- and video- recorded in a room supplied with a variety of toys. The children wore vests that follow a design developed by Buder and Stoel-Gammon (2002). The vests were equipped with a microphone (Countryman Isomax EMW Lavalier) and a wireless transmitter (Samson AL1) that sent a signal to a receiver (Samson AM1). TF-32 software (Milenkovic, 2002) operating a DT322 acquisition card (Data Translation, Inc., Marlboro, MA) is used to digitize the child's signals at 48 kHz after low-pass filtering at 20 kHz using a Data Translation AAF-3 antialiasing board.

Data Analysis Using the PVSP

The speech samples obtained from the audio and video recordings were transcribed verbatim using WAVpedal software (The Programmers' Consortium, Inc, Vienna, Va). Following transcription, each sample was segmented into utterances according to the Segmentation Rules established by Shriberg et al. (1990). As previously stated, segmentation rules include how an utterance is defined, how to segment utterances that include conjunctions, and how to separate a run-on string of words or ideas. Each speech sample, consisting of speech from the CSBS DP and informal play sample, were analyzed.

The next step in the PVSP process was to exclude utterances from prosody-voice coding. Thirty two exclusion codes have been developed to improve the validity of PVSP scores, with each code reflecting a type of utterance that may bias or contraindicate prosody-voice coding (Shriberg, 1990). The exclusion codes are divided into four categories: a) content/context, b) environment, c) register, and d) states, which are defined below (see Appendix F for a complete list of exclusion codes):

1. Content/Context – utterances that are excluded due to linguistic content or sociolinguistic context (e.g. reading, singing, interruptions)
2. Environment – utterances that are excluded because of problems with the recording environment
3. Register – utterances that are excluded because they contain specific prosodic characteristics (e.g. whisper, sound effects, narratives)
4. States – accounts for certain biological states that may influence coding judgments (e.g. laughing, throat clearing, sneezing)

Following the exclusion of specific utterances, the first 100 utterances that met the criteria for PVSP coding were coded according to the six suprasegmental variables of prosody and voice: a) phrasing, b) rate, c) stress, d) loudness, e) pitch and f) quality, which are defined as follows (Shriberg et al., 1990; Paul et al., 2005):

1. Phrasing – the fluency of speech (part- and whole- word repetitions, revisions)
2. Rate – the overall pace of speech (measured in syllables per second)
3. Stress – the emphasis on syllables and words relative to one another
4. Loudness – the intensity with which a speaker produces utterances
5. Pitch – the average frequency of the voice
6. Quality –
    a. Laryngeal Features – how the sound is produced in the larynx (strained, harsh etc.)
    b. Resonance – the sound produced in the vocal tract (nasalized, denasalized etc.).

In order to obtain PVSP scores, it is suggested that a minimum of 12 codable utterances must be obtained, with half of the utterances consisting of at least four words. However, due to the young age and developmental delays of the participants, this rule was altered to include utterances containing three or more words. On average, children between the ages of 24 and 36 months typically produce utterances consisting of two to three words (Garvey & BenDebba, 1974).

The process of prosody-voice coding is similar to that used to exclude utterances. Each of the 32 prosody-voice codes is accompanied by a definition as well as scoring procedures. For example, Phrasing codes classify utterances that include one or more sound, syllable, or word repetitions or part-word revisions, with four of the codes indicating multiple occurrences of these behaviors within an utterance. As stated above, inappropriate phrasing, rate, and stress are coded under prosody, while loudness, pitch and vocal quality are coded under voice (see Appendix G for a complete list of prosody-voice codes). While the PVSP provides definitions to obtain perceptual measures for each of the codes described, the current study incorporated acoustic measures using TF-32 (Milenkovic, 2002) in order to provide more accurate and objective information for several codes, including pitch, stress and rate. Once the speech sample was coded, the suprasegmental variables were tallied to obtain a frequency of occurrence criterion, which was represented as a percentage. The cutoff criterion score was established by Shriberg et al. to exclude individuals who, upon further examination, would not require further evaluation from those who would be recommended to receive clinical services. A score of less than 100% on any one variable indicates that utterances were judged as containing inappropriate prosody or voice characteristics. Shriberg et al. have accounted for speaker and examiner variability in scoring by setting the passing criterion at 90%.

The frequency of occurrence percentage is calculated by dividing the total number of occurrences of a given code by the total number of utterances in the speech sample. This number is then multiplied by 100 to yield a percentage. Because the current study analyzed a total of 100 utterances for each participant, the total number of occurrences for each PV variable also equals the frequency of occurrence percentage. For example, if a child exhibited PV15: Excessive/Equal/Misplaced stress a total of 16 times during the speech sample, 16 is divided into 100 and then multiplied by 100 to yield the frequency of occurrence, which would be 16%. Percentages were calculated for all Prosody-Voice variables for each participant.

A total of two to three investigators listened to and transcribed each speech sample in order to judge the intelligibility of given utterances before they were coded as unintelligible. Interjudgereliability was evaluated for 100% of the samples for PV coding. For several PV codes, including phrasing, loudness, laryngeal features and resonance, two investigators analyzed 100% of the speech sample in order to obtain reliability. Due to time constraints, three investigators listened to 40% of each speech sample in order to analyze rate, stress and pitch. Each investigator overlapped across 10 utterances that were used to obtain reliability for these three codes. The mean interjudge reliability calculated was 94%, with values ranging from 80-100%. These results are similar to that obtained in reliability studies for prosody-voice coding described by Shriberg et al., in which estimates from developmental studies for interjudge agreement ranged from 78-96% and estimates from clinical studies ranged from 74-99%.

V. Results

The first question, “Do children with ASD differ from children with TD with regard to type or number of utterances related to content and/or context that must be excluded from the speech sample?” was answered by comparing the exclusion codes most frequently used for the ASD group to those most frequently used for the TD group. The second question, “Does the number of prosodic characteristics present in children with ASD differ from those present in the speech of typically developing children?” was answered by determining whether or not specific PV variables appear more often in the speech of one group versus the other. To determine if the groups significantly differ from each other, and whether or not there are any interactions among the dependent variables, the data was analyzed using univariate analysis of variance. If a group difference was found a post hoc analysis was conducted to determine how the two groups differed from one another. The third question, “Are the types of prosodic characteristics present in the speech of young children with autism different from those in typically developing children?” was answered by looking descriptively at whether or not the percentages obtained for the ASD group exceeded the 10% criterion. The independent variable for the current study was the diagnosis of the groups and consisted of two factors: ASD versus TD. To answer the first question, the dependent variable consisted of the twelve exclusion codes. To answer the second and third question, the dependent variable consisted of the six prosody factors. These factors are phrasing, rate, stress, loudness, pitch and quality, which are the variables of interest in the PVSP.

Exclusion Code Analysis

In order to answer the first question, “Do children with ASD differ from children with TD with regard to type or number of utterances related to content and/or context that must be excluded from the speech sample?” a 12x2 ANOVA was conducted to evaluate the effects of exclusion code and group on the percent of utterances excluded. The means and standard deviations for exclusion codes and as a function of the two factors are presented in Table 3. The ANOVA indicated no significant interaction between the exclusion code and group $F(11, 144) = .461$, $p = .924$, partial $n^2 = .034$. ANOVA indicated no significant main effect for group $F(1, 144) = .240$, $p = .625$, partial $n^2 = .002$, however a significant main effect was found for the exclusion codes $F(1, 11) = 37.127$, $p = .000$, partial $n^2 = .739$.

Table 3

12x2 ANOVA results for the effect of exclusion codes

		SF_0		
	df	*MS*	*F*	*p*
Group	1	3.090	.240	.625
Exclusion Code	11	477.843	37.127	.000
Group * Exclusion Code	11	5.939	.461	.924
Error	144	12.871		

Note. df = degrees of freedom; *MS* = mean square; *F* = Fisher’s *F* ratio; *p* = probability

Follow up analysis to the main effect for exclusion codes consisted of all pairwise comparisons among the 12 types of exclusion codes. The Tukey HSD procedure was used to control for Type I error across the pairwise comparisons. Several conclusions can be derived from the results of this analysis. First, the results indicate that there was a significantly higher percentage of utterances excluded due to C7: Only One Word when compared to all other exclusion codes ($p = .000$). Second, there was a significantly higher percentage of utterances excluded due to C12: Too Many Unintelligibles when compared to all codes with exception of C4, C5, C7 and C11. Third, there was a significantly higher percentage of utterances excluded due to C5: Interruption/Overtalk when compared to C2, C6 and C9. Finally, there were no significant differences among C1, C2, C3, C6, C8, C9 and C10 (see Table 4).

Table 5 highlights the means, ranges and standard deviations for each exclusion code for the ASD group and the TD group. Appendices F and G include the keys for the Exclusion codes and Prosody-Voice codes used in the PVSP (Shriberg, Kwiatkowski, & Rasmussen, 1990). As indicated in Table 3, there was not a difference between the groups with regard to the percentage of utterances that had to be excluded from the analysis because the utterances met the criteria for one of the exclusion codes. As shown in Table 5, the ASD participants had an average of 48.22% of utterances excluded, while the TD participants had an average of 44.27% of utterances excluded.

Results depicted in Table 5 further indicate no major differences between groups with regard to frequency of each exclusion code. The most frequent codes used in each group were C5 – Interruption/Overtalk, C7 – Only One Word and C12 – Too Many Unintelligibles. Although there were no statistically significant differences between groups with regard to frequency of a particular exclusion code, the ASD group did have a higher percentage of utterances excluded due to instances of C4 – Imitation. The ASD group had 3.81% of utterances excluded due to this code, while the TD group only had

0.96% excluded. Since a number of research studies have described the speech of children with ASD as echolalic (Prizant & Duchan, 1981; Wetherby, 1986), this trend is consistent with the literature.

Table 4

p *values for pairwise comparisons between exclusion codes*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
C1												
C2	1.00											
C3	1.00	1.00										
C4	.924	.836	.925									
C5	.066	.035*	.066	.875								
C6	1.00	1.00	1.00	.836	.035*							
C7	.000*	.000*	.000*	.000*	.000*	.000*						
C8	1.00	1.00	1.00	.904	.056	1.00	.000*					
C9	1.00	1.00	1.00	.836	.035*	1.00	.000*	1.00				
C10	1.00	1.00	1.00	.898	.053	1.00	.000*	1.00	1.00			
C11	.997	.984	.997	1.00	.556	.984	.000*	.995	.984	.994		
C12	.002*	.001*	.002*	.194	.994	.001*	.000*	.001*	.001*	.001*	.052	

Note. * indicates significance

Table 5

Exclusion codes by group

ASD			TD		
Code	Mean	SD	Code	Mean	SD
1	.421	.958	1	.147	.269
2	0	0	2	0	0
3	.254	.331	3	.334	.488
4	3.810	4.73	4	.964	1.49
5	3.399	2.53	5	5.927	3.251
6	0	0	6	0	0
7	20.953	11.75	7	20.239	7.758
8	.227	.101	8	.194	.101
9	0	0	9	0	0
10	.064	.171	10	.313	.546
11	1.766	1.422	11	1.606	1.310
12	7.221	6.312	12	5.127	4.660
Percent Utterances Analyzed	193.14	41.26	Percent Utterances Analyzed	179.43	37.02
Percent Utterances Excluded	48.22%		Percent Utterances Excluded	44.27%	

Note. Mean reflects mean percentage for total utterances

Analysis of PVSP Group Differences

In order to answer the second question, "Does the number of prosodic characteristics present in children with ASD differ from those present in the speech of typically developing children?", a 7x2 ANOVA was conducted to evaluate the effects of prosody and group on the percent inappropriate prosody-voice. The means and standard deviations for percent prosody-voice as a function of the two factors are presented in Table 6. The ANOVA indicated no significant interaction between prosody and group, $F(6,84) = 2.165$, $p = .054$, partial $n^2 = .134$, but significant main effects for prosody $F(6,84) = 47.280$, $p = .000$, partial $n^2 = .772$, and group, $F(6,84) = 5.187$, $p = .025$, partial $n^2 = .058$. The group main effect indicated that the ASD group tended to have a higher percent inappropriate prosody-voice than the TD group.

Table 6

7x2 ANOVA results for the effect of inappropriate prosody-voice

		SF_0		
	df	*MS*	*F*	*p*
Prosody	6	1902.14	47.28	.000
Group	1	208.66	5.187	.025
Prosody*Group	6	87.09	2.165	.054
Error	84	40.23		

Note. *df* = degrees of freedom; *MS* = mean square; *F* = Fisher's *F* ratio; *p* = probability

Follow up analysis to the main effect for prosody consisted of all pairwise comparisons among the 7 types of prosody. The Tukey HSD procedure was used to control for Type I error across the pairwise comparisons. Several conclusions can be derived from the results of this analysis. First, the results indicate that there was a significantly higher percentage of inappropriate rate codes when compared to all other prosody codes ($p = .000$). Second, there was a significantly higher percentage of inappropriate stress codes when compared to phrasing, loudness, pitch, laryngeal features and resonance. Third, there was a significantly higher percentage of inappropriate phrasing codes than resonance codes. Finally, there were no significant differences among loudness, pitch, laryngeal features and resonance (see Table 7). Overall, the results indicate that there was a higher percentage of inappropriate rate and stress codes when compared to phrasing, loudness, pitch, laryngeal features and resonance.

Table 7

p *values for pairwise comparisons between prosody-voice codes*

	Phrasing	Rate	Stress	Loudness	Pitch	Laryngeal Features	Resonance
Phrasing							
Rate	.000*						
Stress	.767	.000*					
Loudness	.060	.000*	.001*				
Pitch	.081	.000*	.001*	1.00			
Laryngeal Features	.658	.000*	.041*	.845	.895		
Resonance	.021*	.000*	.000*	1.00	.999	.619	

Note. * indicates significance

Table 8 highlights the means, ranges, and standard deviations for the 7 prosody variables assessed. In relation to the prosody codes assessed (phrasing, rate and stress), inappropriate stress was observed more often in the speech of children with ASD than the TD group. The ASD group produced an average of 18.43 instances of inappropriate stress per 100 utterances compared to the TD group, who produced an average of 4.57 instances of inappropriate stress. Phrasing and rate codes did not differ between groups.

Table 8

PVSP Codes by Group

	ASD				TD			
PV Code	Mean	Min	Max	SD	Mean	Min	Max	SD
Phrasing	9.71	5	24	6.99	6.29	3	19	1.98
Rate	34	20	58	12.79	32.14	15	61	15.53
Stress	18.43	12	32	6.55	4.57	2	12	3.93
Pitch	1.57	0	3	1.27	0.86	0	2	0.69
Loudness	1.43	0	3	1.27	0.43	0	2	0.79
Laryngeal Features	3.86	0	16	5.49	4.29	1	10	3.55
Resonance	0	0	0	0	0	0	0	0

Note. ASD = Autism Spectrum Disorder; TD = Typically Developing

Group Differences Observed for PVSP Cut-off Criterion

In order to answer the third question, "Are the types of prosodic characteristics present in the speech of young children with autism different from those in typically developing children?", a 7x2 ANOVA was conducted to evaluate the effects of prosody and group on the number of participants who surpassed the 90% cutoff criterion. The means and standard deviations for percent prosody-voice as a function of the two factors are presented in Table 9. The ANOVA indicated a significant main effect for prosody F(6,84) = 43.357, p = .000, partial n^2 = .756, a significant main effect for group, F(6,84) = 13.714, p = .000, partial n^2 = .140 and a significant interaction between prosody and group, F(6,84) = 7.214, p = .000, partial n^2 = .340.

Table 9

7x2 ANOVA results for the effect of inappropriate prosody-voice

	df	SF_0		
		MS	*F*	*p*
Group	1	.653	13.714	.000
Prosody	6	2.065	43.357	.000
Group*Prosody	6	.344	7.214	.000
Error	84	.048		

Note. df = degrees of freedom; *MS* = mean square; *F* = Fisher's *F* ratio; *p* = probability

Because the interaction between prosody and group was significant, we chose to ignore the method main effect and instead examine the method simple main effect-that is, the difference among prosody for the two groups. To control for Type I error across the two simple main effects, we set alpha for each at .025. There were no significant differences for phrasing, rate, loudness, pitch, laryngeal features and resonance prosody-voice codes, but there was a significant difference for the stress prosody-voice code (see Table 10).

Table 10

7x2 ANOVA results for the effect of failing to pass 90% cutoff criterion

	df	Prosody		
		MS	*F*	*p*
Phrasing	1	.071	1.50	.224
Rate	1	3.263E-31	.000	1.00
Stress	1	2.571	54.00	.000*
Loudness	1	1.139E-31	.000	1.00
Pitch	1	8.156E-32	.000	1.00
Laryngeal Features	1	.071	1.500	.224
Resonance	1	2.723E-29	.000	1.00
Error	84	.048		

Note. df = degrees of freedom; *MS* = mean square; *F* = Fisher's *F* ratio; *p* = probability; * indicates significance.

Follow up tests were conducted to evaluate the seven pairwise differences among the means for prosody with alpha set .004 (.025/7 = .004) to control for Type I error over the seven pairwise comparisons. Results indicate that significantly more children with ASD failed to surpass the 90% cutoff criterion for the stress prosody-voice code. There were no significant differences between the two groups with regard to the number who failed to surpass the 90% cutoff criterion for phrasing, rate, loudness, pitch, laryngeal features and resonance prosody-voice codes. This indicates that children with ASD are more likely to fail to surpass the 90% cutoff criterion of the stress portion of the PVSP.

VI. Discussion

A number of research studies indicate that the speech of children with ASD contains atypical vocalizations and unusual prosody (Baltaxe, 1984; Fosnot & Jun, 1999; Grossman, Bemis, Skwerer, and Tager-Flusberg, 2010; McCann & Peppe, 2003; McCann et al., 2007; Sheinkopf, Mundy, Oller & Steffens, 2000; Shriberg, Paul, McSweeny, Klin, Cohen, & Volkmar, 2001). These studies have shown that children with ASD display atypical rate, rhythm, intonation and stress patterns when compared to children with typical development (Baltaxe, 1984; Fosnot & Jun, 1999; Shriberg, Paul, McSweeny, Klin, Cohen, & Volkmar, 2001). However, these studies have differed with regard to number of participants, age ranges included and methodology.

The primary purpose of the current study was to evaluate the prosodic characteristics of young verbal children with autism between the ages of 24 and 68 months. Specifically, this study explored characteristics such as loudness, pitch and vocal quality of individuals with ASD. The PVSP (Shriberg, Kwiatkowski and Rasmussen, 1990) was used to evaluate the degree to which atypical prosodic characteristics appear in the speech of young children autism. This particular assessment was used because it is one of the only published and readily available prosody assessments that can be used with a variety of age ranges and speech and language disorders. Following the assessment, the prosodic characteristics of the ASD group were compared to the prosodic characteristics of the TD group determine whether or not differences exist.

PVSP Exclusion Codes

As indicated in Table 5, there was not a difference between the two groups with regard to the percentage of utterances that were excluded from the analyses. As shown in the table, 48.22% of utterances were excluded for the ASD group, compared to 44.27% for children with TD. These findings differ from Shriberg et al. (2001), where researchers found a significant difference between utterances excluded from the samples of children with HFA when compared to children with TD. Specifically, Shriberg et al. found that the HFA participants averaged 42.3% excluded utterances, compared to 21.3% for the TD group. Differences in results may be due to the fact that participants in the current study were much younger than those included in the study conducted by Shriberg et al. Because children are still developing language between the ages of 24 and 68 months, it serves to follow that a higher number of utterances will be excluded from the speech sample, regardless of the group.

Results depicted in Table 5 further indicate that the majority of utterances excluded from the ASD group and TD group were due to content/context codes. The most frequent codes were C5: Interruption/Overtalk, C7: Only One Word and C12: Too Many Unintelligibles. These codes reflect conversation between the examiner and participant and indicate that utterances that were excluded were due to interactive constraints between the clinician and child or the parent and child. Codes related to Environment, Register, and States (vegetative) occurred less frequently. Codes C5 and

C7 were also the most frequently used codes in a study conducted by Shriberg et al (2001). Specifically, Shriberg et al. found that C5 was used to exclude around 5% of utterances from each group included in the study. These results are similar to the current study, where 3.40% of utterances were excluded from the ASD group and 5.13% of utterances were excluded from the TD group due to exclusion code C5: Interruption/Overtalk. With regard to C7: Only One Word, results differed slightly from Shriberg et al. with regard to utterances excluded from the TD group. Data from the current study showed that 20.95% of utterances were excluded from the ASD group and 20.23% of utterances were excluded from the TD group. While Shriberg et al. found that about 20% of utterances were excluded from the ASD group due to C7, they found that only 12% of utterances were excluded from the TD group. This contrast between TD groups is most likely due to the age of the participants included in each study. Participants in the current study were of preschool age, while participants in the study by Shriberg et al. were adolescents. Finally, results show that the ASD group had a higher percentage of utterances excluded due to C4: Imitation than the TD group. The ASD averaged 3.81% excluded utterances compared to the TD group who only had .96% of utterances excluded due to this code. Although the results are not statistically significant, this difference lends support to previous studies that show that children with autism often exhibit instances of echolalia, or immediate repetition of another speaker's utterance, during conversation. Though imitative speech is common during early language development, children with autism tend to imitate longer utterances that are closer approximations to the original utterance (Lovaas, 1977; Prizant & Duchan, 1981; Wing, 1981). Research by Rutter (1968) and Wing (1971) suggested that echolalia was characteristic of three-quarters of children with autism studied. While this statistic is much higher than that found in the current study, it confirms the result that echolalic speech is more common in children with autism than in children with TD. Furthermore, these studies did not differentiate among participants with regard to severity of the disorder (low-functioning versus high-functioning autism or Asperger's syndrome).

Although earlier research studies suggest that echoed utterances do not serve a communicative function, more recent studies suggest that non-focused echoed utterances are relatively rare in the speech of children with autism, making up 1-7.1% of a given speech sample (Prizant & Duchan, 1981). Instead, Prizant and Duchan (1981) and Prizant and Rydell (1984) found that the majority of echoed utterances serve communicative functions such as turn-taking, requesting and answering questions. This was evidenced by the inclusion of gestures (pointing, touching, showing), eye gaze or changes in body orientation. Overall, results from both studies showed that 40.7% - 72.5% of echoed utterances of children with ASD showed evidence of communicative intent. This can lead to the conclusion that utterances excluded as a result of echolalia on Shriberg et al.'s criteria could possibly remain in the speech sample. Instead of excluding all imitated utterances, it may be beneficial to determine whether or not the imitated utterances differ from nonimitated utterances on prosody measures. According to previous research, these utterances may serve communicative intent and should therefore consideration of whether they should remain in the speech sample is warranted.

Prosody-Voice Results

Results from the current study both support and contradict findings from previous studies. Specifically, data from this study indicated that children with ASD produced atypical stress patterns, such as multisyllabic word stress or reduced stress, in relation to the TD group. The majority of inappropriate stress for the ASD group involved the use of lexical stress within multisyllabic words. This suggests that children with ASD encounter difficulty with the grammatical use of prosody, which relates to the appropriate placement of stress within words and sentences. Previous studies have also found that individuals with ASD demonstrate difficulty with lexical stress, including McCann et al. (2007) and Paul et al. (2005). Specifically, McCann et al. found that children with ASD misassigned stress placement, often stressing the first syllable within a word. In this study, all but one child with ASD produced inappropriate stress cues within utterances, indicating deficits in the pragmatic use of stress. This is consistent with results described by Baltaxe (1984), Fine et al. (1991) and Shriberg et al. (2001), who have also reported significant increases in the inappropriate use of contrastive stress in children with ASD. While results for this specific aspect of prosody were in agreement with results from previous studies, results for several other prosodic characteristics measured conflicted with findings from previous studies.

In contrast to several previous studies, the ASD group in the current study did not differ from the TD group with regard to production of rate, loudness and pitch. These results conflict and agree with results from studies that have previously addressed this topic. Results from the current study support previous findings by Grossman, Bemis, Skwerer and Tager-Flusberg (2010), who found no significant differences in the pitch or loudness of children with HFA when compared to children with TD. However, several research studies have described atypical pitch accents and timing patterns in the speech of children with ASD (Diehl, Watson, Bennetto, McDonough and Gunlogson, 2009; Fosnot and Jun, 1999). Fosnot and Jun (1999) found that the speech of children with autism was most deviant from children with TD in terms of duration, intonation and pitch during reading and imitative tasks. Specifically, the authors found that declarative and question sentences read by children with autism were longer in duration than children who stutter and typically developing children. The same results were found for the imitative tasks. Fosnot and Jun also reported that the children with autism did not use proper intonation patterns, making it difficult to distinguish declarative sentences from interrogative sentences during the reading task. Although these results were not replicated in the current study, the two studies differ in the method of data collection. That is, Fosnot and Jun used reading passages and imitative speech tasks, while the current study used a variety of structured play activities in order to obtain a spontaneous speech sample.

Results from a study by Diehl, Watson, Bennetto, McDonough and Gunlogson (2009) also differed from the current study. Diehl et al. used acoustic and perceptual measures to analyze the fundamental frequency of adolescents and children with HFA. The authors found that both age groups exhibited increased fundamental frequency variation and a higher fundamental frequency average when compared to typically developing children. Perceptual analysis of pitch for the current study did not find any significant differences between groups with regard to pitch variation.

Several reasons may account for differences between results from the two studies discussed above and the current study. First, the children included in the current study were between the ages of 24 and 68 months, an age group that is significantly younger than those included in previous studies of individuals with ASD. At this young age, children with TD may not have mastered prosodic cues necessary to determine differences between these two populations. Although several research studies suggest that children begin to integrate prosodic cues into their speech before the age of 2, differences exist in the literature concerning the age at which children begin to master this aspect of communication (Allen & Hawkins, 1980; Gerken & McGregor, 1998; Klein, 1981; Snow, 1994). Second, a significant number of previous studies used structured reading passages and imitative tasks in order to elicit speech samples (Baltaxe, 1984; Fine et al., 1991; Fosnot and Jun, 1999). In contrast, the current study used spontaneous speech samples to determine whether or not atypical prosodic characteristics were present in the speech of children with ASD. This method was used because spontaneous speech samples are more likely to be representative of a child's speech and language abilities than imitative tasks or structured reading passages.

Of significant interest is the fact that both the ASD and TD group exhibited high instances of inappropriate rate codes in comparison to all other prosody-voice codes. According to the PVSP, appropriate rate is defined as utterances that contain 2-4 syllables per second. Of the four rate codes (PV9 – slow articulation/pause time, PV10 – slow/pause time, PV11 – fast and PV12 – fast/acceleration), both groups exhibited more instances of PV11 – fast rate than any other rate code. These results stand in contrast to those described by Grossman et al., who found that children with HFA produced longer word productions than children with typical development. Additionally, Grossman noted that participants with HFA produced more pauses between syllables than the TD group, making word production sound awkward and disfluent. Results from the current study did not indicate that children with ASD produce utterances that are longer in duration. Instead, both the ASD group and the TD group produced a large number of utterances with a fast rate. This may be caused by moments of excitement during testing, in which a variety of toys of high interest were used in order to prompt and facilitate communication. This fast rate may also be characteristic of younger children.

Finally, results depicted in Table 10 show that significantly more children with ASD failed to surpass the 90% cutoff criterion for the stress prosody-voice code. However, there were no significant differences between the two groups with regard to the number who failed to surpass the 90% cutoff criterion for phrasing, rate, loudness, pitch, laryngeal features and resonance prosody-voice codes. These results are similar in some aspects to those obtained by Shriberg et al., who found that significantly more speakers with HFA and AS failed to pass the stress prosody-voice code (HFA = 53.3%, AS = 26.7%) compared to speakers with TD (5.7%). However, Shriberg et al. also found that significantly more speakers with HFA and AS failed the resonance prosody-voice code (HFA = 40%, AS = 26.7%) than speakers with TD (1.9%), and significantly more speakers with AS (66.7%) failed the phrasing prosody-voice code than speakers with TD (26.4%). These results were not replicated in the current study. Specifically, neither group had any utterances coded as inappropriate resonance. Additionally, both groups had a similar number of utterances coded as inappropriate phrasing (ASD = 9.71%, TD = 6.29%). This difference may be accounted for by the difference in the age groups included in the current study versus the older age group included in the study by Shriberg et al. Results from the current study stand in agreement with research by Yairi (2005), who found that the speech of young preschool children is more disfluent than the speech of school-age children. This is due to the fact that at a young age, the motor planning of speech is still developing. Therefore, their speech is often more awkward and disfluent than the speech of older children.

Conclusion

Currently, clinicians and caregivers look for evidence of a communication delay in verbal children suspected of ASD (Wetherby & Prizant, 1996; Wetherby, Goldstein, Clearly, Allen & Kublin, 2003). Because there is no readily apparent delay in spoken language in verbal children with ASD, it is difficult for clinicians to identify these children early in development. Young verbal children with ASD may obtain scores within normal limits on standardized speech and language tests administered to preschool-age children, and are therefore not identified as having a communication delay. This apparent issue necessitates more precise indicators of ASD in order to improve early and accurate diagnosis methods. Results from this study suggest that atypical stress patterns consistently appear in the speech of children with ASD, which coincides with previous data collected (Baltaxe, 1984; McCann et al., 2007; Shriberg et al., 2001). Therefore, it may be beneficial to evaluate the frequency and type of stress patterns present in the speech of children suspected of ASD. Such an evaluation would provide clinicians with an additional diagnostic tool.

VII. Future Research

Because the present study included a small number of participants, it will be important for future studies to include a larger number of children with ASD in order to better understand the prosodic patterns present in this population. It would also be interesting to determine whether echoed utterances, which were excluded from the current study, differ from non-echoed utterances based on PVSP variables. Further investigation should also be conducted to compare the type and frequency of atypical prosodic patterns of children with ASD to other populations, such as children with developmental disabilities. This analysis would help determine whether the prosodic patterns observed are related to a general developmental delay or if the patterns are specific to children with ASD. Additionally, this information would provide clinicians with important information concerning the prosodic characteristics of a given population and whether or not these prosodic patterns warrant treatment. Finally, it would be interesting to compare the prosody characteristics of each child with ASD over several years in order better understand the development and progression of prosody within this population. In doing so, researchers and clinicians would obtain information as to whether or not the prosody of children with ASD improves or becomes more atypical with age, and whether or not there are any unique patterns to the prosodic patterns of children with ASD.

In summary, the results of this study indicate that the prosodic patterns of young children with ASD do not differ significantly from children who are TD, with the exception of grammatical pragmatic stress. While these results differ from those of previous studies, the current study involved a much younger age group. Therefore, it is difficult to determine whether or not the participants had reached a level of mastery with regard to use of prosodic cues. Additionally, two of the prosody and voice characteristics measured in the current study involved the use of instrumental assessment, which may provide more accurate results than perceptual measures used in a significant number of previous studies (Baltaxe, 1984; McCaleb & Prizant, 1985; Paul et al., 2005; Shriberg et al., 2001). Although the majority of the prosodic cues assessed did not differ between groups, the presence of atypical stress patterns within the ASD group may serve as an early indicator of autism spectrum disorders in verbal children, however this subject needs to be investigated in future research.

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Appendix A

Diagnostic Criteria for 299.00 Autistic Disorder

A. Six or more items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3):

1. Qualitative impairment in social interaction, as manifested by at least two of the following:
   - Marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
   - Failure to develop peer relationships appropriate to developmental level
   - Lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)
   - Lack of social or emotional reciprocity
2. Qualitative impairments in communication as manifested by at least one of the following:
   - Delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)
   - In individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others
   - Stereotyped and repetitive use of language or idiosyncratic language
   - Lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level
3. Restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:
   - Encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
   - Apparently inflexible adherence to specific, nonfunctional routines or rituals
   - Stereotyped and repetitive motor manners (e.g., hand or finger flapping or twisting, or complex whole-body movements)

- Persistent preoccupation with parts of objects

B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play.

C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder.

Diagnostic Criteria for 299.80 Asperger's Disorder

A. Qualitative impairment in social interaction, as manifested by at least two of the following:

   a. Marked impairment in the use of multiple nonverbal behaviors such as eye-to eye gaze, facial expression, body postures, and gestures to regulate social interaction

   b. Failure to develop peer relationships appropriate to developmental level

   c. A lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest to other people)

   d. Lack of social or emotional reciprocity

B. Restricted repetitive and stereotyped patterns of behavior, interests and activities, as manifested by at least one of the following:

   a. Encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity of focus

   b. Apparently inflexible adherence to specific, nonfunctional routines or rituals

   c. Stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)

   d. Persistent preoccupation with parts of objects

C. The disturbance causes clinically significant impairment in social, occupational, or other important areas of functioning.

D. There is no clinically significant general delay in language (e.g., single words used by age 2 years, communicative phrases used by age 3 years).

E. There is no clinically significant delay in cognitive development or in the development of age-appropriate self-help skills, adaptive behavior (other than in social interaction), and curiosity about the environment in childhood.

F. Criteria are not met for another specific Pervasive Developmental Disorder or Schizophrenia.

299.80 Pervasive Developmental Disorder Not Otherwise Specified (Including Atypical Autism)

This category should be used when there is a severe and pervasive impairment in the development of reciprocal social interaction associated with impairment in either verbal or nonverbal communication skills or with the presence of stereotyped behavior, interests, and activities, but the criteria are not met for a specific Pervasive Developmental Disorder, Schizophrenia, Schizotypal Personality Disorder, or Avoidant Personality Disorder. For example, this category includes "atypical autism" - presentations that do not meet the criteria for Autistic Disorder because of late age at onset, atypical symptomatology, or subthreshold symptomatology, or all of these.

Diagnostic Criteria for 299.80 Rett's Disorder

A. All of the following:

  a. Apparently normal prenatal and perinatal development
  b. Apparently normal psychomotor development through the first 5 months after birth
  c. Normal head circumference at birth

B. Onset of all of the following after the period of normal development:

  a. Deceleration of head growth between ages 5 and 48 months
  b. Loss of previously acquired purposeful hand skills between 5 and 30 months with the subsequent development of stereotyped hand movements (e.g., hand-wringing or hand washing)
  c. Loss of social engagement early in the course (although often social interaction develops later)
  d. Appearance of poorly coordinated gait or trunk movements
  e. Severely impaired expressive and receptive language development with severe psychomotor retardation

Diagnostic Criteria for 299.10 Childhood Disintegrative Disorder

A. Apparently normal development for at least the first 2 years after birth as manifested by the presence of age-appropriate verbal and nonverbal communication, social relationships, play, and adaptive behavior.

B. Clinically significant loss of previously acquired skills (before age 10 years) in at least two of the following areas:

    a. Expressive or receptive language
    b. Social skills or adaptive behavior
    c. Bowel or bladder control
    d. Play
    e. Motor skills

C. Abnormalities of functioning in at least two of the following areas:

    a. Qualitative impairment in social interaction (e.g., impairment in nonverbal behaviors, failure to develop peer relationships, lack of social or emotional reciprocity)
    b. Qualitative impairments in communication (e.g., delay or lack of spoken language, inability to initiate or sustain a conversation, stereotyped and repetitive use of language, lack of varied make-believe play)
    c. Restricted, repetitive, and stereotyped patterns of behavior, interest, and activities, including motor stereotypes and mannerisms

D. The disturbance is not better accounted for by another specific Pervasive Developmental Disorder or by Schizophrenia

(Reprinted from the American Psychiatric Association [2000]. *Diagnostic and statistical manual of mental disorders* [4th ed., text revision]. Washington, DC: Author).

Appendix B

*Participant ID number*_________

Telephone Interview

"I'd like to take a few moments to familiarize you with the research project. The purpose of this study is to examine the fluency and prosody of young children with autism spectrum disorders. Very little is known about the fluency and prosody of children with autism spectrum disorders. We hope this research project will help to develop information that will lead to better treatment of autism spectrum disorders for young children.

I am going to ask you to provide information about your child so that I can determine whether your child meets the eligibility criteria for the research project. If your child is eligible, you and your child will be asked to participate in about 2 to 6 hours of face-to-face evaluations.

The information that you provide will be kept confidential to the extent allowed by law. There are no known risks or benefits to you for providing this background information. Participation in this study is voluntary, and you may choose not to continue with the study at any time.

1. Is your child between 24 (2 years) and 68 (51/2 years) months of age?
2. Does your child speak English as their primary and only language?
3. Does your child have any visual or hearing impairments?
4. Does your child have good control of their body and arms?

Telephone Screening Eligible? ☐ Yes ☐ No

(If yes, to all of the above)
Do you have any questions about the research study or your participation in the study?
Would you like to continue and to participate in the research study at this time?" ☐Yes

☐No

I have read the research project description to the child's caregiver and the caregiver has provided verbal consent to begin participation in the research project's.

____

Signature of Research Staff Member Printed Name Date

Appendix C

Autism Research Study

Be part of an important autism research study!

Do you want to help advance autism research?

Is your child between 24 and 68 months of age?
Does your child have good arm and trunk control?
Does your child only speak English?
Does your child have normal vision and hearing?
Do you want a free assessment of your child's speech and language development?

If you answered ***YES*** to these questions, you may be eligible to participate in autism research study.

You are invited to participate in a research study that investigates the fluency and prosody (i.e., the rhythm and flow of speech) of young children with Autism Spectrum Disorder. Through this study, we hope to develop a better understanding of the ways in which fluency and prosody are different in children with autism than other children and how those differences contribute to deficits in communication and social relationships. Benefits include a comprehensive speech and language evaluation. Participants will be given parking vouchers for the clinic parking lot.

Children with autism spectrum disorders, children with developmental delays, children who stutter, and children who are typically developing may be eligible to participate in this research study.

This study is being conducted by Dr. Laura Plexico and Dr. Allison Plumb in the Department of Communication Disorders.

Please contact Dr. Laura Plexico at **lwp0002@auburn.edu** or **(334) 844-9620** for more information.

Appendix D

Informed Consent Form

COMMUNICATION
DISORDERS

SPEECH &
HEARING
CLINIC

AUBURN UNIVERSITY

COLLEGE OF LIBERAL ARTS

The Auburn University
Institutional Review Board
has approved this document for use
from 4/30/10 to 5/12/11
Protocol # 09-099 MR 0905

Informed Consent
For a Research Study Entitled
Disfluency Patterns and Prosodic Adaptations Associated with Autism Spectrum Disorders

You are invited to participate in a research study that investigates the fluency and prosody of young children with Autism Spectrum Disorder. Through this study, we hope to develop a better understanding of the ways in which fluency and prosody (i.e., the rhythm and flow of speech) are impaired in children with autism and how those impairments contribute to deficits in communication and hinder the development of social relationships. This study is being conducted by Dr. Laura Plexico and Dr. Allison Plumb in the Auburn University Department of Communication Disorders. Your child was selected as a possible participant because they are between 2 years and 5 years 6 months of age and are using words to communicate. Participation in this study will require that your child come to the clinic for one to three sessions of assessment. Specifically, your child's developmental skills (i.e., communication, play, social and intellectual abilities) will be assed with tests routinely used to evaluate a child's development. We will also ask that you complete some questionnaires and participate in an interview about your child's development, family history and home environment. Participation in this study could require 1-3 assessment sessions could take from 1-2 hours each. The information you provide and your child's scores will remain confidential and will not be shared with anyone. The data obtained from you and your child will be immediately assigned a code, and then be recoded to maintain the confidentiality of your ratings.

Your decision whether or not to participate will not affect your future relationship with Auburn University or with any services your child may be receiving through the University. Your participation in this study is entirely voluntary and your refusal to participate will involve no penalty or loss of benefits and treatment to which you or your child are otherwise entitled. You are also free to withdraw from the study at any time without penalty or loss of benefits to which you are otherwise entitled. If you choose to withdraw from the study, any information about you and any data that you have provided will be destroyed upon your request.

We do not anticipate any risks associated with you or your child's participation in this study. You and your child's privacy will be protected. Any information obtained in connection with this study and that can be identified with you or your child will remain anonymous. Your child's identity and participation in this study will be known only to Laura Plexico and Allison Plumb. After the assessments are completed the primary investigator will remove all identifying information and code all data. After the data is coded a co-investigator will recode the data. After recoding the data, a graduate assistant will enter the data into a spreadsheet and prepare it for analysis. The primary investigators and their research assistants will be the only individuals with access to the recoded data. Laura Plexico will be the only person with access to the original codes and those codes will be stored in a secure place under lock and key.

Page 1of 2

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Participant Initials

1199 Haley Center, Auburn, AL 36849-5232; Telephone: 334-844-9600; Fax: 334-844-4585
w w w . a u b u r n . e d u

You and your child will be videotaped and audio recorded during the evaluation sessions. These video and audiotapes will be kept by project staff in a locked room and will be saved indefinitely. These videotapes will be accessible only to research staff, unless otherwise specified by you. The video and audiotapes will be used for research purposes. When Laura Plexico has completed the study, she will discuss the research findings with you and provide you with a written report of the findings. The data collected from you and your child's participation in this study may be used by Laura Plexico and the co-investigators for other research purposes or for developing a paper for presentation or publication in a professional journal. If so, none of your child's identifiable information will be included.

If you or your child has questions about any aspect of the study you can contact Laura Plexico by phone at (334) 844-9620 or email lwp0002@auburn.edu. She will be happy to answer any questions you might have. If you should have any questions about your rights as a research participant, you can contact the Office of Human Subjects Research or the Institutional Review Board by phone at (334) 844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu. You will be provided a copy of this form to keep.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

Participant's signature Date	Investigator obtaining consent Date
Printed Name	Printed Name

The Auburn University
Institutional Review Board
has approved this document for use
from 4/30/10 to 5/12/11
Protocol # 09-099 MR 0905

COMMUNICATION DISORDERS

SPEECH & HEARING CLINIC

AUBURN UNIVERSITY

COLLEGE OF LIBERAL ARTS

The Auburn University Institutional Review Board has approved this document for use from 4/30/10 to 5/12/11 Protocol # 09-099 MR 0905

Parental Permission/Child Assent Informed Consent
For a Research Study Entitled
Disfluency Patterns and Prosodic Adaptations Associated with Autism Spectrum Disorders

Your child is invited to participate in a research study that investigates fluency and prosody of young children with Autism Spectrum Disorder. Through this study, we hope to develop a better understanding of the ways in which fluency and prosody (i.e., the rhythm and flow of speech) are impaired in children with autism and how those impairments contribute to deficits in communication and hinder the development of social relationships. This study is being conducted by Dr. Laura Plexico and Dr. Allison Plumb in the Auburn University Department of Communication Disorders. Your child was selected as a possible participant because they are a verbal communicator between 24 and 68 months of age. Participation in this study will require that your child come to the clinic for two to three sessions of assessment. Specifically, routine standardized measures will be administered to assess your child's communication, play, nonverbal cognitive skills, social skills and adaptive behavior. We will also ask that you complete some questionnaires and participate in an interview about your child's development, family ecology and home environment. Participation in this study could require 1-3 assessment sessions could take from 1-2 hours each. Your child's scores will remain confidential and will not be shared with anyone. The data obtained from your child will be immediately assigned a code, and then be recoded to maintain the confidentiality of your ratings.

Your decision whether or not to participate will not affect your future relationship with Auburn University, with your child's school or with any services your child may be receiving at the clinic. Your participation in this study is entirely voluntary and your refusal to participate will involve no penalty or loss of benefits and treatment to which you are otherwise entitled. You are also free to withdraw your child from the study at any time without penalty or loss of benefits to which he or she is otherwise entitled. If you choose to withdraw your child from the study, any information about your child and any data that they have provided will be destroyed upon your request.

We do not anticipate any risks associated with your child's participation in this study. Your child's privacy will be protected. Any information obtained in connection with this study and that can be identified with your child will remain anonymous. Your child's identity and participation in this study will be known only to Laura Plexico and Allison Plumb. After the assessments are completed the primary investigator will remove all identifying information and code all data. After the data is coded a co-investigator will recode the data. After recoding the data, a graduate assistant will enter the data into a spreadsheet and prepare it for analysis. The primary investigators and their research assistants will be the only individuals with access to the recoded data. Laura Plexico will be the only person with access to the original codes and those codes will be stored in a secure place under lock and key.

____
Parent/Guardian Initials

Page 1of 2

____
Participant Initials

1199 Haley Center, Auburn, AL 36849-5232; Telephone: 334-844-9600; Fax: 334-844-4585
www.auburn.edu

You and your child will be videotaped and audio recorded during the evaluation sessions. These video and audiotapes will be kept by project staff in a locked room and will be saved indefinitely. These videotapes will be accessible only to research staff, unless otherwise specified by you. The video and audiotapes will be used for research purposes. When Laura Plexico has completed the study, she will discuss the research findings with you and provide you with a written report of the findings. The data collected from your child's participation in this study may be used by Laura Plexico and the co-investigators for other research purposes or for developing a paper for presentation or publication in a professional journal. If so, none of your child's identifiable information will be included.

If you or your child has questions about any aspect of the study you can contact Laura Plexico by phone at (334) 844-9620 or email lwp0002@auburn.edu. She will be happy to answer any questions you might have. If you should have any questions about your rights as a research participant, you can contact the Office of Human Subjects Research or the Institutional Review Board by phone at (334) 844-5966 or email at hsubjec@auburn.edu or IRBChair@auburn.edu. You will be provided a copy of this form to keep.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

Participant's signature	Date	Investigator obtaining consent	Date
Printed Name		Printed Name	
Parent/Guardian Signature	Date		
Printed Name			

The Auburn University Institutional Review Board has approved this document for use from 4/30/10 to 5/12/11 Protocol # 09-099 MR 0905

Page 2 of 2

COMMUNICATION DISORDERS

SPEECH & HEARING CLINIC

AUBURN UNIVERSITY

COLLEGE OF LIBERAL ARTS

PERMISSION FOR USING VIDEOTAPES FOR EDUCATIONAL PURPOSES

I, ______________________________________(Parent or Guardian's name), as parent or guardian of __________________________________ (child's name) hereby give consent that any portion of the videotapes of this evaluation session of my child and myself or any reproduction of these materials made by Dr. Laura Plexico or co-investigators in the Department of Communication Disorders may be used for instructional or educational purposes. Signing this form does not in any way obligate me to give permission for broader use of these clips.

I understand that I will receive no financial compensation for the use of these recorded materials. I also understand that if in the future, I decide to revoke permission to use the video of me and/or my child, a concerted effort will be made to remove the segment of the educational video, but that this cannot be guaranteed. The reason for this is that once the educational video has been developed, it is difficult to remove a segment without needing to rework the entire product.

I have read the foregoing statements and agree to abide by them.

_______________________________________   _____________________

Signature of Parent/Legal Guardian   Date

1199 Haley Center, Auburn, AL 36849-5232; Telephone: 334-844-9600; Fax: 334-844-4585

www.auburn.edu

Appendix E

*Participant ID number*_________

Demographic Form

Date: ____

Child's Name: ____

☐Male ☐Female

Address: ____

____

Home Phone: ____

Cell Phone: (M) ______________________ (F) ______________________

Work Phone: (M) ______________________ (F) ______________________

Email address: ______________________ ______________________

When is the best time to call? ____

What is the best number to call? ____

Child's Date of Birth: ____

Child's Race:

☐ American Indian/ Alaska Native ☐ Black or African American

☐ Asian ☐ White

☐ Native Hawaiian or Other Pacific Islander ☐ More Than One Race

☐ Unknown

Child's Ethnicity:

☐ Hispanic or Latino ☐ Not Hispanic or Latino ☐ Unknown

Mother's Name: ____

Mother's Date of Birth: ____

Mother's Race:

☐ American Indian/ Alaska Native ☐ Black or African American

☐ Asian ☐ White

☐ Native Hawaiian or Other Pacific Islander ☐ More Than One Race

☐ Unknown

Mother's Ethnicity:

☐ Hispanic or Latino ☐ Not Hispanic or Latino ☐ Unknown

Mothers' highest level of education: ______________________________

Mother's occupation: ______________________________

Father's Name: ______________________________

Father's Date of Birth: ______________________________

Father's Race:

☐ American Indian/ Alaska Native ☐ Black or African American

☐ Asian ☐ White

☐ Native Hawaiian or Other Pacific Islander ☐ More Than One Race

☐ Unknown

Father's Ethnicity:

☐ Hispanic or Latino ☐ Not Hispanic or Latino ☐ Unknown

Fathers' highest level of education: ______________________________

Father's occupation: ______________________________

Siblings' Names:	Dates of Birth:	Relationship to Child:	Gender:
____________	__________	______________	☐M ☐F ________
____________	__________	______________	☐M ☐F ________
____________	__________	______________	☐M ☐F ________
____________	__________	______________	☐M ☐F ________

At how many weeks gestation was the child born? ______________________________

What was the child's birth weight? ______________________________

What is the name of the child's pediatrician/doctor and medical group? ______________________________

____

Has the child been diagnosed with an autism spectrum disorder? ☐Yes ☐ No

If so, what was the diagnosis?

☐ Autism Spectrum Disorder ☐ Pervasive Developmental Disorder – Not Otherwise Specified

☐ Asperger's Disorder ☐ Autistic Disorder

From whom did the child get the diagnosis? ______________________________________

____

What was the date that the child received the diagnosis? ___________________________

Has the child been diagnosed with a developmental delay? ☐Yes ☐ No

If so, what was the diagnosis?

☐ Language Delay ☐ Cognitive Delay ☐ Motor Delay ☐

Other__________________________

From whom did the child get the diagnosis? ______________________________________

____

What was the date that the child received the diagnosis? ___________________________

Has the child been diagnosed with a fluency disorder (i.e., stuttering)? ☐Yes ☐ No

If so, how severe?

☐ Mild ☐ Moderate ☐ Severe

From whom did the child get the diagnosis? ______________________________________

____

What was the date that the child received the diagnosis? ___________________________

Has anyone ever told you that the child has a medical problem or given the child a medical diagnosis (other than autism spectrum disorder)? If so, what were the medical problems or medical diagnoses?

____

____

____

Has the child's vision or hearing been tested? If so, what were the results?

____

What language is spoken in the home?_______________________________________

If there are any languages besides English spoken in the home, how many hours per day is the child exposed to this language?

Briefly describe how your child is communicating.

Does your child have any food restrictions or food allergies? If so, what?

How did you hear about the study?

Eligibility Criteria	Yes	No
Between 24 and 68 months of age		
English speaker		
Good trunk and arm support		
No known hearing or visual impairment		

Appendix F

Exclusion Codes

Content/Context Codes:
C1 – Automatic speech (counting etc.)
C2 – Back channel
C3 – "I Don't Know"
C4 – Imitation
C5 – Interruption or one speaker talking over another
C6 – Not 3+ Words
C7 – Only one word in the utterance
C8 – Only person's name in the utterance
C9 – Utterance contains speaker reading
C10 – Singing
C11 – Second repetition of an utterance
C12 – Too many unintelligible words in the utterances

Environment:
E1 – Noise interfering with clarity of speech sample
E2 – Recorder flutter
E3 – Speaker too close to microphone
E4 – Speaker too far away from microphone

Register:
R1 – Speaker using a character register
R2 – Speaker using a narrative register
R3 – Speaker using a negative register (i.e., speaker upset, yelling etc.)
R4 – Speaker using sound effects (i.e., car sounds)
R5 – Speaker whispering

Vegetative States:
S1 – Belch/burp
S2 – Coughing or throat clearing
S3 – Speaking with food in mouth
S4 – Hiccup
S5 – Laughing while speaking
S6 – Smacking lips
S7 – Body movement interrupts smoothness of speech
S8 – Sneeze
S9 – Telegraphic speech (i.e., utterance containing 3+ morphemes without function words)
S10 – Yawn during speech

Appendix G

Prosody-Voice Codes

Phrasing:
P1 – Appropriate
P2 – Sound or syllable repetition
P3 – Word Repetition
P4 – Sound/syllable and word repetition
P5 – More than one word repetition
P6 – One word revision
P7 – More than one word revision
P8 – Repetition and revision

Rate:
P1 – Appropriate
P9 – Slow articulation/pause time
P10 – Slow/pause time
P11 – Fast
P12 – Fast/acceleration

Stress:
P1 – Appropriate
P13 – Multisyllabic word stress
P14 – Reduced/equal stress
P15 – Excessive/equal/misplaced stress
P16 – Multiple Stress Features

Loudness:
P1 – Appropriate
P17 – Soft
P18 – Loud

Pitch:
P1 – Appropriate
P19 – Low pitch/glottal fry
P20 – Low pitch
P21 – High pitch/falsetto
P22 – High pitch

Laryngeal Features:
P1 – Appropriate
P23 – Breathy
P24 – Rough
P25 – Strained
P26 – Break/shift/tremulous
P27 – Register break
P28 – Diplophonia
P29 – Multiple laryngeal features

Resonance Features:
P1 – Appropriate
P30 – Nasal
P31 – Denasal
P32 – Nasopharyngeal

(see Shriberg, L. D., Kwiatkowski, J., & Rasmussen, C. [1990]. *The Prosody-Voice Screening Profile*. Tucson, AZ: Communication Skill Builders for complete lists and descriptions of exclusion codes and prosody-voice codes).