DEVELOPMENT OF A QUESTIONNAIRE TO ASSESS AUDITORY BEHAVIORS IN CHILDREN DIAGNOSED WITH AUTISM SPECTRUM DISORDERS

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By
Kelsey Dunning, B.A.

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The Ohio State University
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Master's Examination Committee:
Gail Whitelaw, PhD, Adviser
Paula Rabidoux, PhD

Approved by

Adviser
Department of Speech and Hearing Science
ABSTRACT

Although a considerable amount of research has demonstrated that auditory difficulties exist in a large number of individuals with the diagnosis of Autism Spectrum Disorder (ASD), little research has been able to thoroughly investigate the auditory domain of ASD. Auditory concerns, including hypersensitivity to sound, difficulty when background noise is present, and difficulty maintaining focus on auditory information are some of the major issues raised by parents and teachers for children with autism spectrum disorders (ASD). Little research has been done to thoroughly evaluate the prevalence and cause of these behaviors. Although some researchers have developed their own questionnaires to assess some of these auditory issues (Rimland, 1991; Vicker, 1993; Bettison, 1996), at this time there is no reliable measure to clinically evaluate the auditory behaviors seen in children with ASD.

The purpose of this study was to create a clinically useful assessment tool to evaluate the auditory behaviors seen in children with ASD. A web-based survey was distributed among a diverse group of professionals with experience in working with children with ASD. The survey contained several questions addressing background information and several open-ended questions focused on the auditory behaviors observed by these professionals in children with ASD. Analysis of these results
revealed several trends in the responses regarding the auditory behaviors observed in children with ASD. Hypersensitivity, hyposensitivity, phonophobia, adverse reactions to sound, unresponsiveness to verbal input, lack of auditory focus, receptive language difficulties, repetition/imitation of auditory input, difficulty in background noise, delay in processing time, auditory processing difficulties, and so on, were all common behaviors reported by the respondents.

To obtain a different perspective of the auditory domain of ASD and to further validate the development of an assessment tool, a second survey was sent to a group of parents of children with ASD. Similar trends to the professional survey were found in the responses from the parents. The results from both the professional and parent survey were then used to develop a preliminary draft of the Auditory Behavior Questionnaire (ABQ). Future research will further construct this questionnaire and validate it for clinical use.
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VITA

November 26, 1978..........................Born – Columbus, OH

2001..............................................B.A. Social Sciences, The Ohio State University

2001-2002......................................Graduate Assistant,
                                          FutureCom Technologies, Inc.

2002-2003.................................Course Instructor, The Ohio State University

FIELDS OF STUDY

Speech and Hearing Sciences
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CHAPTER 1

INTRODUCTION

Autism is a pervasive and complex developmental disorder that has a myriad of symptoms that typically differ from individual to individual. It is a disorder defined by impairment in social interaction, communication, and a markedly restricted repertoire of activity and interests (American Psychiatric Association, 1994). The definition of autism has changed drastically since Kanner first discussed the disorder in 1943. Kanner described autism in relation to schizophrenia and since that time the definition of autism has grown to include a spectrum of disorders.

Throughout time controversy has surrounded the definition and diagnostic criteria of autism. More recently, the term Autism Spectrum Disorders (ASD) is commonly used when discussing this topic. Features of autism have led to it being discussed as a spectrum disorder since no two cases are the same. Autism has been expanded diagnostically under the umbrella of Pervasive Developmental Disorders (PDD). PDD includes the following spectrum of disorders: Autistic Disorder, Asperger’s Syndrome, Rett’s Disorder, Childhood Disintegrative Disorder (CDD), and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS).
More controversy surrounds the prevalence rates of ASD and possible etiologies. Some epidemiologists believe the incidence of ASD is increasing, while others suggest this increase is due to more public awareness and better diagnostic techniques (Hyman, Rodier, and Davidson, 2001). Improved diagnostic criteria have surfaced after a great effort in discovering the cause of ASD. Genetics, environmental factors, and neurological differences have all been investigated, but many results are inconsistent and there is a lack of consensus regarding etiology.

Though autism is defined primarily by impairments in social interaction, abnormal auditory behaviors are frequently reported in individuals diagnosed with autism spectrum disorders (ASD). Auditory concerns, including hypersensitivity to sound, difficulty listening when background noise is present, and difficulty maintaining a focus on auditory information are often the major issues raised by parents and teachers for children with autism. Some of the early observations of autism included the concept that these children often acted as if they were deaf (Kanner, 1943; Wing, 1966; Hayes and Gordon, 1977). As seen in Table 1.1, in addition to suspected peripheral hearing loss, other auditory behaviors have been reported in research as being associated with autism; these include hypersensitivity to sounds, difficulty hearing or responding when background noise is present, difficulty processing auditory information, unresponsiveness to certain sounds (i.e. verbal commands, environmental noises, etc...), and middle ear anomalies (See Table 1.1 for references). All of these behaviors have been observed in a large number of individuals diagnosed with ASD.
Due to the variability of behaviors associated with ASD, the frequency and presence of these auditory behaviors appear to vary from individual to individual. Due to this variation and the fact that some individuals with autism do not report any auditory issues, these behaviors are not included in the diagnostic criteria of ASD. It should be noted that these behaviors may also be part of a greater sensory dysfunction that is not specific to the auditory domain. Although these behaviors may be noted in individuals on the spectrum, their presence is not necessary for the diagnosis of ASD.

Very few studies have been successful in investigating the auditory domain of autism. There is much speculation on the cause of such behavior, but few empirically sound studies have reached any conclusions on this matter. Based on review of current literature, there is a significant need for studies focused on the auditory realm of autism. Abnormal reactions to sounds may lead to social avoidance and disturbances causing a decrease in the quality of an individual’s life. Treatments have been proposed to reduce or eliminate these deviant auditory behaviors, but little research has been conducted to validate these treatments and the underlying mechanisms involved in such behaviors. Much more research is needed to put together the pieces of the puzzle before an effective treatment can be established.

Currently, studies focusing on auditory issues lack information about the quantification of auditory behaviors exhibited by individuals with ASD. Subjective measures were used, including parent interviews and questionnaires that have not been validated. The purpose of the current study was to develop a clinically useful assessment tool that will focus on the auditory behaviors of children diagnosed with
ASD. A more objective means is needed to provide professionals information about the auditory domain of their clients with ASD. Currently there is no clinically useful instrument available that focuses on these auditory issues. Though some researchers have developed questionnaires to use in their studies (Rimland, 1991; Bettison, 1996), there is no published or validated questionnaire used clinically to address this issue. Practitioners collect quantified measures of their clients’ problems to (1) improve treatment by measuring problems and aspects of treatment, (2) to enhance clinical knowledge, and (3) to provide accountability, that is, evidence that treatment is actually helping clients (Erdman, 1993). A questionnaire evaluating the auditory behaviors of children with ASD will be useful in research and clinical management of these patients.
<table>
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Table 1.1: Auditory behaviors reported as being observed in individuals with the diagnosis of ASD.
CHAPTER 2

REVIEW OF THE LITERATURE

To fully understand the auditory behaviors seen in children with ASD, a thorough review of the history and literature behind this disorder is needed. With new technology and techniques, more is known about autism today than ever before. However, as the following review will show, there is still much to be learned about this disorder and many avenues to be explored by research.

In 1943, Leo Kanner discussed the existence of a syndrome called “early infantile autism.” He found that a small group of children all experienced a similar combination of social isolation, language expression difficulty, and unusual behavioral actions (Kanner, 1943). Kanner described many similarities of this disorder with schizophrenia, but he also noted many differences. During the years subsequent to this description, the disorder was treated as a type of childhood schizophrenia. It was not until the development of the International Classification of Diseases (ICD) in 1978 and the Diagnostic and Statistical Manual of Mental Diseases (DSM) in 1980 that a separate diagnostic category for autism was created. Kanner’s
original definition of autism is typically referred to as “classic autism.” At that time it was assumed to be a unique and discrete condition.

Kanner’s Austrian contemporary, Hans Asperger, believed autism was not so clear-cut and observed children that appeared autistic with variations from the original definition (Asperger, 1944). Asperger originally used the term autistic psychopathy to coin what is today known as Asperger’s Syndrome (Wing, 1981). Wing used this term to describe children who presented with “classic autism” features while very young, but later developed fluent speech and some socialization skills. Over time more variations of autism were observed and there has been many discussions about this disorder. In the decades following Kanner’s original description, there has been much debate over the definition of autism and though a consensus definition has been reached, there is still controversy surrounding this topic.

**Definition of Autism**

The chief criteria currently used in diagnosing autism are compiled in a set of diagnostic handbooks, such as ICD-10 (World Health Organization [WHO], 1992) and DSM-IV (American Psychiatric Association, 1994). Both of these handbooks state that diagnostic criteria for an autistic disorder include abnormalities of social interaction, impairments in verbal and non-verbal communication and a restricted repertoire of interests and activities, all present from early childhood. These criteria have been agreed upon worldwide and have been used in both clinical and research settings.
Much of the controversy surrounding the definition of autism arises from the fact that the boundaries of this disorder are considered unclear. Many behaviors commonly observed in individuals with autism also can be observed in individuals who do not have autism (Willemsen-Swinkels and Buitelaar, 2002). Communicative impairments can range from an individual having limited communication skills to an individual that has fairly typical expressive and receptive language abilities. Some individuals may have a delay in speech and language development with symptoms of perseveration (the inappropriate repetition of words or sounds) and echolalia (echoing of words) (Murray-Slutsky and Paris, 2000). This disorder is further influenced by developmental level or intelligence and associated medical disorders. There is a wide variation in level of intellectual functioning among individuals with autism.

At least 25-30% of individuals with autism have associated medical conditions that may include attention deficit disorder, motor incoordination and psychiatric symptoms such as anxiety and depression (Hill and Frith, 2003; Bryson and Smith, 1998; Bryson, Clark, and Smith, 1988; Lotter, 1967). As these studies suggest, there is a significant amount of clinical heterogeneity seen in the population of individuals diagnosed with autism. It appears that no two cases of autism are completely alike.

Due to these clinical variations, attempts have been made to categorize the population into subgroups. A combination of clinical observations and empirical studies (Wing, and Gould, 1979; Tanguay, Robertson, and Derrick, 1998) suggest that autistic-like symptoms better fit to a multivariately distributed dimensional trait than
to categorical entities. More recently, the definition of autism has been extended to incorporate the idea of a continuum of related disorders without sharp boundaries between a core group of symptoms which define autism and additional clustered groups, known as pervasive developmental disorders (PDD).

**Pervasive Developmental Disorders (PDD)**

The DSM-IV (1994) and ICD-10 (1992) have given the overall construct of disorders with autistic and autistic-like symptoms the name pervasive developmental disorders (PDD). Volkmar and Cohen (1991) suggested the term “pervasive” emphasized that autism development was disturbed over a range of different domains, in contrast to the relatively more delineated difficulties of specific developmental disorders and the centrality of cognitive problems in mental retardation. They also stated the term “developmental” implies that individuals with these conditions experience disturbances in the normative unfolding of multiple developmental competencies, including social relations and communication. These disorders have an onset within the first few years of life. PDD has been used as a term to describe all categories seen in autism and autism-related disorders.

**PDD-Not Otherwise Specified (PDD-NOS)**

The category PDD-Not Otherwise Specified (PDD-NOS), which includes atypical autism, is used for conditions that are characterized by pervasive impairments in reciprocal social interaction, verbal and nonverbal communication, or rigid and stereotyped behavior patterns, but fail to meet the full set of criteria for autistic disorder (Buitelaar, Van der Gaag, and Klin, 1999). Due to a variety of
reasons (i.e. not having an onset before age 3, atypical presentation of symptoms, etc...), these cases do not fit the criteria of DSM-IV for an autistic disorder. However, due to the impairments in social interaction, communication, and the abnormal behaviors exhibited that are characteristic of autism, PDD-NOS is included in discussion of autism spectrum disorders.

Asperger’s disorder

An Austrian physician, Hans Asperger (1944), noticed several cases that largely resembled Kanner’s description of autism, but with some variations. Asperger’s description differed from Kanner’s in that speech was less commonly delayed, motor deficits were more common, the onset appeared somewhat later, and all the initial cases occurred in boys (Asperger, 1944; Wing, 1981). It was not until decades later that the disorder was recognized independently and currently Asperger’s disorder is included in the DSM-IV. In DSM-IV, the criteria for Asperger’s disorder was the same as those for the autistic disorder in terms of impairment in social interaction, restricted, repetitive patterns of behavior, interests, and activities (American Psychiatric Association, 1994). The main contrasts in the current definition of Asperger’s disorder in comparison to autism are that there are no clinically significant delays in the early development of language in the 12-24 month age range and there is no significant delays in cognitive development or the development of age-appropriate self-help skills and adaptive behavior are observed (American Psychiatric Association, 1994).
Childhood disintegrative disorder (CDD)

Childhood disintegrative disorder (CDD) is also included along the autism spectrum. The general guidelines for diagnosis include an onset of the condition after a prolonged period of normal development and a marked deterioration in multiple developmental areas accompanied by development of “autistic-like” features (Willemsen-Swinkels and Buitelaar, 2002). The main difference observed in CDD is that children will appear to develop along the normal progression for several years, followed by a rapid deterioration in developmental skills. CDD is also included in the DSM-IV under PDD. The DSM-IV criteria describe the period of normal development to have been at least 2 years, but less than 10 years (American Psychiatric Association, 1994). CDD is a relatively uncommon condition, much less frequent than autism (Volkmar and Cohen, 1989). Mouridsen, Rich and Isager (1999) stated that CDD could be distinguished from autism with reference to epilepsy. Significantly more children with disintegrative disorders developed seizures. Though these two disorders may be distinguishable, individuals with CDD have “autistic-like” behaviors that have kept it included on the autism spectrum.

Rett’s disorder

Very similar to CDD, Rett’s disorder begins with a period of normal development. However, the period of normal development is typically shorter than in CDD, lasting only a matter of months (Tsai, 1992). Following this period is a deceleration of head growth, followed by loss of hand skills and the appearance of stereotypic hand-wringer movements (Willemsen-Swinkels, 2002). One
distinguishing feature is that Rett’s disorder is only seen in girls, whereas autism is also seen in girls and is four times more prevalent in boys (Murray-Slutsy and Paris, 2000). Ataxia and apraxia are prominent features, gait becomes broad-based and jerky, and breathing functions may be impaired (Tanguay, 2000). This disorder has several symptoms that differ significantly from autism, but once it is established it contains autistic features such as social impairment, impairments in communication, and stereotyped behaviors (Tsai, 1992).

**Autism Spectrum Disorders**

Many researchers have argued about the term continuum to describe autistic disorders. “Continuum” implies a linear progression from mild to severe. In view of considerable variability observed in the symptoms of individuals diagnosed with autism, there is no true linear continuum from which to reference. Many believe the description is much more complex in terms of autistic disorders. The term “spectrum” is used to indicate the fact that although there is a common denominator, different types of children with a PDD present their own pattern of symptoms (Willemsen-Swinkels and Buitelaar, 2002). These children differ by nature and not merely degree. This idea is similar, metaphorically speaking, to the spectrum of distinct colors after refraction of light by a prism (Van der Gaag, Buitelaar, and Van der Ban, 1995). Each individual with ASD is different and will exhibit different behaviors. This spectrum ranges from high functioning individuals with Asperger’s disorder to nonverbal low functioning autistic individuals.
In the present study, the term autism spectrum disorders (ASD) was used when discussing individuals diagnosed with autism, Asperger’s disorder, childhood disintegrative disorder, Rett’s disorder, and PDD-NOS. The ICD-10 (1992) and DSM-IV (1994) provide tentative diagnostic descriptions of Asperger’s disorder, childhood disintegrative disorder, Rett’s disorder, and PDD-NOS.

Prevalence

Since the disorder was first described, there has been an increase in the number of epidemiological studies of autism. Research has made the diagnostic procedure more precise and it now covers a larger spectrum of autistic disorders. The current prevalence rates and whether rates have increased are highly debated topics. Dramatic changes in the diagnostic criteria, an increase in public awareness of autism and related disorders, and sweeping changes in the types and availability of therapeutic and educational services have made it difficult for researchers to determine if the prevalence of ASD is increasing (Hyman, Rodier, and Davidson, 2001).

Research published before 1985 reported prevalence rates of 4 to 5 per 10,000 children for the broader autism spectrum and approximately 2 per 10,000 for the diagnosis of “classic autism” (Lotter, 1967; Wing and Gould, 1979; Gillberg, 1984). Since 1985 non-U.S. studies have found higher rates of autism, ranging from a prevalence of 7 to 10 per 10,000 children for autistic disorder and an estimated prevalence for ASD 1.5 to 2.5 times higher (Fombonne, 1999). Studies in the U.S. after 1985 have shown variation of the prevalence of ASD in the U.S. A recent study
in Brick Township, NJ found the prevalence of all ASDs combined was 67 per 10,000 and 40 per 10,000 for children diagnosed with autistic disorder (Bertrand et al., 2001). An even more recent study in Atlanta, GA found fairly similar results. The prevalence of autism in metropolitan Atlanta was found to be 34 per 10,000 (Yeargin-Allsopp et al., 2003).

Many of the researchers focused on prevalence have discussed how varying prevalence rates are based on a number of factors, including changes in diagnostic criteria and increased public awareness. Many of the older studies mentioned in this review used different diagnostic criteria than are currently used. Some of the first prevalence rates used a more “classic” autism definition for diagnosis and more recent research has used wider diagnostic criteria, possibly improving the efficiency of diagnosing an individual with ASD. The public is more aware of this disorder and more cases are being brought forward, whereas in the past these children may have been overlooked or misdiagnosed. These differences make it difficult to compare the results. More research is needed throughout the U.S. to determine a more representative and current prevalence rate.

**Causes of Autism**

Since Kanner first proposed autism as a disorder in 1943, many theories have developed about its origin. Original theories included the psychogenic ideas of the “refrigerator mother,” reporting that children became autistic in response to a threatening and unloving parent (Bettelheim, 1967). Current theories have progressed to include the behavioral characteristics of the disorder and now seek to provide a
more detailed taxonomy of both cognitive and biological levels (Hill and Frith, 2003). Current research is focused on genetic, cognitive, and environmental factors.

In 1977, Folstein and Rutter published the first twin study in autism. This study suggested that the concordance rate in identical twins was much higher than in non-identical twins. This finding was replicated by Bailey et al. (1995) and is well established. These strong genetic links have led many researchers to investigate actual susceptibility genes, which may cause this disorder. This suggestion is based on the idea that the presence of one or more genes may be a cause for autism. Several genome-wide linkage studies have found regions on chromosomes 2, 7, and 13 that may contain one or more susceptibility genes, but actual susceptibility genes have not yet been identified (Folstein and Rosen-Sheidley, 2001). There continues to be no empirical evidence that one or more genes are causes of autism, however, more research is needed in this area.

More recent work conducted by the UCLA Neuropsychiatric Institute has localized a region on chromosome 16 that is likely to contain a risk gene for Attention Deficit Hyperactivity Disorder (ADHD) and may also be involved in autism (Smalley et al., 2002). ADHD and autism are very distinct clinical conditions, but this study provides compelling evidence that these two disorders may have more in common than was previously believed. More investigation is needed to find the exact pattern of gene transmission and which specific genes are involved. Once again, the researchers speculate on a gene pattern for autism, but do not yet have conclusive evidence.
Many researchers have investigated the brain structure and function involved in autism. Evidence has been provided that structural abnormalities exist in the brains of people with autism (Bauman and Kemper, 1994; Kemper and Bauman, 1998). Focus has been directed on the inner core of the limbic system, called the amygdala, which is known to help regulate aspects of social and emotional behavior. Avoidance and defensive behaviors have been shown to be orchestrated by this area of the brain (Gray, 1991; Pribram, 1991; Ledoux 1996). A handful of studies have reported distinct functional abnormalities in a number of cortical (focusing on the frontal and temporal lobes and the cerebellum) and subcortical regions (focusing on the amygdala and hippocampus), but the results are inconsistent (See Cody, Pelphrey, and Piven, 2002 for a review of studies). Through the use of Magnetic Resonance Imaging (MRI) techniques, more recent studies have also found that, on average, the autistic brain is heavier than the normal brain. Importantly, the increased size is not evident from birth, but from 2-4 years (Lainhart et al., 1997; Courchesne et al., 2001). This is fairly important when many cases of autism do not fully develop or get diagnosed until age 3.

Hill and Frith (2003) discuss recent developments and the findings of the three main neuro-cognitive theories of autism: theory of mind deficit, weak central coherence and executive dysfunction. The “theory of mind deficit” hypothesis states that a fault in any one area of the social brain can lead to difficulty in understanding certain aspects of communication. Weak central coherence alludes to poor connectivity throughout the brain between more basic perceptual processes and top-
down modulating processes. Individuals with ASD have been found to have a tendency to focus on the local, rather than global aspects of an object of interest. The executive dysfunction hypothesis makes an explicit link to frontal lobe failure when comparing individuals with autism to neurophysiological patients who have suffered damage in the frontal lobe. These are not three rival theories, but are attempts to understand the neuro-cognitive dimensions of autism (see Hill and Frith, 2003 for a review).

Environmental risk factors have also been thoroughly investigated in conjunction with autism. The only environmental factors for which there is preliminary evidence of causation are thalidomide-induced embryopathy (Folstein and Rosen-Sheidley, 2001) and anti-convulsants taken during pregnancy (Zwaigenbaum et al., 2002). Allergies have also been investigated in conjunction with autism. Avoidance of particular foods such as chocolate, carbonated drinks, milk products, as well as additives such as tartrazine, have been observed to improve the behaviors associated with autism in some children, but dietary restrictions have not been a cure for the condition (Aarons and Gittens, 1999). Vaccines have also been implicated by some individuals as specific “triggers” for autism. However, there is strong epidemiological evidence that the measles, mumps, and rubella (MMR) vaccine is not an environmental risk for autism, despite much publicity and speculation concerning this theory (Taylor et al. 2002).
Auditory Behaviors

The present study is focused on the auditory behaviors exhibited by children diagnosed with autism spectrum disorders. Besides the typical issues with social interaction, researchers, parents, and professionals have witnessed several behaviors that may relate to the auditory system. It is not uncommon for a child with autism to have been suspected of having a hearing loss before the diagnosis of autism was made (Kanner, 1943; Wing, 1966; Hayes and Gordon, 1977). As previously mentioned, other auditory behaviors included hypersensitivity to sounds, receptive language difficulties, difficulty processing information, and unresponsiveness to auditory input (See Table 1.1 for a summary of studies). These behaviors have commonly been observed in individuals with ASD, but are not seen in every individual with this diagnosis, thus the presence of these disorders is not a diagnostic criterion. However, the behaviors are typically taken into account in each diagnostic case.

Prevalence of Peripheral Hearing Loss

Rosenhall et al. (1999) reported that hearing deficits in autism occurs at a rate of 0 – 100% depending on the study. Due to differences in sample size, inclusion criteria, and assessment procedures, there is considerable variability seen in the studies focused on the prevalence of peripheral hearing loss in autism. Hearing loss that is due to pathology in the peripheral hearing system (i.e. outer, middle, or inner ear, hair cells, etc...) is considered a peripheral hearing loss. Rosenhall et al. cite several studies that use auditory brainstem response (ABR) as the primary tool used to assess hearing status (Student and Sohmer, 1978; Novick et al., 1980; Skoff,
Mirsky, and Turner, 1980; Rosenblum et al., 1980; Taylor, Rosenblatt, and Linschoten, 1982; Gillberg, Rosenhall, and Johansson, 1983; Skoff et al., 1986). However, Klin (1993) reviewed the 11 ABR studies on autism conducted prior to 1993, including the above studies cited by Rosenhall et al., and found the results to be quite contradictory. The focus of Klin’s study was on the auditory brainstem function in relation to the etiology of autism, but she also discussed some methodological concerns in the 11 studies. Though Rosenhall et al. use several of these studies to state the variability of a prevalence rate of hearing loss in autism, Klin (1993) states how these studies are not comparable due to differences in laboratory protocols, sample variables, stimulus presentation, wave form variables, and definitions of variability that will all affect the interpretation of the ABR results. Rosenhall et al. recognize these concerns, but use this information to state how there is little valid data concerning the prevalence of hearing loss in autism.

In addition, Arnold (2000) discusses how ABR results cannot give a complete picture of an individual’s hearing sensitivity and does not truly measure “hearing.” One problem with studying the prevalence of peripheral hearing loss in ASD by behavioral means is the difficulty associated with testing individuals with ASD. Many researchers have relied on ABR to test for hearing, due to the lack of cooperation, poor attention, and cognitive issues that make it very difficult to obtain reliable threshold estimates from individuals with ASD (Rosenhall et al., 1999). Depending on the stimuli used, ABR tests only certain frequencies and normative data is needed for interpretation. A commonly used stimulus, the click evoked ABR,
can only test between about 1000-4000Hz, possibly missing a low frequency hearing loss (Klin, 1993). ABR results can give some information about hearing but are not considered hearing thresholds.

All of the above mentioned concerns have made it difficult to compare past research concerning the prevalence of hearing loss in ASD. Due to the suspicion of hearing loss because of impaired communication, audiologists need to attempt to obtain complete audiological information about a child with suspected ASD. Patience and additional time are needed to perform an audiological evaluation on a child diagnosed with ASD. More current research is needed to investigate peripheral hearing loss in individuals with ASD and a more representative prevalence rate is needed.

Abnormal Sensitivity

Trevathan, Aitken, Papoudi, and Robarts (1998) reported “autistic children seem to have either abnormally high sensitivity to sounds (hyperacusis) or difficulty recognizing or hearing sounds (hypoacusis).” Early research found hyperacusis in individuals without the diagnosis of ASD to be associated with abnormally low auditory thresholds and the presence of intolerance to everyday environmental sounds, when hearing thresholds are in fact normal (Vernon, 1987; Jepsen, 1963). Hypersensitivity has been investigated by looking at hearing thresholds and loudness growth data. Results from a study by Brandy and Lynn (1995) suggest that loudness growth was significantly different for hyperacusic subjects compared to nonhyperacusic subjects. Loudness growth functions were obtained using the method
of adjustment procedure whereby the subjects doubled the loudness, using 1 dB steps. Vernon (1987) stated that hyperacusis is not the same as recruitment due to its presence in the absence of hearing impairment. Hyperacusis is associated with normal hearing, whereas loudness recruitment is usually associated with hearing loss (Klein, Armstrong, Greer, and Brown, 1990). Katzenell and Segal (2001) provide an extensive review of the possible etiologies for hyperacusis in individuals not diagnosed with ASD. However, the exact cause of this problem in children with ASD is still undetermined, and the behavioral aspects of hyperacusis in those with ASD may differ in etiology from individuals with hyperacusis that do not have ASD.

The evaluation of individuals who are not diagnosed with ASD, but have symptoms of hyperacusis is a relatively new area in audiology. Several diagnostic criteria have been proposed as valid treatments for hyperacusis, but have not been investigated for use in the ASD population. The treatment of hyperacusis in individuals without the diagnosis of ASD is not universally agreed upon. Desensitization therapy is a common recommendation for the hyperacusic patient (Vernon, 1987; Hazell and Shelldrake, 1991; Byrne and Dirks, 1996, Jastreboff, Gray, and Gold, 1996; and Sandlin and Olsson, 1999). This approach focuses on training the patient to change his/her loudness sensitivity so he/she can gradually tolerate greater sound levels, making normal sound environments more comfortable. Many hyperacusic patients desire earmuffs or other protective devices to block out bothersome sounds and noises. However, use of such devices will only exacerbate the problem and will not provide recovery (Vernon, 1987). As research in this area
expands, many of these techniques may be transferable to the ASD population with hypersensitivity. However, more investigations are needed in to evaluate the efficacy of these techniques in regards to the hyperacusic patient diagnosed with ASD.

Rosenhall et al. (1999) found that one in five individuals with autism and "normal hearing" (<25 dB HL thresholds) have hyperacusis, a phenomenon that is considered rare among children and adolescents who do not have autism. However, Rosenhall et al. used the ABR presentation of a broadband click to evaluate the tolerability of a loud sound (80dBNHL), an uncommon practice to detect hypersensitivity. Individuals were determined to be hypersensitive if they could not tolerate the click at this level and needed it presented at 70dBNHL. Though the intolerance of an 80dBNHL click may arouse a hypersensitive individual, the authors used no other means to determine the presence or absence of hypersensitivity. This prevalence of hypersensitivity may be an inaccurate estimate of the actual prevalence of the behavior. The protocol used in this study is not a recommended protocol for evaluating hypersensitivity. More evidence is needed than the intolerance of an 80dBNHL click to confirm the presence of hypersensitivity. Due to the difficulties in testing this population, little research has been done to investigate hyperacusis in individuals with ASD. In previous discussion, this technique was never mentioned as a means for detecting hypersensitivity. One may assume that Rosenhall et al. created such a technique for their own means without truly investigating the efficacy. Many other researchers have used invalidated techniques or protocols that have not been fully investigated as reliable means to ascertain hypersensitivity in any individuals,
whether with or without the diagnosis of ASD. More research is needed in this area to find a physiological difference that verifies the presence of hypersensitivity in individuals with ASD.

Rimland and Edelson (1992) used results from their Hearing Sensitivity Questionnaire (HSQ) completed by parents and found that hypersensitive hearing affected up to 40% of the individuals with autism that were sampled. Information about the Hearing Sensitivity Questionnaire (Rimland, 1991) is available from the Autism Research Institute. The Autism Research Institute has used the HSQ frequently, but no validation of this questionnaire has been published in a peer-reviewed journal. Though this questionnaire may provide additional information about an individual’s difficulties, it cannot be used as a diagnostic tool for hypersensitivity until more research of its validity is done.

Vicker (1993) also had parents of children with autism complete a questionnaire. Results revealed that 57.5% said their children were sensitive to sound. Of the 233 respondents, 38.6% reported that their children were sensitive to common everyday environmental sounds and 9.4% indicated that their children were sensitive to infrequent environmental sounds. Many of the results were based on the parent’s observations of their children and were more subjective in nature. Once again, the questionnaire used was not validated through research. Very few, if any, research studies have been successful in objectively and scientifically explaining the presence of hyperacusis in children with autism. Many of the studies that discuss the
presence of hypersensitive behavior have done so through observational means.

Further investigations are needed to gain more insights into this problem.

**Auditory Defensiveness**

Due to the extreme reactions to sound that may accompany hypersensitivity, auditory defensiveness might occur to auditory input that generally would be ignored or habituated to by individuals without the diagnosis of ASD (Murray-Slutsky and Paris, 2000). This may include behaviors such as the child covering his/her ears to noises, becoming upset when fire bells or alarms ring, or the child may become upset or agitated in noisy open environments by throwing a tantrum. These reactions may create a tendency to attend to only certain preferred auditory stimuli (Berkell, Malgeri, and Streit, 1996). This is exhibited by the “selective hearing” that is commonly reported in children with ASD. They may ignore an adult speaking to them or the T.V., but once the bell rings for recess or the alarm goes off for an oven baking cookies, they may be the first ones to react to the sound. Children without the diagnosis of ASD may also exhibit some of these inconsistent responses to auditory stimuli, but the children with ASD may exhibit more extreme selectivity.

A recent study found that orienting and attentional deficits in autism might be speech-sound specific (Ceponiene et al., 2003). This study used event-related brain potentials (ERPs) to examine the attentional processing of sounds with different complexity. Simple tones, complex tones, and vowels were presented to the two groups of subjects: individuals classified as “high functioning autistic” and a normal control group. ERPs were analyzed for the presence of the mismatch negativity
(MMN) component and the P3a component. From analysis of the P3a, the researchers investigated how well the subjects attended to the differing stimuli. To elicit the P3a, a series of standard sounds were presented in an “oddball” paradigm with a “deviant” sound sporadically injected. This paradigm is commonly used to elicit a P3a due to the electrophysiologic response that occurs when the subject shifts their attention to that deviant sound (Escera, Alho, Schroger, and Winkler, 2000). In this study, Ceponiene et al. found the P3a to be present for the simple and complex tones, but was absent when vowels were presented to the sample with autism. They reported that the findings demonstrate that, despite the availability of the sensory information on the vowel and changes in is pitch, autistic children’s orienting could not be triggered by those changes. They concluded that attentional orienting to sound changes was impaired, but was exclusively for the speech sound (vowel). Ceponiene et al. further hypothesize that if such an attentional orienting deficit is present as early as in infancy, it profoundly compromises the development of verbal and nonverbal communication in the affected children. This study has opened a new avenue for research into the attentional issues with autism and the lack of auditory focus that is commonly seen when individuals are speaking to an individual with ASD. However, further research is needed in this area.

The reactions to auditory input, such as covering their ears or avoiding environments that may produce uncomfortable sounds, may cause children with ASD that are hypersensitive to have a difficult time interacting in everyday situations. Some children exhibit “acting out” behaviors, such as throwing a tantrum and causing
a disturbance once a sound stimulus bothers them. Since these reactions to sound can have a detrimental effect on children with ASD, a number of techniques have been developed that claim to treat these behaviors through stimulation of the auditory pathway.

**Auditory Integration Training**

Auditory Integration Training (AIT) was developed by Guy Berard, MD, in France during the late 1960s. Dr. Berard was an otolaryngologist who specialized in treating individuals with auditory problems, including some who were autistic. Children with ASD that exhibit hypersensitivity to sound may be enrolled into an AIT treatment schedule. First audiometric testing must be done to see if individuals exhibit “auditory peaks.” These peaks refer to frequencies at which there is 5 or 10 dB difference between the specific frequency and its adjacent frequencies. Berard believed that these auditory peaks were the frequencies where an individual was “overhearing” and could be reduced or even eliminated by AIT (Berard, 1993). However, the validity of defining these “peaks and valleys” as auditory abnormalities has been questioned elsewhere (Gravel, 1994; Miller and Lucker, 1997; Tharpe, 1998, 1999). Berard suggests that AIT treats these distortions by exercising the middle ear muscles and auditory nervous system and in a sense retraining them. By having this treatment he stated that an individual’s overall hearing sensitivity will improve.

When an individual is enrolled in AIT they listen to different tones with varying intensities through headphones for several sessions that last about an hour
(American Academy of Pediatrics, 1998). Rimland and Edelson (1994, 1995) found AIT to be quite effective in reducing the overall sensitivity of their subjects, along with improvements in comprehension and behavioral skills. These behavioral changes were documented through questionnaires, including the Aberrant Behavior Checklist (ABC), Fisher’s Auditory Problems Checklist (FAPC), and Conner’s Rating Scales (CRS).

Rimland and Edelson (1994, 1995) also found that there was a slight but statistically significant, improvement in hearing thresholds that resulted in an audiogram with the auditory peaks “smoothed out.” In the 1994 study, they reported a slight, but statistically significant improvement in the subject’s hearing from the first hearing test to the second hearing test ($t(198) = 3.721, p<.01$). It should be noted that the changes were calculated and analyzed via a mean threshold level at all 11 frequencies recorded on the audiogram. The significant changes were within a 1-2dB difference. Standard audiometric testing does not use such small decibel ranges to find thresholds. Typically 5dB steps are used in clinical audiometry (Carhart and Jerger, 1959). Thus the changes reported by Rimland and Edelson are not significant when discussing true changes in hearing sensitivity. Other research has shown that hearing sensitivity can fluctuate from moment to moment due to external and internal factors (Green and Swets, 1974). Intrinsic factors include noise created from breathing and cardiovascular activity. Extrinsic factors include temperature and ambient background noise. Though the extrinsic factors may be controlled in an adequate test environment, the intrinsic factors are not controlled and may result in
these slight fluctuations in hearing sensitivity (Harrell, 2002). Rimland and Edelson concluded that the findings from their studies were consistent with Berard’s assertion that hearing acuity will improve slightly and auditory peaks will decrease as a result of AIT. However, as previously discussed, these changes have no clinical significance.

Other researchers have yet to replicate these findings and controversy surrounds the use of AIT clinically (Bettison, 1996; Dawson & Watling, 2000; Mudford, Cross, Breen, Cullen, Reeves, Gould, et al., 2000). A large number of anecdotal and non-refereed studies have been cited as supporting the use of AIT clinically, however there is not a significant number of peer-reviewed, data based reports in support of this training. This is a common occurrence when a treatment is first introduced. The Rimland and Edelson studies (1994, 1995) were published in peer-reviewed journals, but have received critical review by other researchers. Howlin (1997) pointed out some inconsistencies in the Rimland and Edelson’s studies. She discussed how statistical problems exist when using $t$ tests for such small group of subjects and that closer examination of the data indicates the differences are too small to be meaningful in practical terms. This is especially true when less than 1 dB changes in subject’s hearing thresholds have no functional significance (ASHA, 2003). Howlin also reported the need to have a control group for studies focused on the efficacy of AIT.

The American Speech-Language-Hearing Association (ASHA) working group (2003) reported discrepancies in the 1995 Rimland and Edelson study. They found
that an analysis of pretreatment data revealed a significant difference between groups on the parental questionnaires of adaptive behavior. These questionnaires were used to show significant changes in the subject’s behavior pre- and post- AIT. This difference in pretreatment data violates the integrity of the control group, thus showing the two groups were too different to be comparable. The working group further discusses how the authors attempted to compensate for this error by using difference scores reflecting the amount of change since the baseline assessment for the analyses. This would make the experimental group appear to have had more significant changes; however, since the experimental group started out so much poorer on these measures than the control group, this analysis procedure is very questionable.

In an attempt to replicate Rimland and Edelson and to further investigate the efficacy of AIT, Bettison (1996) conducted a study with 80 children, 3-17 years of age, with the diagnosis of autism or Asperger syndrome and mild to severe distress in the presence of some sounds. Bettison created a modification of the Hearing Sensitivity Questionnaire (Rimland, 1991) called the Sound Sensitivity Questionnaire to assess hypersensitivity to sound in her study. However, this questionnaire was never validated for such use. Bettison reported that children exposed to AIT made no greater progress than those who simply listened to music for the same length of time. Bettison recognized the need for a control group in this study and future studies of AIT. Other may conclude that an effect other than a specific treatment, such as AIT, was responsible for the improvements. However, the lack of control group and use of
an invalidated questionnaire has made these results less substantial when evaluating the efficacy of AIT. Future studies need a control group to investigate this area further.

Several studies have concluded that there was no significant difference in behavior in individuals with autism after receiving AIT (Gillberg, Johansson, Steffenburg, and Berlin, 1997; Zollweg, Palm, and Vance, 1997; Mudford et al., 2000). Mudford et al. concluded that no individual child was identified as benefiting clinically or educationally from the treatment. Aarons and Gittens (1999) discuss how advocates of AIT are ambiguous in denying that they are promoting it as a “cure” for autism, yet they claim an “80% success rate.” On review of AIT and sensory integration therapy for individuals with autism, Dawson and Watling (2000) state that there is no equivocal support for this intervention approach based on the available controlled studies.

Several position statements have been published in regards to AIT; American Academy of Audiology (AAA), 1993; American Speech-Language-Hearing Association (ASHA), 1994, 2003; Educational Audiology Association (EAA), 1997; American Academy of Pediatrics, 1998. All of these position statements are in agreement that AIT has not been proven to be a viable treatment for any disability. These position statements also concur that AIT should be considered an experimental procedure. Despite approximately one decade of practice in this country, this method has not met scientific standards for efficacy and safety that would justify its inclusion as a mainstream treatment for this disorder (ASHA, 2003). Practitioners of AIT
should be aware of all the issues surrounding AIT. More scientific, controlled studies of AIT are needed to support its effectiveness as a treatment option for individuals with ASD.

Auditory Research

When discussing all the auditory behaviors that have been commonly observed in individuals with ASD, there is a need for more valid insights into the auditory process behind such actions. Many researchers have been investigating the etiology of such behaviors, but have not been to find conclusive evidence. Since many of these auditory behaviors are thought to be a common characteristic of individuals with ASD, some researchers speculated that the biological mechanisms behind these behaviors might give more insight into the overall etiology of autism and the differences between autistic and non-autistic individuals.

As research methods and technology have improved, so too has the focus of auditory research. In the past, many researchers believed the brainstem was involved in autism. As previous discussed in relation to the prevalence of hearing loss in autism, several studies were performed to explore auditory brainstem functioning using ABR. Klin (1993) reviewed the 11 ABR studies focused on individuals with ASD conducted prior to 1993. She found the results to be quite contradictory and did not support the hypothesis that the brainstem was involved in autism. Klin (1993) made several points to support her conclusions. First, when factors such as diagnostic and inclusion criteria, the presence or absence of control for variables influencing ABR waveform, the measures obtained as well as the adopted definitions for
abnormalities are considered, the ABR studies in autism do not provide clear evidence of brainstem dysfunction in autism. Secondly, when mental retardation and associated neurological disorders are controlled for, no central transmission abnormalities were evidenced. And finally, there was evidence of peak I delays and shortened central transmission times reported in some studies reflecting that there may have been peripheral hearing loss in the subjects with ASD participating in those studies. Several of these studies did not test for peripheral hearing loss using tympanometry or standard audiological protocols, but relied solely on ABR results.

Other studies have focused on peripheral hearing issues in individuals with ASD. Some researchers decided to focus on middle ear anomalies due to Katz’s (1978) suggestion that mild, fluctuating conductive hearing loss due to middle-ear anomalies may account for the language and attention problems of children with learning disabilities (Konstantareas and Homatidis, 1987; Smith, Miller, Stewart, Walter, and McConnell, 1988). Konstantareas and Homatidis (1987) conducted a retrospective study through parental reports focusing on the frequency of otitis media, myringotomy, and hearing loss of autistic children. The questionnaire used asked questions about past medical history, including ear infections, ear aches, or the need for myringotomy surgery with pressure equalization tube placement. They found a higher incidence of ear infections in the sample of children with autism based on the questionnaire results. It should be noted that this retrospective study was solely based on the recollections of parents. The parents were encouraged to consult their spouse and any available records. However, no true documentation of ear infections,
earaches, etc... was obtained. These results cannot be valid due to the subjective nature by which they were obtained.

In 1988, Smith et al. used impedance measures to compare children diagnosed with ASD, children that did not have ASD but were learning disabled, and a normal control group in terms of middle ear functioning. They reported that bilateral, fluctuating, negative middle ear pressure was greater than normal in the autistic children. They defined middle ear pressure of ± 25 mm H₂O as "abnormal." They found that 83% of the autistic group, 65% of the learning disabled, and 34% of the normal controls were outside this range. They concluded that these results show significant differences in middle ear pressure among the three groups. However, functionally these values are not very significant. Clinical impedance testing is not considered "abnormal" if the peak of max compliance is outside of 25 mm H₂O. Margolis and Hunter (2000) state that measuring tympanometric peak pressure is not a reliable indicator of medically significant middle ear disease. They further state that -300 da Pa is considered a "significant clinical finding" for middle ear pressure. Smith et al. do not have any protocols to strengthen the use of ± 25 mm H₂O as a cut off for abnormal versus normal middle ear pressure. It should be noted that 1 mm H₂O equals .98 da Pa. Thus, the findings from Smith et al. may show some differences between the groups, but these results are insignificant clinically and cannot be inferred to cause any abnormal auditory behaviors.

Otoacoustic emissions (OAE) have also been explored as a non-invasive electrophysiologic method to investigate peripheral hearing in an individual.
diagnosed with ASD. Since children with ASD are often difficult to test with behavioral means, OAEs have been shown to be a beneficial tool (Grewe, Danhauer, Danhauer, and Thornton, 1994). Grewe et al. wanted to determine if transient evoked otoacoustic emissions (TEOAE) could be obtained from children with autism. Khalifa et al. (2001) used TEOAEs as a means to assess medial olivary complex (MOC) involvement in children with ASD. They used the assessment tool as a means to explore the descending auditory pathways. The results of this study found an asymmetry in the efferent system of children with ASD. The authors concluded that these results suggest there may be a problem with higher level auditory processing. A second finding showed a decrease in TEOAE amplitude with age and Khalifa et al. also concluded that this change may correspond with a decrease in hearing sensitivity. A larger scale study is needed to fully investigate the use of otoacoustic emissions in children with ASD.

Research by Lauter (1998, 2000) suggests that there may be some physiological explanation for these observed irregular auditory behaviors seen in individuals with ASD. Lauter designed the AXS Battery to provide a way to noninvasively examine the "neurological fingerprint" for each individual. Along with other tests, otoacoustic emissions are part of this battery. Lauter (1998) discussed how her tri-modal brain model provides "a means of relating a wide range of human behaviors and clinical states according to a common base of neural organization." She discussed how several developmental disorders, including autism, can be explained by this neurological organization, but also states that further research is
needed. Lauter discussed that resolution of autistic behaviors achieved by treatments such as AIT or programs using auditory stimulation should be accompanied by documentable physiological change (Lauter 1998). No research has been able to fully explain the auditory behaviors in ASD with physiologically evidence at this time. Lauter's theory is in the beginning stages of investigation and has not focused specifically on autism. However, Lauter's approach provides a new avenue for exploration in the auditory domain of ASD.

A recent study using Mismatch Negativity (MMN) hypothesized that behavioral hypersensitivity to change in autism might be related to particular brain processes involved in the automatic detection of any change occurring in the physical features of the stimulation (Gomot, Giard, Adrien, Barthelemy, and Bruneau, 2002). MMN is a latency auditory evoked potential with the major component generated bilaterally in the supratemporal plane of the auditory cortex (Alho, 1995). The response in MMN is assumed to be generated by the brain's ability to compare an infrequent (deviant) auditory stimuli and a neuronal sensory memory trace formed by the repetitive standard sound (Naatanen, 1992). Results from Gomot et al. found earlier MMN peak latency in children with autism than in normal controls, suggesting different brain mechanisms involved in auditory stimulus-change detection. They concluded that one explanation for these results might be that children with autism possibly detect acoustic changes in their surroundings more rapidly than typically developing children because of a higher cerebral reactivity to deviancy. Gomot et al. also found atypical activity of the left frontal region in children with autism. Children
with autism have also been shown to exhibit difficulties with attention shifting. Some 
children may appear to have a difficult time shifting from one speaker to another or to 
a certain auditory stimuli. The abnormal functioning of the left frontal lobe is 
suggested to be involved in the automatic detection of stimulus change in children 
with ASD (Gomot et al., 2002). Results from this study strongly suggest processing 
of auditory stimulus change in children with autism that might be related to their 
behavioral need to preserve sameness. More research is needed to fully investigate 
this area.

Literature involving the auditory issues of individuals with ASD appears to be 
a new area with a large amount of potential. This is in part due to the fact that as new 
technology becomes available researchers have been able to slowly investigate the 
many areas of the brain that may be different in individuals with ASD. As one study 
proves or disproves an idea, a new study will build off this previous work and get 
more insights into this auditory process. There is still a large amount of research that 
is needed before any of this information will be useful clinically.

**Purpose of this Study**

The purpose of this study is to develop a questionnaire that assesses auditory 
behaviors in children diagnosed with ASD. There is no instrument currently used 
clinically that focuses on all the previously mentioned auditory behavioral issues. 
With the many proposed treatment options there is a need for a clinically useful tool 
to provide information about the auditory behaviors of this population in order to 
further address true abilities. Rimland (1991) developed the Hearing Sensitivity
Questionnaire to assess hypersensitivity, but has not had research completed to validate its use clinically in children with ASD. This questionnaire focused only on sensitivity and has little statistical strength.

Further research is needed to determine the etiology behind the auditory behaviors seen in autism to give physiologic and/or behavioral explanations. A questionnaire may be the first step in providing professionals with information about the auditory domain. Such a questionnaire may be used in future research to identify specific trends in autism, help to identify individuals that may benefit from an auditory treatment, or identify individuals that may qualify for a research study. Many parents and professionals are always looking for new treatments and techniques to give more information to better treat the auditory behaviors in autism. A clinically useful questionnaire to address auditory issues may be very helpful in future investigations of autism.
CHAPTER 3

METHODS

In order to investigate the auditory characteristics of ASD, a survey was developed to begin to identify the auditory behaviors of some children with ASD. The survey was administered to two groups: professionals with experience working with children with ASD and parents of children with ASD. Both groups were asked to identify auditory characteristics they observed in children with an ASD. From the literature review and survey results the questionnaire was developed.

Survey: Professionals

A web-based survey was sent to a variety of professionals with experience working with children diagnosed with ASD. The survey consisted of 13 questions addressing professional and educational experience and observations of the auditory domain of ASD. The website contained a brief summary of the study, IRB procedures/protocol for participating, and an explanation of the respondent’s choice to continue with the survey. Respondents were also asked to provide their zip code for geographical tracking of the survey disbursement. The actual questions for the respondents to complete were on the second page of the website, as shown in
Appendix A. Questions 1-7 addressed demographic information including professional title, highest degree attained, years in profession, work setting, years working with individuals with ASD, and frequency of ASD patients. These questions were closed-ended and had answers from which the respondents could choose (via a radio button). A respondent had the option to choose “other” and provide a response if none of the listed answers applied.

Questions 8-12 were focused on the auditory behaviors observed in ASD and typically developing children, frequency of such behaviors, and whether or not a questionnaire helping to quantify these behaviors would be useful to that respondent. These questions utilized an open-ended format. The investigator was interested in seeing what observations the respondents would share with little to no prompts. Cummings, Stewart, and Hulley (2001) discussed how open-ended questions are typically used in the exploratory phase of question design in order to facilitate understanding of a concept as the respondents express it. Prompting the respondents may have influenced what behaviors they perceived as auditory in nature. An objective analysis of the responses was not possible due to the open-ended nature; however, the responses would provide a basis for the wording of the questionnaire. Certain phrases or words used by the respondents can form the basis for the more structured items in a later phase (Cummings, Stewart, and Hulley, 2001). Ample amount of space was provided for each response to the open-ended questions. Question 13 allowed the respondents to share any additional comments. Once the respondents completed the survey they needed to click the mouse on a specified area.
to submit the responses. At that point a message appeared with an e-mail address for
the respondents to contact if they would like to receive results of this study.

The responses from the survey were stored on a separate web page for later
analysis. The web page provided all responses along with the time and day when the
response was submitted. There was an additional page with a running total of how
many individuals submitted responses. Tracking of responses was possible on a daily
basis. After Institutional Review Board approval was obtained, responses were
collected from March to May 2003.

A paper-based survey was also available, but was not the preferred manner to
collect data. The website reached a larger group of potential respondents and allowed
them to complete the survey in their own time frame and at their convenience. The
paper-based survey included all the same information from the website, along with a
print out of the survey. The paper survey was used for a large group of employees at
the Children's Hospital Intensive Behavioral Intervention Clinic Autism Center.
With the permission of the director, the survey was distributed at a departmental
meeting. The surveys were collected and later entered into the web-based survey by
the investigator. This allowed all responses to be stored in the same web page and
format and allowed for ease of data analysis. This group of employees works with
children with ASD on a daily basis. The investigator had experience observing at this
Autism Center and believed the staff may have valuable insights into the auditory
behaviors of ASD. All other groups and respondents were contacted via e-mail to
request participation.
Respondents

The respondents were obtained (or solicited) from a variety of sources. The aim was to reach a diverse group of professionals from several fields that may have had experience with individuals with ASD. At this phase in the study the investigator did not recruit parents to complete the survey. The aim was to obtain the insights from professionals with experience working with individuals with ASD. The majority of respondents received notification of the survey via e-mail with a link to the website. The investigator distributed the initial e-mail to professionals in the Ohio State community who may have had experience with ASD. The e-mail asked respondents to forward the survey to any colleagues with experience with people with ASD. Starting with those professionals with an affiliation with the SHS Department at OSU and the Leadership Education Excellence in Neurodevelopmental and Related Disabilities (LEND) program at the Ohio State University Medical Center the e-mail reached many individuals with diverse backgrounds related to autism and its disorders.

Analysis Procedure

From the initial e-mails sent, the paper-based survey, and the many respondents that passed the e-mail along to others, the investigators were able to obtain 96 responses. From these responses, 87 were included for analysis in this study. Nine were discarded as incomplete or completed by parents. One response was not included due to the respondent being an administrator with no experience working directly with individuals with ASD.
Questions 1-7 were analyzed using SPSS software (Green and Salkind, 2003). Each possible answer was coded for use in SPSS. For example, if a respondent stated “high sensitivity to sounds,” the answer was coded with a one for hypersensitivity. If multiple answers were given in the “other” category, another code was added. The remaining individual “other” answers were grouped in that category.

Answers for questions 8 describing the auditory characteristics were more descriptive in nature and required investigator categorization. The majority of respondents discussed several behaviors of interest and multiple categories were developed and assigned. Before beginning to assign the categories, the investigator reviewed all the responses several times to ascertain the main areas addressed by the respondents. This review was completed five times to obtain the initial list of main auditory behaviors, but the investigator went through the results several more times as needed. Because of the paucity of research in this area and to maximize ecological validity, open questions were selected to allow respondents maximum flexibility in their responses. The main disadvantage of open-ended questions is that they usually require qualitative methods to code and analyze the responses, which takes more time and subjective judgment than the closed-ended questions (Cummings, Stewart, and Hulley, 2001). Through systematic analysis and categorization, the investigator was able to discern conceptual categories of significant behaviors the respondents thought were applicable. These categories were coded and then assigned to each response. SPSS was also used for analysis of these reported behaviors. Results from question 11 were analyzed to determine what percentage of the respondents thought a
questionnaire focusing on auditory issues in ASD would be useful. With the exception of question 11, the responses for questions 9-13 were not statistically analyzed at this time.

**Survey: Parents**

The original data collection provided insight into a significant number of areas. Upon analysis of the initial survey results, the investigator decided additional information would further validate the development of the assessment tool. All of the information obtained from the first survey was helpful in the development of the assessment tool; however, the information was limited to observations made by professionals.

To further validate the development of this tool, the investigator determined it would be useful to compare the observations of the professionals with parent perspectives. The investigator decided to expand the survey to include the observations from parents of children diagnosed with ASD. While the professionals are very knowledgeable about this population, there is an additional benefit in gaining the observations from the parent perspective. Certain trends were observed in the data from the professionals and the investigator wanted to determine if the parent group would confirm similar trends. The expectation was that the new survey results would coincide with the previous results and further validate the focus of the questionnaire.

A simplified questionnaire was used with the parent respondents, as shown in Appendix B. Similar to the first survey, the main focus is on auditory behaviors.
observed and minimal information was asked in regard to # of children with ASD and their ages. IRB approval was modified for the additional survey and approval was obtained.

Respondents

To reach a large group of parents as quickly as possible the survey was posted on a Yahoo Chat group message board. There is an autism group in Ohio that has e-mail postings through Yahoo at autismohio@yahoo.com. A colleague and parent of ASD children introduced the autism group to the investigator. Members of the group had the choice to respond or not. There are about 345 members of this online group. To limit the number of potential responses, the data collection was limited to a period between June 16 and June 27, 2003.

The respondents were asked to e-mail autismsurvey@yahoo.com to share their observations. The e-mail was created for the sole purpose of collecting this information. The pertinent information from the e-mails was stored and the results were analyzed in the same manner as the original survey and were used accordingly.

Analysis Procedure

From the Yahoo group, ten responses were received. Due to the open-ended nature of this simplified survey, the results were grouped according to the same main topics established from the professional’s survey. These responses were then compared to the professional survey responses.
CHAPTER 4

SURVEY RESULTS

Professional Survey

As previously stated, 96 responses were received from the original survey and 87 were used for analysis. As Table 4.1 will show, a very diverse group completed the survey, with the majority (27%) being completed by speech/language pathologists. The “other” group (12%) included professions such as Family Services Intervention, Cognitive Neurology, Family Science, Nursing, Behavioral Consultation, Administration, and “other” unspecified professions. An additional question addressed whether the respondent was a clinic director, researcher, or faculty member. As seen in Table 4.2, these results show that over half (59%) of the respondents did not fit into these categories, whereas the remaining group was mixed within these three categories.

Tables 4.3 to 4.7 also provide additional information received in regards to professional experience, highest degree attained, work setting, experience with ASD, and frequency of ASD patients. The highest degree attained was fairly varied, with all but 2% having a minimum of a Bachelor’s degree. Two respondents indication “other” and specified a high school degree. These results further confirm that a

45
variety of professionals with different backgrounds and experience completed this survey. The amount of professional experience (Table 4.5) shows that the respondents varied somewhat in their years of experience in their specific career or profession. Table 4.4 shows the different work settings of respondents. When focused on experience with ASD, Table 4.6 shows that the respondents varied in the number of years working with ASD. However, Table 4.7 shows the majority of respondents (48%) see patients with ASD on a frequent (daily) basis. In addition to Table 4.6, Figure 4.1 shows that the majority of professionals whom completed this survey were very experienced in working with ASD patients. From these results the investigator concluded that this survey group was a diverse group of professionals with the experience, knowledge, and a foundation to give insightful observations into the auditory behaviors of ASD.

Auditory Behaviors Observed

The results were analyzed for key terms, examples, and trends. From these results, certain trends were repeatedly reported by a large number of respondents. The investigator continually read through each response looking for patterns in the responses and key behaviors that were mentioned by a large number of respondents. After several analyses, categories of main auditory behaviors were identified. Table 4.8 provides a list of these main categories. The behaviors include hypersensitivity, hyposensitivity, phonophobia, adverse reactions to sounds, unresponsiveness to verbal input/lack of auditory focus, receptive language difficulties, suspicion of hearing loss, auditory processing disorder, difficulty with background noise, difficulty
with discrimination, delay in processing time, frequent ear infections, self-stimulation on auditory input, imitation of auditory input, enjoyment of music, visual cueing, and an "other" category. The other category was used if respondents mentioned unique behaviors or shared specific experiences within their responses.

It should be noted that each response was unique and had a different level of elaboration. Some responses contained single topics or minimal explanation, while others were very descriptive with examples to illustrate key points. Due to the variability of responses, it was occasionally difficult to categorize certain responses. Also due to the variation in the respondent’s level of experience with ASD, some individuals may not have been fully aware of the terminology used to describe certain behaviors.

Many respondents discussed the inconsistent expression of these behaviors and the situational nature that may occur. Many discussed how these behaviors might only occur in specific situations and vary in expression. As the following results will show, there was variation noted across all the topics and in what the respondents shared as auditory characteristics, however distinct trends and patterns were noted.

Abnormal sensitivity was commonly mentioned as an auditory issue seen in children with ASD. As Table 4.8 will show, hypersensitivity was mentioned by 76% of the respondents. It should be noted that some responses said “hypersensitivity” specifically and others were more descriptive or used different wording. For example, “high sensitivity to loud sounds/noises”… “these children over-respond to sounds that other children do not notice”… “over-stimulated by some intensities and
pitches of sounds” were some of the responses given. It should be also noted that several respondents mentioned the variability of this behavior. Many discussed how this hypersensitivity is not seen in all children with ASD and that those who do exhibit this behavior may function properly if there is no stimulus to disturb them. Some mentioned its presence in over half of the children they see. However, hypersensitivity was a common enough occurrence for the majority of respondents to mention it as an auditory characteristic of ASD.

Some respondents were very descriptive in their responses. A fair amount (27%) discussed how children with ASD who are hypersensitive might exhibit some adverse reactions to sounds. These reactions included covering their ears, getting very upset, avoiding certain objects or situations, and being upset to the point of “throwing a tantrum.” Some respondents mentioned how the children may make vocalizations to focus on while trying to block out the stimuli that may be upsetting them. One respondent discussed how one child hated to flush the toilet and would be very upset about doing it. She mentioned how the child knew he had to do it so he would cover his ears, push the lever down, and run away as quickly as possible.

Many respondents shared similar stories to illustrate these reactions; however, they all mentioned how this behavior would vary from child to child and in the frequency of expression.

Only 5% mentioned phonophobia as a characteristic in children with ASD. Phonophobia is a fear of sounds (Hazell, 2002). Some respondents discussed how the hypersensitivity would get to the point of causing some children pain; the child in
question would avoid that situation or stimulus and become fearful of the sound. Although not mentioned specifically as an auditory characteristic by many of the respondents, the adverse behaviors seen in response to these sounds may signify the painful reaction some children experience. While some respondents did describe behaviors that appeared to result from a fear of sound, only a few actually mentioned phonophobia or the fear behind their child’s behaviors. Only responses that mentioned phonophobia specifically or discussed the fear of certain sounds were counted for this category.

Lack of response to sounds or hyposensitivity (34%) was another common characteristic reported in individuals with ASD. Examples of responses included “unresponsive to loud sounds”... “lack of sensitivity to sound”... “do not startle by certain loud sounds.” Many respondents actually mentioned both hypersensitivity and hyposensitivity together as common characteristics. As previously mentioned, this may be due to these behaviors varying in expression and the fact that not every child may show these behaviors. The professionals may work with two children and one is hypersensitive while the other is hyposensitive. Also, if a child is not disturbed by a loud sound they may function without showing hypersensitive behaviors in that setting. The same is true with lack of sensitivity. A child may exhibit these behaviors at different times of the day or in certain situations.

In addition to a lack of sensitivity, a number of respondents (36%) mentioned a lack of responsiveness to verbal input or a lack of auditory focus. Many discussed children who required multiple verbal prompts for a task or those who demonstrated
delayed responses to verbal input. One respondent discussed a child who would “zone out” and not respond to verbal commands or individuals talking about that child while in the same room. The respondent also state that while most children may be upset by others talking about them, this child was not responsive to the discussion going on only a few feet away.

Some individuals discussed a delay in processing time associated with auditory input. A separate category was developed for this behavior and 9% of the respondents mentioned this as an auditory characteristic seen in ASD. They discussed how the children appeared to need more time to process or register an auditory command. One respondent discussed how a child would repeat what was said and appeared to be using this behavior as a way to give himself more time to process what he just heard. Others stated a “delay in processing time” with little or no elaboration. Some respondents mentioned receptive language difficulties (16%) as the cause of the lack of responsiveness to auditory input, whether verbal or not. Once again, a number of respondents mentioned receptive language issues as a characteristic without much elaboration or examples. This may be due to their professional title. Of the 14 respondents stating this as a behavior seen in children with ASD, 5 were speech/language pathologists. It should be noted that none of these responses discussed whether formal diagnosis of a language disorder has occurred.

In this study, 9% of the respondents discussed the suspicion of hearing loss in children with ASD early in development. Many of these responses included that the hearing was normal, however this suspicion may have occurred before the diagnosis
of ASD. Several respondents discussed how this suspicion was typically due to the lack of responsiveness to verbal and auditory input commonly seen in ASD. This observation is important in audiological assessment and management. An individual with ASD that is undiagnosed may be a patient in an audiologist’s clinic. Audiologists need to be prepared to make appropriate referrals if such a case presents itself.

Many children with ASD may have difficulty in situations with background noise. Fifteen percent of the respondents mentioned this as a distraction during school or therapy sessions. Responses stated that background noises could be as soft as the hum of a heating system or as loud as other children playing on the playground. These respondents discussed how the children would be unable to focus on the task at hand if any background noise were present. Some children would be completely disturbed by the noise, while others would focus on it and not listen to the speaker or teacher. Several respondents reported that attempts were often made to decrease extraneous noise sources in order to facilitate better learning or therapy. Unfortunately a formal quantification of the amount of noise was not possible and additional information could not be inferred from the responses given.

Difficulty with discrimination of sounds was also mentioned as an auditory characteristic of ASD. As Table 4.8 will show, 11% of respondents mentioned that children with ASD have difficulty with discrimination of sounds. Unfortunately few of the responses elaborated on this issue. One might infer that such behavior was
seen in some form of auditory training therapy. Once again, such a response may be due to the respondent’s professional experience.

Some respondents speculated that auditory processing issues may be a problem in children with ASD. Auditory processing disorders (APD) have been defined as a deficit in the processing of information that is specific to the auditory modality (Jerger and Musiek, 2000). Nine percent of the respondents specifically named APD as an auditory characteristic, but did not discuss if a formal diagnosis was obtained. This percentage may increase if the accepted responses were expanded to include those with reference to any behavior that may be related to APD. Separation of the groups was done to see what differences were noted. As with previous responses, some respondents elaborated about the characteristic, while others just simply noted APD as an auditory behavior. One may question whether a actual diagnosis of APD was present. Many of the individuals who mentioned this disorder were not certified audiologists capable of making such a diagnosis (ASHA, 1996) and many might have speculated on its presence. These respondents included speech/language pathologists, psychologists, teachers, behavioral therapists, and occupational therapists.

Another auditory behavior of ASD was self-stimulation on auditory input. Several respondents (15%) mentioned how children with ASD would imitate auditory input and appear to “crave it.” One respondent discussed how a child would exhibit perseveration by repeating others or environmental sounds and appearing to be calmed by the action. Besides appearing to self-stimulate on sounds, many
respondents mentioned how children with ASD were often seen as simply imitating sounds and vocalizations. Fourteen percent of the respondents discussed this behavior as a common auditory behavior seen in ASD. These two behaviors were separated due to the sensory component of the self-stimulation responses, however these behaviors are very similar. Some professionals may have the experience to identify the behavior as a stimulation technique, whereas others may not.

Several other categories were occasionally mentioned in the survey. Six percent of the respondents discussed how children with ASD enjoy music and how it may help to calm them. Another 4% discussed how children with ASD are not efficient auditory learners and perform much better with a visual cue. These respondents discussed the need for a visual aid in therapy or in a classroom setting.

Though past research has mentioned ear infections as a common occurrence in ASD, only 4% of the respondents mentioned frequent ear infections as an auditory characteristic in this survey. Analysis for this response showed that the actual frequency of the ear infections and how many was not discussed. The limited number of respondents discussing this may be due to the respondents not seeing an ear infection as an auditory characteristic, but more of a medical issue.

Classifying the main auditory characteristics was difficult. The category “other” was created to capture solitary behaviors that no other respondent mentioned and to include those who gave very descriptive and elaborate illustrations of their responses. Examples of responses counted in the “other” category include “poor phonemic awareness”… “poor localization of sounds”… “weak auditory memory”…
“don’t like headphones”… “difficulty imitating rhythms or sequences”… “sensory issues”… “expressive language difficulties”… “like to be addressed in monotone voice” and so on. Other respondents gave examples of sounds that were bothersome to children with ASD. These sounds included vacuum cleaners, sirens, dishes clanking together, other children crying, crowds, a blender, a hair dryer, the lawn mower, other children yelling or screaming, a toilet flushing, a balloon popping, bells ringing, and the hum of a fluorescent light running. As Table 4.8 will show, over half of the respondents shared something that was categorized in the “other” category.

Question 11 of the professional survey addressed whether or not a questionnaire to address auditory difficulties in children with ASD would be useful to the respondents. Results from this question are seen in Table 4.9. These results show that 85% of the respondents felt such a questionnaire would be useful, 13% did not, and 2% did not know. When asked to describe how one would use such a questionnaire in Question 12, some responses discussed the need for additional case history information and for planning treatments. Several respondents discussed how such information could assist in determining additional services or accommodations that would be beneficial to a child with ASD. Many respondents were very interested in any tool that would provide additional information about their patients. Of those that did not see any use in such a tool (13%), several stated that additional paperwork is not needed or that they had other means by which to assess such behaviors. Some respondents stated that years of experience allows them to address these issues on a case by case basis and that such a tool would not be useful.
The final question of the survey, Question 13, allowed the respondents to share additional comments. The majority of respondents discussed the need for more investigation of the auditory domain of ASD. Several stated that this study appears to be a start in the right direction for this population and many of the respondents were eager to see the results of this study. These comments supported the investigators initial hypothesis that a clinical tool to address auditory difficulties would be useful in children with ASD.

**Parent Survey**

There were a total of ten responses to the parent survey. Two of the responses were from the original survey of the professionals. The remaining eight responses were from the message posting at the Autism Ohio Yahoo group site. More responses were anticipated but due to time constraints, only ten were received. The online chat group survey collection was concluded on June 27th, 2003. These results did not have statistical strength due to the small number of responses, however the responses were still analyzed to determine if similar trends in auditory behavior were found as previously discovered in the professional’s survey.

Similar to the professional survey, some parents gave very elaborate responses and others were more concise. The responses were broken down into the original categories as seen in Table 4.10 for a better comparison with the professional survey. The responses were also analyzed to see if any additional trends were noted, but no such categories were added.
The parent respondents varied in terms of number of children with the diagnosis of ASD and their ages. Six of the ten respondents have one child and the remaining respondents varied from two to four children. The ages varied from three to twenty-two years of age. One respondent was an adult (age 40) and reported she had the diagnosis of “high functioning autistic disorder.” This respondent was able to provide insights from observations of her four children with ASD and personal experience. Additional insights are needed from adolescents and adults with the diagnosis of ASD to obtain another perspective on auditory behaviors, but due to time constraints and Institutional Review Board procedures this was not possible during this study. However, the responses from the adult respondent with ASD were analyzed to provide an additional perspective.

Auditory Behaviors Observed

Once again, the data shows a majority of the parent respondents (80%) described hypersensitivity as an auditory behavior observed in their child or children with ASD. One respondent described his child’s difficulty with electronically generated voices. These included electronic toys, “drive thru” windows at fast food restaurants, and intercom systems. Another respondent described difficulties with high-pitched sounds, especially female voices. This respondent also discussed how her child would hear sounds in the distance that others did not appear to hear. As was seen in the professional’s survey, the parents often discussed how this sensitivity would vary in expression. One respondent discussed how it was “hit or miss” as to their child’s reaction to the microwave timer going off and other environmental
sounds. Others discussed the variability seen in different situations. Only one respondent described that her child exhibited phonophobia. This parent discussed how certain sounds appeared to be painful to her child and the child would avoid those situations.

Three of the ten respondents discussed how their children have difficulty in the presence of background noise. This was discussed in terms of hypersensitivity and others stated that the noise appeared to overtake their child. One respondent stated how their child appeared unable to filter the relevant auditory information from all the extraneous auditory input. Two of the respondents discussed how this noise is even more bothersome if it were speech sounds/noise from multiple people talking.

Another common behavior discussed was the adverse reactions to sound. Seventy percent of the parent respondent’s described their child or children’s reaction to sounds. Many discussed their child becoming very upset and throwing a tantrum, covering of the ears, or exhibiting other aggressive behaviors in response to an auditory stimulus. These behaviors understandably appeared to be very bothersome to the parents. Many discussed how these behaviors cause them to avoid certain situations and limit their ability to take trips outside of the home. All of the parents expressed interest in the area of auditory behaviors seen in individuals with ASD. The difference seen in the professional survey result (27%) may be due to parents spending more time with their children and observing these reactions on a more
frequent basis. Due to the impact such reactions may have on the family, several of the parents discussed the need to find new ways to treat these behaviors or to find their cause.

Besides hypersensitivity, 4 of the 10 respondents discussed their child or children’s lack of responsiveness to auditory stimuli or hyposensitivity. Five of the ten respondents described this in terms of a lack of responsiveness to verbal input or “selective hearing”. Several discussed the need to repeat directions and sometimes touch their child to get them to respond. Only one of the respondents discussed this in terms of a delay in processing time. This parent discussed her child’s need for additional time to understand a command or question. This parent also stated that it took her child a count of five before she would respond and appear to understand what was said. Further discussion included how these behaviors made her child appear to not have heard what was said. Two respondents discussed the suspicion of hearing loss in their child.

Three of the ten respondents discussed their child or children’s enjoyment of music. These respondents discussed how their children enjoy humming songs or listening to certain types of music. One respondent stated that his child only likes classical music and would listen to the same score over and over again. Two of the respondents discussed how their children were very good at singing and one child’s music teacher said he had “perfect pitch.” As seen in Figure 4.10, 33% of the respondents stated their child or children exhibit self-stimulation behaviors in response to auditory input. One parent stated that her child would do hand
stimulations in time to the music. She knew it was a stimulation due to the look on her child’s face and the way he waved his hand in his face. Other parents discussed how their children would perseverate (repetition) on certain auditory inputs and exhibit echolalic (echoing) auditory behaviors.

Only one respondent mentioned an auditory processing disorder as a characteristic. This respondent discussed her child’s difficulties with understanding commands and how he would sometimes only hear certain words in a sentence. She did not mention if a formal diagnosis of APD was obtained. Similarly to the professional survey no information was obtained in regards to diagnosis of an APD.

Unlike the professional survey, the parents did not mention the following areas: difficulty with discrimination, frequent ear infections, or an improvement with visual cues. This may be due to the parent’s lack of knowledge in these areas. The results of these two surveys show that both the professionals and parents agreed on several areas of auditory behavior as being common in children with ASD. The areas where there were differences noted might be due to differing perspectives of professionals and parents. These results show that the survey was successful in obtaining a variety of perspectives on the auditory behaviors observed in children with ASD.

**Adult with ASD**

One parent participating in the survey stated she had the diagnosis of “high functioning autistic.” This parent had four children and all but one had the formal diagnosis of Asperger’s syndrome. This respondent discussed her personal
experience with auditory issues in conjunction to her children. She began by stating how she can sometimes hear sounds that “others claim not to hear.” She also discussed having difficulties with high pitch sounds or any repetitive prolonged sounds. This respondent stated that these sounds could sometimes be very painful. Examples she gave included “too many TVs on in the room and not knowing which to tune into” and she is more distracted by “background noise than prominent sounds of a room.”

She also discusses how, along with her children, she is “often the source of loud repetitious noises.” This was interpreted as the perseverative or echolalic behaviors commonly seen in individuals with ASD in which they repeat and imitate sounds in the environment around them. This respondent continued to discuss how this behavior does not seem to impact them in terms of sensitivity, but if they are not the source of the noise then it becomes bothersome to them. An example she gives is how playing with the dog and “rough housing her” will cause a loud bark that is not bothersome to her or her children, but if they are not the ones engaged in this play then they will become irritated with the person and the dog.

In the final paragraph the respondent makes reference to some auditory processing issues. She discusses how listening can be very difficult. She states that she cannot always hear what others are saying and sometimes the “words simply do not process as a meaning (and) it comes in delayed.” She states “it is like our brain kicks out a strand of words expressed (and) our brain does not register it, but the words get stored on the hard drive and come back later to use with a meaning.”
Having this respondent’s response provided a third perspective that will further validate the questionnaire development. The response was interpreted as mentioning issues with hypersensitivity, difficulty with background noise, imitating auditory input, and a delay in processing time. Future research will aim to obtain more responses from adults and adolescents with the diagnosis of ASD. Their insights will provide a unique and personal perspective of the auditory domain of ASD.
<table>
<thead>
<tr>
<th>Title</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech Language Pathologist</td>
<td>23</td>
<td>27%</td>
</tr>
<tr>
<td>Teacher</td>
<td>9</td>
<td>11%</td>
</tr>
<tr>
<td>Occupational Therapist</td>
<td>7</td>
<td>8%</td>
</tr>
<tr>
<td>Psychologist</td>
<td>6</td>
<td>7%</td>
</tr>
<tr>
<td>Audiologist</td>
<td>6</td>
<td>7%</td>
</tr>
<tr>
<td>Physical Therapist</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral Intervention Aide</td>
<td>8</td>
<td>9%</td>
</tr>
<tr>
<td>Behavioral Therapist</td>
<td>6</td>
<td>7%</td>
</tr>
<tr>
<td>Behavioral Case Supervisor</td>
<td>5</td>
<td>6%</td>
</tr>
<tr>
<td>ABA Aide</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>IBI Aide</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>ABA Case Supervisor</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Unspecified</td>
<td>10</td>
<td>11%</td>
</tr>
</tbody>
</table>

Table 4.1: Answer to Q1 of the professional's survey: Professional classifications of the respondents.
<table>
<thead>
<tr>
<th>Title</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic Director</td>
<td>6</td>
<td>7%</td>
</tr>
<tr>
<td>Researcher</td>
<td>8</td>
<td>9%</td>
</tr>
<tr>
<td>Faculty Member</td>
<td>27</td>
<td>31%</td>
</tr>
<tr>
<td>Not Applicable</td>
<td>51</td>
<td>59%</td>
</tr>
</tbody>
</table>

Table 4.2: Answers to Q2 of the professional’s survey: Breakdown of respondents who were clinic directors, researchers, and faculty members.
<table>
<thead>
<tr>
<th>Degree Designator</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA</td>
<td>18</td>
<td>21%</td>
</tr>
<tr>
<td>BS</td>
<td>13</td>
<td>15%</td>
</tr>
<tr>
<td>MA</td>
<td>21</td>
<td>24%</td>
</tr>
<tr>
<td>MS</td>
<td>16</td>
<td>17%</td>
</tr>
<tr>
<td>PhD</td>
<td>12</td>
<td>14%</td>
</tr>
<tr>
<td>MD</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>MEd</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 4.3: Answers to Q3 of professional's survey: Highest degree attained by the respondents.
<table>
<thead>
<tr>
<th>Setting</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>25</td>
<td>29%</td>
</tr>
<tr>
<td>Hospital</td>
<td>12</td>
<td>14%</td>
</tr>
<tr>
<td>MR/DD Facility</td>
<td>4</td>
<td>5%</td>
</tr>
<tr>
<td>Clinic</td>
<td>16</td>
<td>19%</td>
</tr>
<tr>
<td>Specialized Program for ASD</td>
<td>23</td>
<td>27%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Client’s Home</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Clinic and Home</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Unspecified</td>
<td>1</td>
<td>1%</td>
</tr>
</tbody>
</table>

Table 4.4: Answers to Q4 of the professional’s survey: Work setting of the respondents.
<table>
<thead>
<tr>
<th>Answer</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>9</td>
<td>11%</td>
</tr>
<tr>
<td>1-5 years</td>
<td>25</td>
<td>29%</td>
</tr>
<tr>
<td>5-10 years</td>
<td>12</td>
<td>14%</td>
</tr>
<tr>
<td>10-20 years</td>
<td>25</td>
<td>29%</td>
</tr>
<tr>
<td>20+ years</td>
<td>15</td>
<td>17%</td>
</tr>
</tbody>
</table>

Table 4.5: Answers to Q5 of the professional’s survey: Number of years respondents have worked in their profession.
<table>
<thead>
<tr>
<th>Answer</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>9</td>
<td>11%</td>
</tr>
<tr>
<td>1-5 years</td>
<td>25</td>
<td>29%</td>
</tr>
<tr>
<td>5-10 years</td>
<td>25</td>
<td>29%</td>
</tr>
<tr>
<td>10-20 years</td>
<td>18</td>
<td>21%</td>
</tr>
<tr>
<td>20+ years</td>
<td>8</td>
<td>9%</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>1%</td>
</tr>
</tbody>
</table>

Table 4.6: Answers to Q6 of the professional’s survey: Number of years the respondents have worked with ASD patients.
<table>
<thead>
<tr>
<th>Answer</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Rarely (1-5 children per year)</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Occasionally (about 1 child per month)</td>
<td>6</td>
<td>7%</td>
</tr>
<tr>
<td>Sometimes (about 1 child per week)</td>
<td>9</td>
<td>11%</td>
</tr>
<tr>
<td>Often (see several children each week)</td>
<td>29</td>
<td>34%</td>
</tr>
<tr>
<td>Frequently (see multiple children on a daily basis)</td>
<td>41</td>
<td>48%</td>
</tr>
</tbody>
</table>

Table 4.7: Answers to Q7 of the professional’s survey: How often the respondent sees ASD patients clinically.
<table>
<thead>
<tr>
<th>Behavior</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypersensitivity</td>
<td>65</td>
<td>76%</td>
</tr>
<tr>
<td>Unresponsiveness to auditory Input/lack of auditory focus</td>
<td>31</td>
<td>36%</td>
</tr>
<tr>
<td>Hyposensitivity</td>
<td>29</td>
<td>34%</td>
</tr>
<tr>
<td>Adverse reactions to sound</td>
<td>23</td>
<td>27%</td>
</tr>
<tr>
<td>Receptive language difficulties</td>
<td>14</td>
<td>16%</td>
</tr>
<tr>
<td>Difficulty in the presence of background noise</td>
<td>13</td>
<td>15%</td>
</tr>
<tr>
<td>Self-stimulation of auditory input</td>
<td>13</td>
<td>15%</td>
</tr>
<tr>
<td>Imitate auditory input</td>
<td>12</td>
<td>14%</td>
</tr>
<tr>
<td>Difficulty with discrimination</td>
<td>9</td>
<td>11%</td>
</tr>
<tr>
<td>Auditory processing disorder</td>
<td>8</td>
<td>9%</td>
</tr>
<tr>
<td>Delay in processing time</td>
<td>8</td>
<td>9%</td>
</tr>
<tr>
<td>Suspicion of hearing loss</td>
<td>8</td>
<td>9%</td>
</tr>
<tr>
<td>Enjoy music</td>
<td>5</td>
<td>6%</td>
</tr>
<tr>
<td>Phonophobia</td>
<td>4</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 4.8: Most common answers to Q8 of the professional’s survey: Main auditory behaviors mentioned by the respondents as being observed in children with ASD.
<table>
<thead>
<tr>
<th>Frequent ear infections</th>
<th>3</th>
<th>4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement in performance with a visual cue</td>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>Other</td>
<td>46</td>
<td>54%</td>
</tr>
<tr>
<td>Answer</td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>Yes</td>
<td>73</td>
<td>85%</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>13%</td>
</tr>
<tr>
<td>Don’t know</td>
<td>2</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 4.9: Answers to Q11 of the professional survey: Usefulness of a questionnaire designed to address the auditory behaviors observed in children with ASD.
<table>
<thead>
<tr>
<th>Behavior</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypersensitivity</td>
<td>8</td>
<td>80%</td>
</tr>
<tr>
<td>Adverse reactions to sound</td>
<td>7</td>
<td>70%</td>
</tr>
<tr>
<td>Unresponsiveness to auditory Input/lack of auditory focus</td>
<td>5</td>
<td>50%</td>
</tr>
<tr>
<td>Hyposensitivity</td>
<td>4</td>
<td>40%</td>
</tr>
<tr>
<td>Difficulty in the presence of background noise</td>
<td>3</td>
<td>30%</td>
</tr>
<tr>
<td>Self-stimulation of auditory input</td>
<td>3</td>
<td>30%</td>
</tr>
<tr>
<td>Enjoy music</td>
<td>3</td>
<td>30%</td>
</tr>
<tr>
<td>Imitate auditory input</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td>Suspicion of hearing loss</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td>Delay in processing time</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>Receptive language difficulties</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>Auditory processing disorder</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>Phonophobia</td>
<td>1</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 4.10: Answers to the parent's survey: Breakdown of the main auditory behaviors observed in children with ASD.
Figure 4.1: Answer to Q7 of professional survey: How often the respondent sees ASD patients clinically.
CHAPTER 5

QUESTIONNAIRE DEVELOPMENT

The Auditory Behavior Questionnaire (ABQ)

After analysis of the survey results from the professionals, parents, and adult with ASD, initial development of the Auditory Behavior Questionnaire (ABQ) began. Due to the limited time for this study, only a preliminary draft of the assessment tool was possible. Appendix C shows the initial draft that was developed by the end of this study. As noted, this is a preliminary draft due to the continued construction of the ABQ.

Questions were formulated based on many of the responses given in the survey results. Key terms and phrasing from the analysis of the survey results were used for the wording of some of the questions in the ABQ. Several categories were created to organize the formulated questions. Gillman (2000) discusses the need to draft questions and pilot them on a diverse audience prior to questionnaire development. Therefore, no scoring scale was developed at this time. Future research and piloting will continue the development of the ABQ in order to make it a
clinically useful tool. When the format of the questionnaire is completed, further piloting will occur to thoroughly investigate the validity and usefulness of this questionnaire.
APPENDIX A

PROFESSIONAL SURVEY QUESTIONS
Question

1. What is your profession or job classification?
   a. Audiologist
   b. Speech Language Pathologist
   c. Psychologist
   d. Teacher
   e. Teacher’s Aide
   f. Occupational Therapist
   g. Physical Therapist
   h. Other...please specify____

2. Please mark if any of the following apply to you
   a. Clinic Director
   b. Researcher (focused on children with ASD)
   c. Faculty member

3. What is your highest degree earned?
   a. BA
   b. BS
   c. MA
   d. MS
   e. PhD
   f. EdD
   g. MD
   h. Other____

4. How would you describe your work setting?
   a. School
   b. Hospital
   c. MR/DD facility
   d. Clinic
   e. Specialized Program for ASD
   f. Research Facility
   g. Other________________
5. How many years have you been in your profession?
   a. Less than 1 year
   b. 1-5 years
   c. 5-10 years
   d. 10-20 years
   e. 20+ years

6. How many years have you been working with children diagnosed with ASD?
   a. Less than 1 year
   b. 1-5 years
   c. 5-10 years
   d. 10-20 years
   e. 20+ years

7. How often do you work with children diagnosed with ASD?
   a. Never
   b. Rarely (1-5 children per year)
   c. Occasionally (about 1 child per month)
   d. Sometimes (about 1 child per week)
   e. Often (see several children each week)
   f. Frequently (see multiple children on a daily basis)

(Additional space was provided for answers to questions 8-13)

8. What auditory characteristics would you describe children with ASD as having?

9. How often have you observed these characteristics or behaviors in children with ASD?

10. What auditory characteristics would you describe typical developing children as having?

11. If a questionnaire to address auditory behaviors in children with ASD were available, would this be useful to you? Why or why not?

12. How might you use information from such a questionnaire?

13. Are there any additional comments you would like to share?
APPENDIX B

PARENT SURVEY QUESTIONS
Question

1. What auditory behaviors have you observed in your child or other children diagnosed with ASD?
   a. Clarification: By AUDITORY please focus on hearing or listening behaviors.

2. How many children in your family are diagnosed with ASD? And what are their ages?
APPENDIX C

DRAFT OF THE AUDITORY BEHAVIOR QUESTIONNAIRE (ABQ)
AUDITORY BEHAVIOR QUESTIONNAIRE (ABQ)
(Draft)

Name_________________________ Age _____ Date completed_______

Hearing/Communication Reception

1. How well does your child follow verbal commands?

2. How often does your child require repeated verbal prompts for a task or command?

3. When given directions with multiple steps, how well does your child follow the directions?

4. How often does your child detect sounds that others have a difficult time hearing or detecting?

5. How often does your child react to very faint or distant sounds?

6. Does your child sometimes appear unresponsive to verbal input or sounds?

7. When compared to his/her peers, how would you rate your child’s tolerance of loud sounds?

8. How well does your child respond in noisy environments?

9. How well does your child filter important information when competing background noise is present?

10. When compared with his/her peers, how long does your child take to process verbal commands?

11. When upset or agitated, how often is your child calmed by music or other sounds?

12. How well does your child respond to songs or music?
Behavioral/Attention

1. When compared to his/her peers, how often does your child become upset or agitated due to a loud sound or noise that is bothersome to them?

2. If a sound is bothersome, how often does your child cover his/her ears in response to the sound?

3. When compared with his/her peers, how would you rate your child’s attention span?

4. How well is your child able to target their listening to a conversation or discussion?

5. When compared with his/her peers, how would you rank your child’s ability to listen carefully to a conversation or verbal command?

Social

1. When compared with his/her peers, how often does your child have difficulty socializing with other children?

2. When compared with his/her peers, how often does your child have difficulty socializing with adults?

3. How often does your child avoid certain situations due to the noises that are present in that environment?

4. How would you rank your child’s ability to get along with his/her peers?

Academic

1. How well does your child appear to do learning a topic with a visual cue?

2. When compared to their peers, how would you rate your child’s academic performance?

Expressive Communication

1. How often does your child have a difficult a time communicating with adults?

2. How often does your child have a difficult a time communicating with his/her peers?
3. How often does your child appear to stimulate him/herself on sounds (i.e. hum, repetition, gestures, etc…)?

4. Does your child commonly repeat/imitate words or sounds?

5. When compared to their peers, how well does your child express themselves?
BIBLIOGRAPHY


