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MUSICAL ECHOLALIA AND NON-VERBAL CHILDREN WITH AUTISM

A DISSERTATION
Submitted by

KRYSTAL LEAH DEMAINE

In partial fulfillment of the requirement
for the degree of
Doctor of Philosophy

LESLEY UNIVERSITY
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LESLEY UNIVERSITY

Lesley University
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Ph.D. in Expressive Therapies Program

DISSERTATION APPROVAL FORM

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Approvals

In the judgment of the following signatories, this Dissertation meets the academic standards that have been established for the Doctor of Philosophy degree.

Dissertation Committee Chairperson: ________________ 4/13/12 (date)

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Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copy of the dissertation to the Graduate School of Arts and Social Sciences.

I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

____
Dissertation Director

I hereby accept the recommendation of the Dissertation Committee and its Chairperson.

____
Dean, Graduate School of Arts and Social Sciences

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ABSTRACT

Typical imitation skills that are integral to language and social learning do not readily develop in children with autism. Echolalia, an echoing or imitation of speech sounds, has historically been considered a non-meaningful form verbal imitation. Since music is intrinsically more meaningful than language for children with autism, musical echolalia may offer path to communication for non-verbal children with autism. This research study sought to identify a potential existence of musical echolalia among non-verbal children with autism. Twelve non-verbal children diagnosed with classic autism, six boys and six girls, aged four to eight, who had no formal musical training or music therapy experience participated in this study. Participants took part in a single, one-on-one, videotaped music therapy session. For this study the term musical echolalia was defined as the demonstration of the immediate, relative, imitation of a pitch, melody or, rhythm sequence of a musical phrase performed through vocal, instrumental, or physical expression. Non-musical utterances or noises such as echoic or imitative speech sounds and unrelated motor movements were not included in this study as musical echolalia. Each child's immediate imitation of discrete musical elements was deemed musical echolalia; thus, elements of pitch, rhythm, voice, musical instrument, and physical expression were included in this study. Based on these criteria seven different sub-types of musical echolalia were identified. Inferential statistics and single factor ANOVA were used to compare the frequency of musical stimuli and musical echolalia, the social responses that occurred after musical echolalia, and the potential associations across gender and age. A statistically significant difference was found for the musical echolalia type RIO (rhythm with a musical instrument) when compared to the frequencies for the

other sub-types of musical echolalia. The identification of musical echolalia sub-types may offer insight to understanding the musical elements that each child attunes to. Furthermore, the identification of musical echolalia abilities may aid in diagnostic assessment and in the development of treatment protocols for these children. Additional research needs to be done, however, to further determine musical echolalia's potential for use as a tool in developing social and communicative reciprocity for non-verbal children with autism.

CHAPTER 1

Introduction

Imitation is a key developmental paradigm for language and social learning (Ozonoff, Rogers, & Pennington, 1991). The relative absence of imitation observed among children with autism has been identified as a fundamental contributor to autism's underlying features (Nadel, 2006; Wing & Gould, 1979). The core features associated with autism include impaired communication, poor social abilities, and the presence of restrictive and repetitive behaviors (American Psychiatric Association [DSM-IV-TR], 2000). Despite the limitations associated with these characteristics, unique abilities and interests in music have been identified and drawn upon to encourage neurodevelopmental benchmarks among children with autism (Whipple, 2004; Wigram & Gold, 2006).

Autism was first diagnosed and labeled by Dr. Leo Kanner (1943). In his seminal paper Dr. Kanner described the cases of 11 children (eight boys and three girls), all under the age of 11, whom he diagnosed with "early infantile autism." Among the group, Kanner noted that 6 of the 11 children possessed musical abilities in the areas of musical performance, perception, and memory. One child (case 4) was able to sing 37 different songs by the age of three. Another child (case 9) was able to identify 18 symphonies by the age of 18 months; "he recognized the composer as soon as the first movement started" (p. 236). Kanner suggested that the children possessed excellent rote memory, and he noted that a typical one, two, or three-year-old child would not be able to easily access such detailed information. Since Kanner reported his findings, researchers have methodically investigated musical abilities among children with autism (Appelbaum, Engel, Koegel, & Imhoff, 1979; Heaton 2009; 2003; 2005; Heaton, Davis, & Happe, 2008; Heaton, Williams, Cummins & Happe, 2008).

In the 1960s Dr. Bernard Rimland (1928-1962), founder of the Autism Society for America, suggested that musical abilities could play an important factor in the diagnosis and treatment of autism (Autism Society, 2011). Since the 1950s music therapy has emerged as an instrumental clinical approach for the treatment of various human needs, and music therapy has become increasingly more utilized for children with autism (Kaplan & Steele, 2005; Kim, Wigram, & Gold, 2008; 2009; Whipple, 2004; Wigram & Gold, 2006). Improvised music is often utilized in music therapy to encourage spontaneous expression and non-verbal social interactions (Wigram, 2004; Bruscia, 1987). Improvised music techniques such as call-and-response, turn taking, and reflection resemble techniques in contemporary talk therapy with however, music as the predominant medium for communication (Bruscia, 1987; Wigram, 2004; Wigram & Elefant, 2009).

Since autism is a neurodevelopmental disorder, the effect of music on the neurologic underpinnings of autism must be considered. Peretz and Zattore (2005) suggested that the human brain is especially organized for musical processing and that individuals with neurodevelopmental and congenital abnormalities may experience musical processes uniquely (Peretz & Zatorre, 2005; Peretz, 2002). Hyde and her colleagues (2009) suggested that music shapes brain development and that music making offers a multisensory motor experience that engages various brain regions and cortices. Furthermore, neuroimaging has indicated that language and music have overlapping brain regions, indicating that musical components such as melody and rhythm can aide in the development and redevelopment of lost or impaired language components associated with speech prosody and rhythm (see Patel, 2008).

Often the measurement of musical ability among children with autism relies on how accurately the child can replicate musical sounds (Applebaum, Engel, Koegel, & Imhoff, 1979) or how well the child makes a choice in response to auditory stimuli (Heaton, Pring, and Hermelin, 1999b; Heaton, 2000; Heaton, Davis, & Happe 2008; Heaton, Williams, Cummins, & Happe, 2008). Participants of these studies were generally intellectually able and musically naïve. However, in terms of measuring imitation, Sevlever and Gillis (2010) suggested that the studies examining imitation abilities among individuals with autism have not used uniform systems of data collection and measurement. This lack of uniform systems may indicate limited reliability across studies. Yet, the majority of that data did suggest that persons with autism showed difficulty with imitation specifically with the emulation of facial features and gross and fine motor tasks. Henceforth, a consideration of words synonymous to "imitation" - such as copy, emulate, or mimic must be clearly defined to determine the concept of "pure imitation" created by individuals with autism (Sevlever & Gillis, 2010).

Imitation typically develops during early infancy when an infant shows imitation of caregiver's facial expressions (Meltzoff & Moore, 1977). Lack of imitation abilities has been suggested to be an early indicator for the diagnosis of autism (Vanvuchelen, Royers, & Weerdt, 2011a). Some researchers have indicated that poor imitation may be a deficit in the putative human mirror neuron system (Depretto et al., 2006; Wan, Demaine, Zipse, Norton, & Schlaug, 2010) while others consider it a problem related to sensory information processing (Kern et al., 2006; Kern et al., 2007; Suarez, 2012). It also has been noted that imitation simply may not have much meaning or purpose for persons with autism (Nadel, 2006; Rogers & Williams, 2006).

The most distinct and often the only mode of imitation observed among children with autism is echolalia (Prizant & Duchan, 1981). Kanner (1943) described echolalia as an immediate or delayed "parrot-like repetitions of words" (p. 243). While some have suggested that echolalia has no functional use for the development of language (Fay & Butler, 1968; Saad & Goldfield, 2009), others believed that it might be useful in language training (Lovaas, 1977; Prizant & Duchan, 1981). Charlop (1983) suggested specifically that immediate echolalia might be important in the development of functional receptive language. Music, on the other hand, when imitated by children with autism, can lead to acts of socialization and communication (Kim, Wigram, & Gold, 2009; Stephens, 2008). Neuroimaging studies have indicated that children with autism display more neural activation for musical sounds than speech sounds (Lai et al., 2012) and that music offers a pleasurable and stimulating mode of engagement (Wigram, 2004). Literature has also indicated that individuals with autism show greater behavioral interst in musical stimuli when compared to other forms of non-musical auditory stimuli (Kellerman, Fan, and Gorman, 2005). Music may be intrinsically more meaningful than common language for children with autism. Thus, musical echolalia abilities may lead to the development of meaningful communication for non-verbal children with autism.

The purpose of this research was to contribute to the literature by identifying musical echolalia and exploring its potential use among non-verbal children with autism. In this current research study, an immediate imitation or echoing of musical sounds produced by children with autism was termed musical echolalia. The goals of the study were to (a) identify musical echolalia abilities among non-verbal children with autism, (b) identify potential types of musical echolalia produced by non-verbal children with autism that expanded beyond the findings of a pilot study produced by this author, (c) develop a coding system for measuring frequency and duration of musical echolalia, and (d) identify social responses associated with musical echolalia. It was hypothesized that the children who participated in this study would demonstrate musical echolalia, and that in contrast to speech echolalia, an engagement an in musical echolalia would lead to meaningful social and / or communicative interactions. Meaningful communication is not typically associated with speech echolalia. It was also assumed that the children in this study would show a general interest in the musical sounds which would demonstrated by the child's ability to remain in the procedure room during the music therapy session. Finally, it was anticipated that the children would exhibit acts of musical echolalia and that the act of musical echolalia would lead socially engaged outcomes.

Twelve non-verbal children diagnosed with classic autism were recruited for this study. Participation involved the child's attendance for a single, one-on-one music therapy session that employed improvised music techniques. The session was videotaped, and the observations were transcribed and analyzed to inform the outcomes of this study. Children with autism reportedly show unique musical interests and abilities (Wigram, 2004), and music therapy has shown to help children with the development of communication and social skills (Whipple, 2004; Wigram, 2004; Wigram & Gold, 2006). This study, therefore, sought to identify how musical echolalia could be considered a useful form of echolalia. Since music and language have overlapping neural networks in the brain (Patel, 2008), and the inhibition of imitation may be the underlying factor to autism's core features, the ability for musical echolalia may aid in the development of communication. Musical echolalia may be a proclivity among many, if not all, non-verbal children with autism, and it may provide an inroad to navigate through the complex and unique disorder known as autism.

CHAPTER 2

Literature Review

This literature review will highlight both current and historical perspectives from three major content areas, which include autism, music, and imitation. Each content area is further divided into specific topics. The first major content area, Autism: Etiology, Diagnosis, and Treatment, is subdivided into the following topics: (a) origin and etiology, (b) descriptive characteristics, (c) diagnostic and assessment measures, (d) sensory perception, (e) cognitive models of autism, (f) speech, language, and communication, (g) echolalia, (h) memory, (i) theory of mind, (j) emotion, (k) treatment and intervention. The second major content area, Music, is subdivided into the following topics: (a) cultural and historical perspectives, (b) cognition and perception of music, (c) music and language, (d) musical communication, (e) music therapy, and (f) music therapy and autism. Finally, the third major content area, Imitation, is subdivided into the following topics: (a) historical and developmental perspectives, (b) autism and imitation, (c) musical imitation, (d) mirror neuron system, (e) auditory-motor action, and (f) neural theories of autism.

Summaries from current research and seminal literature will lay the foundation for this research study. Both historical and current perspectives have informed inquiry and shifted the current view of autism. A concluding discussion of the literature will summarize the connections between each of the major content areas in order to inform the rationale for the study of musical echolalia among non-verbal children with autism.

Autism: Etiology, Diagnosis, and Treatment

Origin and Etiology

Swiss psychiatrist Eugene Bleuler first coined the term "autism" or "autistic" in 1912, when he ascribed autism with the literal meaning of an "escape from reality." In the early 20th century, among the psychiatric community, autism was not labeled a diagnosis but rather a behavioral characteristic. Psychiatrists around this time began to take note that some patients possessed autistic characteristics manifested through psychosis and a broad spectrum of behavioral abnormalities. Prior to labeling children with the diagnosis of autism, psychiatrists simply suggested that children who displayed autistic behaviors had a form of dementia, evidenced by the loss of cognitive ability (Corbier, 2005).

In 1943 Dr. Leo Kanner published the first accounts that laid the foundation for forming the differential diagnosis between autism and other related disorders, such as intellectual disabilities or emotional and / or behavioral disorders. In Kanner's seminal paper "Autistic Disturbances of Affective Contact," his case descriptions of 11 children illustrated that while the children manifested communication and social abnormalities, their behaviors were not indicative of intellectual dysfunction. He first labeled these children with early infantile autism. Kanner, determined that the children were "unquestionably endowed with good cognitive potentialities" (p. 247) and suggested that the cause of the withdrawn and restrictive behaviors he described in a child with autism, originated from the child's parents, specifically mothers who had withheld affection or behaved "coldly" toward the child. Much of this thinking was reflective of the popular psychoanalytic perspective, which took precedence at the time. Kanner's hypothesis soon inspired the ignominious expression, "refrigerator mothers." Among the cases he described, Kanner noted, "there were very few warmhearted mothers and fathers," and they were "often preoccupied with abstractions of a scientific, literary or artistic nature, and limited in genuine interest in people" (Kanner, 1943, p. 250).

In his field, Kanner's concept of the "refrigerator mother" was accepted by some and strongly refuted by the majority of others. In the 1960s, child psychiatrist Bruno Bettelheim supported the notion of the "refrigerator mother," which has since been dispelled as a myth. Bettelheim's famous book, *The Empty Fortress* (1967), included several sections that compared the family home-life of a child with autism to growing up in a German concentration camp. This comparison sparked controversy within both the psychiatric and autistic communities. Whereas the etiology described by Kanner and Bettleheim relied on Freudian theories of psychoanalysis, in 1964 Bernard Rimland, a psychologist and a parent of a child with high functioning autism, proposed a neurobehavioral theory of autism.

Rimland's (1978) work historically shifted the public's thinking and methodology from the prevailing analytic perspective to believing that autism had neurobehavioral underpinnings. Similar to Kanner, Rimland observed that individuals with autism showed unique musical interests and abilities, and in his novel suppositions suggested that music may allow for a clinical intervention and / or used as a possible diagnostic tool. Rimland's (1964) theories led him to become an important advocate for individuals with autism. He founded both the Autism Research Institute and the Autism Society of America, which have served as important resources to individuals with autism and caregivers alike (Autism Society, 2011). Although nearly all current data has supported genetic origins as the root cause of autism, a small group of individuals have continued to support the previously indicated psychoanalytic perspectives (Osteen, 2008).

Though widely debated, a diagnosis of autism is often suggested to stem from genetic susceptibility. In his early reports Kanner (1943) indicated that many of the parents of the children he observed were "often preoccupied with abstractions of a scientific, literary or artistic nature, and limited in genuine interest in people" (Kanner, 1943, p. 250). Such pre-occupations may indicate autistic-like traits. Emerging research more frequently points to genetic origins, commonly citing autistic traits within familial lines (Contstantino, Zhang, Frazier, Abbacchi, & Law 2010; Losh, Childress, Lam, & Piven, 2007), with a noted 63-89% concordance rate in identical twins, 0-10% chance in fraternal twins, and a 3% chance in siblings.

In an effort to compare the neural structures among siblings, Kaiser and colleagues (2010) at Yale University used magnetic resonance imaging (MRI) scanning to compare brain structures of children diagnosed with autism spectrum disorders to that of their typically developing siblings as well as another group of typically developing children, aged 4-17 (*N*=62). Imaging revealed three unique differences among the groups, (a) children with autism and their typical siblings shared a common brain area with reduced activity, (b) children with autism showed the highest reduction of brain activity when compared to the other groups, and (c) typically developing siblings showed an enhanced brain activity not found in the other groups. The study suggested a genetic origin to the disorder, which the authors proposed might offer a basis for clinical diagnosis. Ozonoff and colleagues (2011) conducted a longitudinal study that followed the development of typical infants whose older siblings were diagnosed with autism (*N* =

664). The finding indicated that that 18.7% of infants were however later diagnosed with autism. These findings indicated a significantly different percentage of sibling related diagnosis compared to what had been estimated in previous studies.

Some research has suggested that autism might be identified by a single chromosomal mutation or deletions that could be carried within genetic lines (Sousa et al., 2010; Szatmari et al., 2007; Zeeland et al., 2010). Such findings, however, hold little validity, as the research is found in only a few studies that sampled small groups of individuals. Tager-Flusberg & Joseph (2003) noted that the complexity in heterogeneity across autism spectrum disorder, which includes Asperger's syndrome and PDD-NOS, impedes the possibility of identifying a single specific genetic mutation. The authors, however, contended that two different subtypes of autism may exist and are differentiated by language and cognitive profiles. The authors believe that the identification of autism subtypes will lead to more effective treatment approaches.

Neuroimaging has allowed researchers to identify biological differences in the autistic brain when compared to a typical brain. Frith (1989) suggested that abnormal neural connectivity might explain dysfunction in the characteristic markers of autism. Herbert (2005) has offered speculation as to the role that genetics may play in abnormal brain connectivity. Herbert (2005) found that individuals with autism commonly have larger brains than typical children; a trait identified during the first month in the womb. Increased white matter might causes a disruption in the brain's ability to send important messages through gray matter, which may contribute to the underlying cause of autism (Herbert, 2005; Herbert et al., 2004; Xiaoyan et al., 2009). Accelerated brain growth has been confirmed across various research studies (Nordahl et al., 2011). To investigate the cause for rapid brain growth Courchense and colleagues (2011) compared the postmortem brains of male children with autism (*n* = 7) and typically developing children (*n* = 6) aged 2-16. The researchers found that the brains of those with autism contained 67% more neurons in the pre-frontal cortex when compared to the controls and that brain weigh differed by 17.6% compared to the mean. The pre-frontal cortex is responsible for much of the cognitive processes that occur in the human brain, including executive functioning, social behavior, and the organization of thoughts and actions. Perhaps the increase early neural activity in the brains of the children with autism caused more rapid brain growth compared to typically developing children.

In another study that examined brain growth, Nordahl and colleagues (2011) compared head circumference of pre-school aged boys and girls; with regressive autism (*n* = 61); with non-regressive autism (*n* = 53), and children who are typically developing (*n* = 66). Regression autism is identified when during the first two years of life children begin to lose developmental abilities for communication and social engagement. The results of this study found that only the boys with regressive autism had a larger brain circumference, and thus showed the most rapid brain growth. The authors contended that the findings of this study might suggest a specific neural phenotype for regressive autism in boys that is indicated by rapid brain growth.

When considering the cause of abnormal brain growth, Vaccarino, Grigorenko, Smith, and Stevens (2009) believed that increased excitatory neurons–brain cells that may be responsible for stimulating brain activity, as opposed to inhibitory neurons which block excitatory transmitters, and balance out the brain - may be responsible for an increased brain volume among individuals with autism. Vaccarino and colleagues also pointed out that the increased excitatory neurons might cause the sensory processing problems and seizure activity often found in children with autism. The authors claimed that an overabundance in neurons might stem from Fibroblast Growth Factors (FGF) – a group of genes found in the pituitary gland – which may shift the balance of excitatory neurons. The consideration the neural map for the person with autism is an important discussion for researchers, and may lead to the possible identification of genetic phenotypes of the disorder (Nordahl, et al., 2011)

Descriptive Characteristics

Presently the Diagnostic Manual of Mental Disorders-IV-TR (2000) includes autism in a heterogeneous umbrella known as Autism Specrum Disorders (ASD). ASD is included within a larger group known as Pervasive Developmental Disorders (PDD). Among this group five different diagnoses are included: 1. Classic Autistic Disorder (autism), 2. Asperger Syndrome (AS), 3. Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS); and two less common diagnoses known as, 4. Rett Syndrome, and 5. Childhood Disintegrative Disorder (CDD). Though varying in specific type, all of these diagnoses include three core features: (a) impaired verbal and non-verbal communication (b) impaired social skills, and (c) restrictive and repetitive behaviors and/ or interests (American Psychiatric Association [DSM-IV-TR], 2000). The forthcoming Diagnostic and Statistical Manual of Mental Disorders (5^{th} ed.; DSM-5) will be published in the year 2013. The proposed amendments to the DSM-IV-TR will expand ASD into a broader category of diagnosis and potentially exclude some of the PDD diagnoses (American Psychiatric Association, 2012). Therefore, for the purpose of this literature review, the term ASD will be from this point on used when referring to any of the above-ascribed diagnoses, unless an author specifically designated a diagnosis in the literature.

In order to diagnose autism both behavioral and cognitive abilities must be considered. Behavioral markers related to communication and social development is most commonly ascribed to the diagnosis (Autism Society, 2011), however, diverse levels of cognitive functioning play a role in related sensory abnormalities, often indicated as restrictive and repetitive behaviors. Sensory abnormalities can often play a role in assessing intelligence levels for the person with autism. Autism has been referred to as either mild or severe in its presentation of sensory processing and based on level of IQ. The term High Functioning Autism (HFA) has been ascribed to those who demonstrate an IQ score above 70, for those who demonstrate and IQ score below 70, the term Low Functioning Autism (LFA) has been labeled (Ozonoff, Rogers, & Pennington, 1991; Szatmari, Archer, Fisman, Streiner, & Wilson, 1995). Given the variability of behavioral and cognitive functioning it is possible for misdiagnosis to occur. Leyfeyer and colleagues (2006) found that the most common disorders misdiagnosed as autism have included global developmental delay, seizure disorder, childhood schizophrenia, behavioral disorders, and sometimes attention deficit hyper activity disorder. In order to diagnosis autism the assessment protocol must be thoughtfully and accurately carried out.

Commonly known as a less severe diagnosis among the autism spectrum disorders, Asperger’s Syndrome (AS), is often compared to the other autism diagnoses by the individuals ability to use verbal language. The diagnosis of Asperger’s syndrome was first coined and identified by Austrian pediatrician Hans Asperger in 1944. Asperger reported autistic-like symptoms in four boys who showed unique preoccupations for particular subjects such as mathematics, music, or art. The difference between the children with Asperger's syndrome and those that Kanner (1943) observed was the ability of those with Asperger's syndrome to express their interests verbally to others. Similar to the children with classic autism, persons with Asperger's syndrome shared the same impaired social reciprocity, obsessive and restrictive behaviors, sensory sensitivities, and poor motor coordination (National Institute for Neurologic Disorders and Stroke: Asperger's Syndrome Information Page, 2011).

According to 2012 statistics from the Centers for Disease Control (CDC), in the United States of America, 1out of 88 children are diagnosed with autism spectrum disorders; it is the third most common diagnosis among children, a veritable epidemic. This rate of incidence has increased dramatically in recent years. Boyle and colleagues (2011) noted that developmental disabilities were diagnosed in one out of every six children during the years 1997-2008, and, specifically, autism spectrum disorders showed a 289.5% increase during that time. Because of the amplified awareness of autism, parents and caregivers alike are more likely to notice the characteristics of autism. According to the CDC (2010) autism spans all ethnic groups, occurs four times more likely in males than females, and 41% of children score an IQ below 70, with girls displaying the more severe symptoms of the spectrum.

The National Institute for Mental Health (2012) reported that autism is most commonly diagnosed at the age of three. This late diagnosis often occurs most frequently when intellectually able children who develop language in a typical time frame begin to lose such developmental benchmarks. A study conducted by Shattuck and colleagues (2009) surveyed 13 different communities and found that that the median age of diagnosis was 5.7 years. The authors commented that this late diagnosis presents clinical concerns in terms of providing early intervention. Nevertheless, autism can be diagnosed as early as age one. Early diagnosis is most commonly identified when caregivers have the ability to report an infant's failure to achieve developmental benchmarks such as babbling and finger pointing (National Institute of Neurologic Disorders and Stroke, 2012). While autism can be identified early, Vanvuchelen, Roeyers, and Weerdt (2011b) also proposed that a late diagnosis might be related to uncertainty with current diagnostic procedures, even among professionals. According to the Autism Society for America (2010), early intervention before three years of age allows for the best results in improving or maintaining developmental skills in children with autism. A systematic review conducted by Warren and colleagues (2011) examined the use of intensive early intervention across several research studies and found that children with autism showed gains in cognition, language, abilities, and behavioral skills when early interventions were used. Since early intervention can lead to the most successful outcomes for leading a functional life for children with autism, it is important for not only caregivers to be aware of the symptoms, but also for the methods of diagnosis to be most effective and accurate.

Diagnostic and Assessment Measures

The heterogeneity and co-morbidity associated with ASD often challenges proper diagnosis. A variety of diagnostic systems have been established to determine diagnosis and severity of autism. Diagnosis often relies on a set of criteria that are observed by clinical professionals and sometimes parents or teachers. The most commonly used and reportedly most effective assessment protocol was developed by Lord and colleagues

(1989) and is known as the Autism Diagnostic Observation Schedule (ADOS). The ADOS has been considered the gold standard for the assessment of ASD and PDD for both children and adults and for those with and without verbal language. The ADOS provides a play-based assessment for the evaluation of how individuals with autism engage in communication, social play, and restrictive and repetitive behaviors. Schloper and colleagues (1980) developed another observational protocol referred to as the Childhood Autism Rating Scale (CARS), a 15-item behavioral rating scale that utilized behaviors to determine the severity of autism. Additional assessments such as the Autism Behavior Checklist (ABC) and the Gilliam Autism Rating Scale (GARS) (Gilliam & Janes, 1995) determine the severity of the diagnosis. A medical exam in addition to a screening will help to rule out commonly confused medical diagnosis, such as seizure disorder, physical illness, and sleep or eating disorders (Autism Society for America, 2011).

Diagnostic tests are able not only to indicate autistic characteristics, but also the severity of the diagnosis. In an effort to screen for the severity of diagnosis with a large sample of people, Posserud, Lundergold, and Gillberg (2006) used the Autism Spectrum Screening Questionnaire (ASSQ) (Ellers, Gillberg, & Wing, 1999) to test 9,430 Norwegian school children aged seven to nine. The 27-item questionnaire was rated on a 1-3 point scale and administered by teachers and parents of the children. Among the children who scored within the range of the ASD, there was a higher incidence of those with severe autistic traits compared to those who scored with mild autistic traits. The authors acknowledged that there might have been bias in terms of how many screenings were actually fulfilled and returned by the parents and teachers; however, the large sample size strengthened the validity of the study. While one might deduce that there was a larger incidence of sever forms of ASD, further testing is needed to prove the validity of these outcomes.

In the largest total population study to test for the incidence of autism, Kim and colleagues (2011) utilized the ASSQ to test a total population of 55,266 7-12 year-old children in South Korea. Children from both special education and typical educational institutions participated in the study. The authors noted that the majority of the participants were those who attended the special education programs. The results indicated that 1 out of 38 children fell within the criteria for a diagnosis of ASD. The authors reasoned that many of the children found in the typical school settings and given the diagnosis would likely benefit from special education experiences. The authors also contended that autistic traits might be found in much of the general population. While the incidence of autism may vary based on the testing sample, it is important to consider the severity of the diagnosis among the test population (Posserud, Lundergold, & Gillberg, 2006)

Since testing batteries for autism require specific training for administration, Baron-Cohen and colleagues (2001) developed the Autism Spectrum Quotient (AQ) as one of the first instruments that adults with normal intelligence could self-administer for the quick identification of autistic symptoms. To test the AQ, four groups of adults were assessed including adults with AS or HFA (n = 58), a random control group (n = 174), university students (n = 480), and Mathematics Olympiad winners (n = 16). Results indicated that the university students who majored in mathematics and science scored higher on the AQ than those who majored in humanities or social sciences, but did not show a significant difference compared to the control group. The group that scored the highest when compared to the adults with AS and HFA was the Mathematics Olympiad winners. The authors cautioned that the test is not intended to be a diagnostic tool, but rather a type of pre-test that would require clinical follow-up to determine a diagnosis. Interestingly, the outcomes of the AQ indicated an association between autistic traits and scientific skills. The findings of this study resonated with Kanner's (1943) report that parents of the children that he observed seemed to be occupied with scientific areas of inquiry and also echoed the notion of possible autistic traits among familial lines.

Sensory Perception

The way that the person with autism processes sensory stimuli may contribute to the associated sensory restrictive and repetitive behaviors, which are central to autism's diagnosis. Autism, among other diagnoses, has been considered in relation to a set of diagnosis known as Sensory Processing Disorders (SPD). Other diagnoses that fall within the SPD category include attention deficit hyperactivity disorder (ADHD), cerebral palsy (CP), learning disabilities (LD), and childhood anxiety disorders (Kranowitz, 2005). First coined by occupational therapist Jean Ayres (1978), SPD is indicated by the brains inability to easily and sometimes meaningfully process and encode sensory information. Abnormal sensory processing in individuals with autism may be identified by a hyper or hypo response to stimuli such as light or sound. Hyper or hypo responses to such stimuli often lead to atypical or maladaptive behaviors. Such behaviors often present themselves as the cores stereotypical and restrictive behaviors associated with autism. While such behaviors may seem peculiar or erratic, mannerisms such as rocking, flapping, or swaying may be self-soothing for the child or may simply be the child's release of energy (Kranowitz, 2005). In the documentary film Wretches and Jabberer's (Wurzburg, 2011), Tracy, an adult person with autism said that his abnormal body movements are just his natural pattern of movement. This comment may indicate that some of the movement patterns that people with autism engage in are not a response to sensory stimuli but simply the natural way that the person moves. Kranowitz, however, suggested that what she refers to as sensory abnormalities "may play a role in triggering the overwhelming anxiety and can cause some children to withdraw and become mute" (p. 35). Since SPD can manifest through odd behaviors, it can have an impact on the way a child relates socially and can lead the child to the discomforting feelings of being judged or ridiculed. Tantum and Girgis (2009) pointed out that autism is commonly linked to mood disorders, anxiety, and psychotic episodes, all of which could be precipitated by difficulties with sensory processing.

According to Richards, Demaine, McLaughlin, and Crissman (2008) perceive sensory information is perceived through three core domains: (a) communication and auditory, (b) fine motor, and (c) visual motor. The ability to process information in each of these domains play an important role in the achievement of developmental benchmarks, such as finger pointing and imitation, which are pre-cursors to socialization and communication. Kern and colleagues (2007) conducted a cross-sectional examination to identify sensory abnormalities among individuals with ASD. Participants included children with ASD and typically developing children ($N = 104$) aged 3-56 years old. All of the children were evaluated on high and low thresholds of auditory, visual, oral, and touch stimuli, using the Sensory Profile. Individuals with autism showed sensory abnormalities in both high and low levels of sensory processing, a finding which suggested that sensory abnormalities are an inherent characteristic among individuals with ASD. It was also noted that older individuals showed fewer sensory abnormalities, an indication that abnormal response to sensory stimuli might reduce with age. In a follow-up study Kern and colleagues (2007) identified that sensory abnormalities correlated with severity of autism among children, but not in adolescents, or adults. Wiggins, Robbins, Bakeman, and Adamson (2009) reported that sensory abnormalities may be a clear indicator for early identification of autism and can play an important role in the delayed development of verbal expression, emotion, and social reciprocity. The authors suggested that sensory abnormalities should be considered or examined in early pediatric appointments. Donnellan, Hill, and Leary (2010) insisted that each individual sensory abnormalities or the way a child with autism moves (i.e. rocking or flapping tics) may have just as much to do with the diagnosis as the three core characteristics. Nevertheless, children with autism perceive information and process it in ways divergent to those without ASD.

With regard to auditory stimuli alone, Kellerman, Fan, and Gorman (2005) analyzed literature on how children with autism responded to auditory stimuli. The found that the literature reported on three different types of auditory stimuli: (a) social linguistic sounds, (b) non-linguistic and/or non-musical sounds, and (c) musical pitches. The authors cited that the majority of the studies they reviewed indicated that children with ASD, when compared to typically developing children, showed greater brain activation for musical stimuli in comparison to the other noted forms of auditory stimuli. Their findings suggested a possible reason for social isolation and / or lack of interest in engaging in with others who communicate with speech and suggested possible implications for future experimental research with musical auditory stimuli.

Cognitive Models of Autism

Cognitive theories have made an important contribution to the understanding of the characteristics associated with ASD. The most predominant cognitive model is known as the theory of weak central coherence (WCC). The WCC theory was first proposed by Frith (1989) who suggested that individuals with autism possess a weak central coherence (WCC), that is, information (sensory stimuli) is processed locally rather than globally in the brain. In other words, that brain of the person with autism is more likely to focus on small details rather than contextualizing the gestalt of an experience; thus, Frith suggested the weakness in global understanding may indicate greater local understanding of perceptual experiences. Navon (1977) said that this recognition of minute details as appose to the seeing the big picture was like, *noticing many trees without the forest*. Frith (1989) suggested that the WCC theory may explain why individuals with autism can show specific skill in areas such as mathematics and music, but can display challenges in relating in the larger social context.

WCC is often measured through how well the individual tests in the completion of visuo-spatial tasks. Studies that compared visual spatial task outcomes between individuals with ASD and typically developing controls indicated consistent results for local bias among the individuals with ASD (Happe, 1999). A number of studies have supported Frith's (1989) counterpoint theory which argued that because individuals with autism have enhanced local processing, global processing might be impaired (Frith & Happe, 1994; Frith, 1989; Mottron, Peretz, & Menard, 2000; Pellicano, Gibson, Maybery, Durkin, & Badcock, 2005; White, O'Rieley, & Frith, 2009). Happe (1999) argued that the WCC theory is not just concerned with the processing visual spatial information, but also at understanding the semantics of verbal information. In other words, individuals with ASD show difficulty processing and understanding meaning in spoken words and phrases.

A limitation of the WCC theory is that it fails to provide a satisfactory working definition of global perceptual processing. The assumption is that if local processing is in tact, a weakened or diminished global processing music indicate a failure of the global system. Within music, however, global processing has been defined as an ability to represent musical contour (rather than individual tones). That is, to perceive chords as a configuration rather than as individual tones, and to be primed by global musical structure. All of these definitions of global music processing have been tested in studies of musically untrained children with autism, and all have failed to observe deficits in global processing. Research has indicated that when musical stimuli were used to test local bias, children with ASD showed intact melodic contour processing, thus indicating working global perception (Heaton, 2005), holistic perception for chords (2005), and typical priming affects on local-global musical tasks (Heaton, 2008).

Mottron and Burrack (2001) proposed an Enhanced Perpetual Functioning (EPF) theory, which suggested a scaffold by which individuals with autism could understand perceptual experiences. This theory was presented as an alternative model to the WCC theory (Frith, 1989). Mottron and Burrack (2001) assessed perception on a series of auditory and visual perception tests that evaluated high and low levels of cognitive tasks. The authors suggested that both higher and lower order perceptual processing is varied among children with autism. In a follow-up study, Mottron and colleagues (2006) suggested a new model of the EFP theory, which identified eight different types of perception among individuals with autism. These perceptual types are designated as ordered thinking, neural region, diagnosis subtype (savant), and perceptual expertise. Findings associated with the EPF expanded the thinking of the WCC model and suggested that individuals with autism are able to show varied perceptual processing which may be dependent upon the stimuli.

When it came identifying melodic contour in music, Heaton (2005) found that children with ASD who had no previous musical training scored just as well when compared to typical controls that completed the same task. Melodic contour was determined by the identification of the direction of pitch in a melodic series. Notably, Heaton (2005) said that the children with ASD showed greater ability than typical learners in pitch discrimination of smaller intervals. Heaton's findings contradicted prior single subject studies that suggested that only children with savant abilities possess a special skill for contour processing (Mottron, Peretz, & Menard, 2000; Heaton, Pring, & Hermelin, 1999a). In a related study, Heaton, Williams, Cummins, and Happe (2008) examined how well children with autism (n=13) and children with AS (n=2) performed on a visuo-spatial pitch matching exercise. Participants were asked to click a computer mouse to move a visual image of a person up and down a set of virtual stairs, which were tuned to a major diatonic scale. Children with autism and AS scored significantly better when compared both to verbal and non-verbal children, and 10% of the children with autism demonstrated a splinter skill for pitch processing. The splinter skill was indicated as the child's ability to show above average skill for pitch identification.

In a similar study, Mottron, Peretz, and Manard (2000) tested how 12 high functioning children with compared to 13 age matched typical controls when asked to identify musical phrases a same or different when they were played. Both groups were equally musically inexperienced. The results indicated that the individuals with autism performed better than the controls when it came to the identification of of melodic changes, which indicated a meaningful function of global perception for music.

In an effort to examine local bias for visual perception, Mottron, Burack, Iarocci, Belleville, and Enns (2003) compared adolescents with HF autism to adolescent controls on a series of visual tasks including: (a) configure processing, (b) rapid perceptual processing, (c) picture dis-embedding, and (d) hierarchal processing tests. The results indicated no significant difference between the groups, which suggested that the individuals with autism did not show a local or global bias when tested with visual stimuli. The authors noted that the neutral result might have been due to the high level of cognitive functioning among the participants with autism. In a related study, Grinter and colleagues (2009) compared how adults with HFA (*n*=26; *M* age=21.76) and adults with LFA (*n*=29; *M* age =21.76) performed on a series of visuo-spatial tasks. Results from the Embedded Figures Test (EFT-Form A), Global Dot Motion test, and Glass pattern (see Glass, 1969) indicated that the HFA group demonstrated higher global processes compared to the LFA group. Thee results supported the suggestion by Mottron and colleagues (2006) who suggested that cognitive functioning levels may play a role in perceptual abilities, as indicated in the EPF theory. In a study that examined visual-spatial processing among artists with autism, Pring, Ryder, Crane, and Hermelin (2010) compared savant artists with both artist and non-artists with autism and learning disabilities, as to how they performed on two versions (meaningful and non-meaningful) of the embedded figures test (EFT) and the block-design task. The results from the tests concluded that there was no significant difference among the groups of individuals on how well they performed in the EFT. Those, however with savant abilities performed better on the block-design test, which may be indicative of poorer global processing among those with non-savant autism. This research supports the notion that savant artists with autism may possess a bias for local visual-motor processing. Yet, it is important to point that that global processing is not required in order to complete the block design test in a coherent format, but in order to complete a work of visual art, global perception may be required.

When examining musical abilities among people with ASD, an important comparison group is individuals with Williams Syndrome (WS). Like those diagnosed with ASD, individuals WS have also been reported to show unique musical interests and abilities. Researchers have been curious to understand if individuals with WS and individuals with ASD possess a similar cognitive and / or neural processing for music. Porter and Coltheart (2006) commented that there was a noted difference among individuals with WS compared to individuals with ASD and Down syndrome when visual spatial testing occurred. The researchers found that individuals with WS and Down syndrome were not able to complete as many of the visual spatial tasks as the individuals with ASD, which indicated weaker global perception among the WS and Down syndrome groups when it came to visual-spatial construction. In relation to music, specifically a contour listening task, Duruelle, Schon, Rondan, and Mancini (2005) studied how 16 children with WS compared to 16 typical children. All of the children were instructed to determine whether or not a melodic pattern was played the same or different when a series of same and different melodies was played back to back. The results indicated that while the typical children showed global perception, demonstrated by their identifying appropriate contour violation, such global perception ability was not present in the individuals with WS (Deruelle, Schon, Rondan, & Mancini, 2005). While both individuals with ASD and WS show unique musical abilities, the global perception for music may not be implicit for those with WS. These testing batteries have helped researchers identify that indeed, the core differences in musical processing between those with WS and ASD is that for those with ASD global processing may be more profound.

Neuroimaging has shown that global and local perceptual processes occur asymmetrically in the brain, with global functioning primarily in the right hemisphere of the brain, and local functioning in the left hemisphere (Martinez et al., 1997; Fink et al., 1997). Various studies have identified hemispheric bias for different kinds of auditory stimuli; some of the most salient studies are displayed in table 1.

Table 1

Hemispheric Specialization for Auditory Processing

Reference	*Left Hemisphere Process*	*Right Hemisphere Process*
Zattore et al. (2002)	Rhythm processing in adults - local	Melody processing in adults
Martinez et al (1997)	Local - adults	Global - adults
Telkemeyer et al (2009)	Speech Rhythm	Speech Prosody
Blackstock (1978)	Music Listening (ASD)	Speech Listening (ASD)
Mottron, Peretz, & Menard (2000)	Local bias for music (high functioning ASD)	Global ability (some deficit) music (high functioning ASD)
Peretz & Kolinsky (1993)	Temporal lobe damage - global integration	Global integration of musical process
Overy et al. (2004)	No hemispheric specialization found in children	No hemispheric specialization found in children

Speech, Language, and Communication

One of the most challenging limitations for an individual with autism is the impairment in communication. All children with autism spectrum disorders are affected in the ability to communicate (American Psychiatric Association [DSM-IV-TR], 2000), particularly those diagnosed with classic autism (Centers for Disease Control, 2011). Johnson (2004) reported that if children with autism develop language, they often lose it. Approximately 40% of all children with autism are non-verbal. Those who do use expressive language often demonstrate atypical prosody, indicated by the stress and rhythm by which speech is intoned. Such prosodic abnormalities are variable and can be influenced by the wide range of intellectual ability or sensory abnormalities (McCann & Peppe, 2003). Meltzoff (1999) suggested that there are four key areas involved in language development: (a) intermodal coordination, (b) imitation, (c) memory, and (d) theory of mind. One suggestion for difficulties with language has to do with poor global visual motor processing, which in effect has to do with sensory processing and plays a role in one's ability to imitate the oral motor actions involved in speech (Blackstock, 1978; Kellerman, Fan, & Gorman, 2005).

Among the skills needed for language development, joint attention or dyadic interaction is critical; it not only plays a role in language function, but also in cognitive and in social development. Joint attention allows one to track objects visually and to utilize appropriate eye gaze and finger pointing. Osterling, Dawson, and Munson (2002) reported that infants who show abnormal eye gaze are often later diagnosed with autism, and that abnormal eye gaze affects dyadic and triadic interactions. However, poor joint attention, abnormal oral-motor imitation, and / or visual-motor integration all may play a role in any childhood speech disorder (Newmeyer et al., 2007); however, abnormal eye gaze affecting that specifically affects joint attention may be a unique predictor or indicator of ASD (Murray et al., 2008; Osterling, Dawson, & Munson, 2002).

While language impairment is a core deficit of ASD, Mayes and Calhoun (2001) said that, “early speech delay may be irrelevant to later childhood functioning and outcome in children with normal intelligence and clinical diagnoses of autism or Asperger’s syndrome” (p. 89). Poor speech development may be indicated by the inability to imitate oral-motor representation. To test this theory, Massaro and Bosseler (2006) used a computerized talking face to find if it would improve vocabulary training for children with autism (*N*=5) aged 8-13. The children were each trained on a set of 24 different vocabulary items. The sessions occurred for 30 minutes each, three days per a week, for two weeks. Results from the pre-test post-test design suggested that children with autism learned more vocabulary words while looking at the computerized face than without it. Investigators commented that the child’s increased learning might be due to memory opportunities aided by the consistency in sound of the computerized voice. The authors of the study pointed out that the distraction-free test environment may have played a role in the result, because the children were not faced with the typical (noisy) environment that they may face in any daily setting. Nevertheless, the study suggested that while visual motor responses may be impaired for children with ASD, auditory motor responses might be intact (Massaro & Bosseler, 2006).

Many individuals with autism have been trained to communicate in ways other than expressive vocal language. Augmentative and alternative communication (AAC) systems are widely used as a means of communication by individuals with ASD.

According to the American Speech-Language-Hearing Association (2011), AAC is defined as the use of a form of communication that excludes oral production. Some examples of AAC include picture symbols, electronic communication devices, American Sign Language (AAC), and / or gestures. A review by Scholosser and Wendt (2008) examined the use of AAC for children with autism and PDD-NOS between 1975 and 2007. The review noted that in most cases AAC helped to increase speech production and did not hinder or replace natural spoken language. A review conducted by Rispoli, Franco, Van der Meer, Lang, and Camargo (2010) suggested that speech-generating devices (SGD), such as text to speak and related talking devices, are viable options to use for non-verbal children with autism; however, their efficacy deserves future research. Nevertheless, AAC has aided many individuals with ASD in the ability to develop a much-desired ability to communicate with their families and friends.

Examples of AAC that utilize electronic speech devices, in conjunction with behavioral therapies have aided non-verbal individuals to express their thoughts and feelings to the speaking world. The documentary film *Autism is a World* told the story of a woman with autism named Sue who was able to write what her life was like a non-verbal person with autism. Sue was able to express her thoughts and feeling by typing on a speak-and-talk device (Wurzburg, 2004). Similarly in the film, *Wretches and Jabberers* (Wurzburg, 2011), two adult men with autism, Tracy and Larry, were able to communicate through typing. Neither Tracy nor Larry was ever given the opportunity to express their world until they began typing in their adulthood. The two men now travel the world meeting other people with autism, and advocating for an understanding of the differences among individuals with autism.

Another young woman with autism Carly Fleishman was not able to communicate her thoughts until she found her voice at age 11 when she began to type her thoughts on a computer. When interviewed by ABC news (2009) Fleishman said that she was "locked inside of a body that she did not know what to do with." When she engaged in self-stimulatory behavior like flapping her arms, she explained that "it's a way to drown out sensory input that overloads us (i.e. those with autism) all at once; we create output to block input." Fleishman also noted "the brains of people with autism are wired different" (Corn, 20090. Autistic adult and animal scientist Temple Grandin suggested that individuals with autism have special abilities and pay specific attention to detail in ways that typically minded individuals do not. Grandin suggested that individuals with autism be given opportunities to use their talents in the sciences and mathematics (Grandin, 2010).

Even though technological advances for AAC and therapy has enabled some individuals with autism a forum to communicate, many individual have yet to uncover a way to "talk" with the speaking world. AAC devices can provide a means of communication for some non-verbal individuals with autism; however, training and behavioral approaches often coincide with learning how to use AAC devices. The responsibility for training how to use AAC falls not only on the children, but also to the caregivers and teachers.

Echolalia

Although 40% of children with autism are considered non-verbal, many show the unique ability for echolalia. Echolalia, an echoing or imitation of speech sounds, is described as the repetition of words or phrases spoken by others and is often the only form of speech for the person with autism (Prizant & Duchan, 1981). The Autism Society of America (2010) reported that 85% of verbal persons with autism exhibit either immediate or delayed / deferred echolalia. Immediate echolalia is the imitation of words or phrases directly after another person speaks them. Delayed or deferred echolalia is the imitation of words or phrases days, weeks, or even months after they have been heard (Prizant, 1983). In Kanner's (1943) case description, he noted that among the 11 children he observed that only eight of the children could express some words, which he described as echoic. Temple Grandin, referred to her expression of echolalia as a "tape recorder" that looped the same phrases over and over again out loud. She said that students in her grade school gave her the nick name "tape recorder" (Grandin, 2006).

Dr. Barry Prizant (1983) is considered an expert on the topic of echolalia and children with ASD. Prizant thought that when deferred or delayed echolalia could have less meaning than for the child with autism than immediate echolalia, and that deferred echolalia could manifest into a perseverative act. Prior to Prizant's research, Kanner (1943) reported both a deferred or immediate echoing of speech sounds and phrases in his first observations of children with autism. Prizant and Duchan (1981) also suggested that immediate echolalia might have implications for the development of functional communication among children with autism. Kanner (1943) suggested that when children engaged in immediate echolalia it seemed to be an expression of affirming what the person was saying.

Prizant and Duchan (1981) conducted the first study to examine a potential functionality of echolalia. In their study they videotaped four children, aged four to nine, over an eight-month period and analyzed the immediate speech utterances that occurred in their home, and school settings. The authors identified seven functional categories of immediate echolalia and six categories for delayed or deferred echolalia. The categories for immediate echolalia included (a) interactive turn taking, (b) declarative, (c) yes-answer, (d) request, (e) non-interactive / non-focused, (f) rehearsal, and (g) self-regulatory. Categories of delayed / deferred echolalia included (a) stereotypic, (b) negativistic, (c) egocentric, (d) time lag, (e) transferred, and (f) mitigated. The authors noted the importance of understanding that for an individual with autism engaged in echolalia, language may not have much meaning and a listener may assume that the child's communication abilities may be seem more sophisticated than they really are. Prizant and Duchan's (1981) findings in deferred and immediate echolalia made an important contribution to the assessment of echolalia among children with autism.

Charlop (1986) conducted a study to assess echolalia when the speech stimuli and environment were changed. For the study she compared how six boys with autism demonstrated immediate echolalia each with a different person, in changing room environments, and with different verbal stimuli. Her analysis revealed that the boys demonstrated echolalia most frequently when presented with unfamiliar stimuli by an unfamiliar person, followed by a familiar person and unfamiliar stimuli. There have not been any follow-up studies to date that have tested echolalia with such changes of stimuli and environment.

The value and meaning of echolalia for children with ASD has been widely debated. Saad and Goldfield (2009) believed that "all verbal autistic individuals go through a period of echolalia" (p. 255) and suggested that when working with children with ASD echolalia should be ignored, because echolalia would not lead to functional speech outcomes. Fay and Butler (1968) believed that there was no relationship between echolalia, intelligence, developmental dichotomy, and / or the auditory motor system and that immediate echolalia had no functional meaning. As an alternative to this thinking, Lovaas (1977) suggested that echolalia was a normal part of the autistic child's language development and may be a helpful indicator for the development of future language abilities. In his work Lovaas thought that if behavioral modification was used in conjunction with echolalia, language could be trained. Lovaas (1981) also reasoned that echolalia might be pleasurable or rewarding to the child and could be utilized to reinforce good behavior. While the functionality of echolalia has debated research toward its use in developing functional language tasks have yet to be employed in large samples.

Memory

The ability for the child with autism to be able to demonstrate delayed echolalia may have to do with memory. Kanner's (1943) early report indicated that children with autism possessed a unique capacity for memory, and thus as an indicator for good cognitive abilities. Boucher and Bowler (2008) found that children with autism demonstrated strong rote memory and encyclopedic memory, yet showed deficit in procedural and episodic memory. When it came to visual memory, Wilkinson, Best, Minshew, and Straus (2010) investigated how well high functioning children and adults with ASD (*n*=34) compared to age matched typically developing individuals (*n* = 25) in how well they were able to recognized faces for memory. Outcomes indicated that both children and adults with ASD were less able to demonstrate memory awareness for faces than typically developing individuals. Lack of face awareness, however, may be due to the global processing required in face recognition (Frith, 1989).

While visual memory may be impaired, auditory stimuli may play a role in the way that individuals with autism memorize information. Heaton (2003) reported that individuals with autism, when compared to typically developing counterparts, possess superior memory for musical pitch; however unique memory abilities may not be ascribed to musical perception alone. In relation to other forms of auditory stimuli, Mottron, Morasse, and Belleville (2001) compared children with HFA (n=14) to age and IQ matched controls (n=14). The children participated in memory tests with three encoding conditions (a) phonologic, (b) semantic, and (c) no-encoding. Among a 15-word stimulus, individuals with ASD scored better on phonological or auditory-based encoding conditions when compared to typically developing individuals. Better phonological and auditory encoding suggested that children with autism might best memorize information when presented through auditory stimuli.

Theory of Mind

Another observation that Kanner (1943) commented upon was the child's deficits in the understanding of feelings and intentions of others. Baron-Cohen, Leslie, and Frith (1985) were the first who referred to the deficits in understanding intentions as a lack of theory of mind (TOM). TOM is often noted as the inability to recognize another's emotions, beliefs, or intentions. TOM is best described by the Sally-Ann test, also known as the false belief test. Typical children are expected to pass this test by age four. In this test an experimenter presents a situation where two girls (Sally and Ann) walk up to a basket. Sally is standing next to the basket when she sees a stone. Sally picks up the stone and puts it in the basket. When Sally goes off to play, the other girl, Ann takes the stone out of the basket and puts it into an adjacent box. The experimenter then asks the child in which container Sally should look for the stone, basket or the box. Choosing the box demonstrated that the child did not understand the intention of the task and was unable to put herself in Ann's shoes. In their initial study, Baron-Cohen and colleagues (1985) found that children with ASD could not pass the Sally-Ann test even if they presented intellectual abilities beyond that of someone their own age. This groundbreaking study hypothesized that the theory of mind would explain many of the symptoms associated with autism. In his famous book *Mindblindness,* Baron-Cohen (1997) suggested that individuals with autism could not detect theory of mind through visual, social, or even auditory stimuli.

Tager-Flusberg (2007), however, suggested that TOM does not explain all of the characteristics associated with ASD, as Baron-Cohen et al. (1985) proposed. Tager-Flusberg (2007) does not negate the problem of TOM, but considers other possible rationales for explaining the core deficits of ASD. Furthermore, Tager-Flusberg (2007) suggested that in some cases children with ASD have been reported to pass the Sally-Ann task.

Emotion

Different than theory of mind, individuals with ASD are limited in their ability to understand and express emotions, a characteristic which can cause individuals to seem non-empathetic (Baron-Cohen, 1985). Neuroimaging has indicated that emotion and of theory of mind encompass different neural processes in the brain, and thus the discussion of emotion must be separated from a discussion of theory of mind (LeDoux, 2000). A review conducted by Molnar-Szakacs and Heaton (2012) reported that while impaired emotion is common among individuals with ASD, research indicates that both children and adults with ASD are able to identify even the most complex emotions when it comes to music. The authors suggested that music might offer a springboard for understanding the noted lack of empathy among individuals with ASD. Along the same lines, Allen and Heaton (2009) however declared that other research has indicated that individuals with ASD are “likely be emotionally unresponsive to music” and are more likely to “respond to the complexity of the music” (p. 251). Allen and Heaton (2009) suggested that since music is able to reach individuals with autism in such a way that music may have clinical implications for both social and emotional development.

More than demonstrating impaired emotion, cases of Alexithymia have been found among individuals with autism (Allen & Heaton, 2009). Alexithymia is term that was first coined by Sifeneos (1972) who ascribed the label to his patients who were unable to express emotions. Sifenoeos said that while the patients could not demonstrate emotional expression somatosensory responses could readily be described. Sifeneos also declared that alexithymia also inhibited the client’s ability to experience imaginative thinking. Heaton and colleagues (2012) reported that the prevalence of alexithymia among individuals with autism is quite high, and often a co-morbid contributor ASD. Bird, Press, and Richardson (2011) suggested that cases of alexithymia among individuals with ASD might make up a select sub-group and that eye gaze may have something to do with it. To test this hypothesis, 13 adults with ASD (without Alexithymia) and 13 adult controls individually sat in a reclining chair in front of a LCD screen 60 cm away. An eye-gaze tracker was placed at the bottom of the LCD screen. The participants were asked to watch four different video clips, two of a news reporter talking and two from a dramatic television series. The participants wore headphones that produced audio from the video clips and the examiners' voice. Results from the eye gaze tracker suggested that individuals with ASD looked at the faces of the people in the video significantly less than did the control group. When a typical person looks at a face, his or her eye gaze is generally directed toward the mouth and eyes. The authors believed that this study would help in the future identification of alexithymia, noted in atypical eye gaze. The research suggested that it is important to differentiate alexithymia from general emotional impairment among individuals with ASD.

In an effort to assess if children with ASD could perceive affect in music, Heaton, Pring, and Hermelin, (1999b) compared children with ASD, children with AS, and typically developing controls (*N* = 14, *M* age = 10 years, 9 months) responded after listing to musical stimuli. The children were asked to choose a schematic face picture – one happy, one sad – after listening to tunes in either major or minor keys. It was presumed that minor keys elicit sad emotions and major keys to elicit happy emotions. The observed result indicated no difference in choosing happy and sad faces in response to music listening between AS and ASD groups and to the controls. These findings indicated that children with ASD and AS were just as able to perceive affect through musical stimuli as typically developing children. In a slightly different study Allen, Heaton, and Hill asked adults with ASD how they responded emotionally to music. Twelve high functioning adults with ASD listened to pop and classical music samples. When asked how the music made them feel, the participants commented that they experienced emotional arousal when listening, but were not able to verbalize the emotion that was felt in the music. The participants were able to describe and recognize changes in their own personal emotional responses. For example, the participants described their response in specific terms such as tension, exhilaration, and calmness, rather than just feelings of happiness, sadness, or frustration.

In another study, Bhatara and colleagues (2010) compared children and adolescents with ASD (*n* = 23) to typically developing controls (*n* = 23), and those with WS (*n* = 11) on how they judged emotion when listening to music. Most of the participants had musical training or some musical influence in their lives. For the experiment, the participants listened to brief samples of Chopin nocturnes adapted into four different versions. The versions were altered with different major and minor keys. Participants were asked to rate how much emotion they felt when hearing the music, rather than judging the music as happy or sad. The participants responded by moving an image on a computer screen across a spectrum labeled "non-emotional" to "very emotional." Results indicated that those who had musical training in both the TD and ASD groups commonly chose the "very emotional" response to the music. When all three groups were compared, it was indicated that the ASD group did not respond the same as the other groups in terms of what was rated as emotional or not. The WS and TD groups showed similar responses, while the ASD group failed to show consistencies in ratings. The authors suggested that individuals with ASD showed impaired understanding of emotion in music. These outcomes contradict the findings of Heaton and Allen (2009) and the suggestions of Molnar-Szakacs and Heaton (2012), who indicated that individuals with ASD could show emotional understanding through music. The outcomes reported by Bhatara and colleagues (2010) could have been due to the lack of control for the visual-motor demands required in moving the computer slide across the spectrum of emotional choice; visual motor tasks can be cumbersome for individuals with autism and thus visual motor demand could have taken away from the focus of the auditory emotional task. Furthermore, the authors did not rule out Alexithymia among the participants. If some of the participants did have Alexithymia, they may not have responded the same as those with out Alexithymia.

Treatment and Intervention

Presently, there is no gold standard treatment to aid in the development of communication and / or manage the behaviors associated with ASD. Due to the heterogeneity of the disorder, treatments are often tailored to each individual and result in wavering success. Interventions range from behavioral techniques and / or combinations of psychotropic medications to specific dietary plans, and / or exclusive therapeutic programs. Children with ASD attend typical education and / or special education classrooms depending on their learning and behavioral needs. A survey conducted by Hess, Morrier, Heflin, and Ivey (2008) found that among 226 children with ASD who attend public school settings (preschool through 12^{th} grade), the most commonly used learning strategies included gentle teaching, sensory integration, social stories, cognitive behavioral modification, and assistive technology. Hess and colleagues (2008) study did not highlight the services that children received from therapists, but rather noted the interventions that are used by classroom teachers and paraprofessionals.

Stephen Shore, an author, professor, and adult with autism, was considered non-verbal as a child, and experts at the time suggested that he be institutionalized. In the documentary film Loving Lamposts, Shore commented that some of the key pieces to his developmental learning were that his parents engaged him with “music, movement, sensory integration, narration, and imitation.” Shore said, “my parents started to imitate me, and once they did that, I became aware of my environment" (Drezner & Silver, 2010). Similarly, adult person with autism Temple Grandin (2006) declared that music and the arts play an important role in her development. Literature has suggested that creative therapies have been successful in allowing children with autism to engage in other languages of expression. Brooke (2009) edited a book that exhibited the use of various creative arts therapies used successfully for children with autism. These therapies included art, music, play, drama, and dance movement therapies (see Brooke, 2009).

A noted therapeutic intervention popular for retraining the complex behaviors associate with autism is known as applied behavioral analysis, also known as ABA therapy. ABA therapy is based on the rules of behaviorism developed by BF Skinner in the 1930s, and has received both acclaim and criticism from parents and caregivers alike. A review conducted by Granpeesheh, Tarbox, and Dixon (2009) concluded that due to all of the evidence-based research that cite positive behavioral changes for children with autism, ABA therapy will be recommended for use for children with ASD. The advancement of ABA therapy is due to the work of Ole Ivar Lovaas (1927-2010) who pioneered the approach and planted the seed of the intervention across the world (Smith & Eikeseth, 2011). While ABA therapy has been able to improve the lives of many children with ASD, various other therapeutic interventions including pharmacological and psychological based treatments have seen success. Nevertheless, due to the heterogeneity of ASD, there is no validity to support a single treatment option.

Music

Cultural and Historical Perspectives

Music is a primal entity in human existence that spans cultures and generations. Anthropologist Stephen Mithen (2006) suggested that music laid the foundation for human social development, cultural strengthening, and evolution of the mind, body, and languages. The antiquity of musical understanding is evidenced by the discovery of 35,000-year-old bird bones that were once carved into tiny flutes. The findings of these ancient musical instruments point to the sophisticated uses of music (and art) in early human history (Mithen, 2006). While music has a rich history in human existence, its origin is widely debated. An essay written by Patel (2010) examined the theoretical views of music's origins, which spanned perspectives from result of Darwinian evolution to suggestions that music was a human invention. Much like the common colloquy, "which came first, the chicken or the egg?" music researchers are often confounded with the inquiry, "which came first, language or music?" Peretz & Zatorre (2005) suggested that the human brain is built for musical processing and that music lights up areas of emotion, perception, memory and other regions of the brain. Patel (2010) pointed out the important role of music in changing human brains – such as in individuals who have lost brain function, yet are able to gain new skills through music (such as music therapy). Thus, Patel suggested that music is a "biologically powerful human intervention," a "transformative technology of the mind…(TTM)" (p. 3). Patel further noted that the importance of TTM is that the importance of music is that its therapeutic applications can have lasting or long-term effects on humans.

Researchers believe that music exists in aspects of every human culture across the globe (Mithen, 2008). Sacks (2007) commented that “Music is part of being human, and there is no human culture in which it is not highly developed or esteemed.” Research into the cognition and perception of musical experiences has widened the spectrum of understanding how musical experiences are understood (Krumhansl, 2000; Peretz & Zatorre, 2005). The musical lexicon includes variations of musical dynamics and timbres. The human brain is capable (in most instances) to perceive such dynamics and timbres, however such perceptual processes can occur both biologically and cognitively different for each individual.

While music encompasses many qualities, the two primary pillars involved in music are melody and rhythm. In the American Heritage Dictionary (2011) melody is defined as, “a pleasing succession of an arrangement of sounds,” and rhythm as “a pattern of musical movement through time.” With regard to understanding the clinical role of rhythm in rehabilitative treatment, Daveson and Skewes (2002) commented that rhythm is a container for which the body becomes organized in movement. Rhythm is a timekeeper and can offer organization to disorganized motor planning or sequencing. For a patient with impaired motor coordination, Sacks (2007) reported that music was able to stimulate a motor response and commented that he (the patient):

> Needs not only the metrical structure of rhythm and the free movement of melody – its contours and trajectories, its ups and downs, its tensions and relaxations – but the ‘will’ and intentionality of music, to allow him to regain the freedom of his own kinetic melody. (p. 258).

Cognition and Perception of Music

Sacks (2007) observed that there is a major drive toward understanding cognitive and perceptual experiences that occur in music. Of particularly interest are the musical experiences that effect rote memory, motor function, emotion, and overall cognitive development. Neuroimaging studies have indicated that typical adults present brain asymmetry for the processing of melody and rhythm; rhythm is indicated with left hemisphere dominance and melody with right hemisphere dominance (Gordon, 1978; Kim, Lambert, Hamm, 2001; Kuck, Grossbach, Bangert & Altenmuller, 2003; Peretz & Zatorre, 2005; Peretz, 2002). Kuck, Grossback, Bangert, and Antenmuller (2003) found that in musically trained adults, rhythmic processes occurred in the left hemisphere; however meter – or musical time keeping - occurred in the right hemisphere, indicated as two separate neural processes for meter and rhythm. The implications for understanding the neural processes for meter versus rhythm can help researchers better analyze how individuals are able to process poly rhythmic sequences. Knowing how individuals process polyrhythmic sequences plays a role in the understanding of higher order thinking and mathematical concepts. It is important to note that the authors of the study commented that the right hemisphere activation may have been due to the musician's imagining the musical score, but the researchers are still convinced with the findings. Alternative to adults, Overy, Norton, Cronin, Winner, and Schlaug (2005) found that children might not show hemispheric dominance for pitch or rhythm. Overy and colleagues used fMRI to measure melodic and rhythmic processes in 33 right-handed, musically naïve children, aged five to seven years. The children were asked to listen to a series of musical tasks while receiving an MRI scan. The scanning revealed that no hemispheric dominance occurred for pitch or rhythm. The authors suggested that hemispheric processing for musical components might develop with age.

Research has historically indicated that auditory processing relies on intact temporal function in the brain. Peretz and Kolinsky (1993) observed that a patient with bi-lateral temporal lobe damage was surprisingly able to perceive music holistically. Neuroimaging revealed that both melody and rhythm were perceived in this patient's brain and that the individual was able to hear music in its complete form, without accessing the typically utilized auditory regions. The authors suggested that music might have the ability to circumvent damaged areas in the brain and be perceived through other brain regions.

A rare auditory anomaly, known as amusia, is known for affecting both a listener's perception of pitch and musical memory. In some cases, certain types of music can be unbearable or even painful to listen to. Peretz, Brattico, Järvenpa, and Tervaniemi (2009), noted that while amusia affects musical perception, it does not impact the way one perceives other auditory stimuli such as non-musical and / or speech sounds. In addition, amusia can affect the perception of melody independently from rhythm and vice versa. Ultimately, it is important to note that musical experiences are unique and divergent for each individual. Furthermore, music can be experienced in brain regions other than the temporal cortex, indicating that music offers a multi-sensory whole brain experience.

Musical and Language

Although there have been differing hypotheses concerning the interplay between music and language, there has been consensus that music and language share several elements. According to Patel, Iverson, and Rosenberg (2006), the elements that include pitch, rhythm, and timbre equally exist in both language and in music. Patel (2011) commented that there is much research to suggest that music affects one's ability to develop language. Thus, he proposed a theory which suggested that music can affect language processing / development when five important components occur. The author referred to this hypothesis through the acronym OPERA, representative of the following five elements:

> 1. Overlap: there is an overlap in the brain networks that process an acoustic feature used in both speech and music. 2. Precision: music places higher demands on the networks than does speech, in terms of the precision of processing. 3. Emotion: the musical activities that engage this network elicit strong positive emotion. 4. Repetition: the musical activities that engage this network are frequently repeated. 5. Attention: the musical activities that engage this network are associated with focused attention. According to the OPERA hypothesis, when these conditions are met neural plasticity drives the networks in question to function with higher precision than needed with ordinary speech communication (Patel, 2010, p. 1-2).

When comparing singing and speaking qualities with two boys with autism, Demaine (2009) observed that over a series of music therapy sessions, the boys with consistently showed singing qualities that were analogous to their speech abilities. Demaine noted that each boy spoke with a unique musical quality. While boy #1 spoke in brief monotones and sang without the use of pitch contour, he was able to imitate rhythmic sequences on the drum and also rhythms with his voice. Alternatively, boy #2 spoke with song-like speech and readily imitated pitches and melodies that were sung in the music therapy session, yet he eliminated virtually all-rhythmic components when he imitated or engaged in musical phrases. Demaine (2009) noted that the divergent qualities in musical expression were analogous to that of the boy's speech expression.

According to Telkemeyer and colleagues (2009), neural processing for sound exists in early infancy and plays a role in the rhythmic and prosodic structures in human language. Trainor, Lee, and Bosnyak (2011) wrote that infants as young as four months old were able not only to identify musical contour but also could identify different musical timbres. Trainor and her colleagues' findings may contradict Overy and colleagues' (2005) suggestion that musical perceptual processing may occur later in life. On the other hand, Zatorre, Berlin, and Penhune (2002), pointed out that hemispheric specialization is a natural development in the human brain, necessary for the perception and cognition all of the natural sounds produced in the environment, not just musical sounds.

For children with ASD musical processing may have unique neurologic underpinnings divergent to speech perception. To examine the potential for musical versus language meaning in the brains of children with autism, Lai and colleagues (2012) tested whether songs would have more influence over speech. Children with ASD (n = 36) and typically developing controls (n = 21) were scanned with fMRI while they listened to personally chosen recorded music with lyrics and recorded phrases spoken by their parents. Neuroimaging indicated that the lyrical songs activated more of the expressive language (Broca's) region of the brain of the child with autism than the speech sounds. These findings support the notion that while language abilities are impaired in children with autism, musical understanding can still be intact, even when the music involves lyrics. Furthermore, Lai and colleagues (2012) findings provide evidence-based outcomes for an intrinsic meaning for music among children with ASD.

Musical Communication

Humans are innately musical, and the way humans communicate encompasses natural musical elements. Malloch and Trevarthen (2009) referred to a human's intrinsic musical interactions as communicative musicality. Malloch (1999) suggested that babies enter into a world of communicative musicality when parents utilize infant directed speech (IDS) – a method of song-like speech - to engage young babies in early acts of social reciprocity and communication. Schachner and Hannon (2011) found that five-month-old infants were able to turn eye gaze toward an adult who engaged in IDS even after the verbal interaction had ended. The eye gaze initiated by the infants may suggest that IDS plays an important role in cueing infants and / or their social and cognitive development. Nakata and Trehub (2011) compared the musical components of IDS when mothers sang to their infants to a non-mothers singing to their selves. Both groups sang the familiar song *Twinkle, Twinkle, Little* Star. Analysis indicated that the mothers who sang IDS utilized higher singing voice and greater modulation of tempo than did the non-mothers who sang to their selves. The authors suggested that the mother's quality of singing might have something to do with her emotional connection to the infant.

Jazz music is a musical genre that relies heavily on musical communication. Jazz music predominantly utilizes improvisation where this is an intricacy of musical dialogue that occurs between the musicians. A jazz performance often originates from a single motif or short melody; musicians then engage in call-and-response phrases with one another. When one musician plays a melody, another responds with a variation of that melody – imitating what was heard and adding a response. These types of musical exchanges have been observed in other musical genres as well: traditional folk songs sung in rounds, gospel singing, folk chants, and traditional classical music where musical variations and themes are built from a motif. Historically, music has shown an innate language or dialogue throughout its development. Furthermore, the training of songs and melodies rely on oral traditions through chant, singing, and imitation. The oral passage of songs has allowed for music to travel the world and to cultivate the phrase "music is a universal language."

Musical communication can also be used in clinical applications. Wigram (2004) described the clinical applications of musical dialoguing in music therapy, where he indicated as a process when a "therapist and client or group of clients communicate through their musical play" (p. 98). Wigram suggested these music therapy dialogues occur in two different ways: 1. "turn-taking dialogue" and 2. "continuous free floating dialogue" (p. 98). He described the musical dialogues that occurred in music therapy as analogous to conversations involved in verbal communications or forms of talk therapy. Wigram and Elefant (2009) cited that such musical dialogues could also be described through turn taking, call-and-response, or musical attunement. Musical communication can be seen as the central element to understanding the inner workings of music therapy. Hans Christian Anderson famously stated, "Where words fail, music speaks." Anderson's expression supports the notion that music, can allow for communication that circumvents typical language restrictions and abilities.

Music Therapy

Music therapy has grown since 1950 into a recognized allied health care profession of trained music therapist who use music as a tool to aide individuals with emotional, social, and cognitive across the life span. Music therapists are trained at bachelor and master degree levels and achieve board certification through Certification Board for Music Therapists (CBMT), and the designation as a board certified music therapist (MT-BC). According to the CBMT there are over 5,000 individuals who hold the MT-BC credential worldwide. Music therapists are trained to work with various populations of all ages, whether their needs are biomedical or psycho-emotional needs. According to the American Music Therapy Association (AMTA) music therapy is defined as "the evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program" (para 1.).

Particularly, music therapy has become an increasingly utilized treatment approach for individuals with ASD. Parents and teachers alike often report significant outcomes when compared to the more commonly utilized modes of therapy such as speech therapy or occupational therapy (Whipple, 2004). The clinical goals in music therapy are non-musical; instead goals are achieved through a client-therapist relationship that focuses on areas including communication, cognition, social, motor, and emotional well being for persons of all ages (American Music Therapy Association, 1999). Bruscia (1998) commented the partnership between therapist and client is central to the music therapy process. The therapist and client work in tandem as a type of contractual agreement to achieve goals facilitated by the client-therapist relationship. For individuals with ASD the goals often encompass the meeting of developmental benchmarks.

For individuals with ASD music therapy services are becoming more a mainstream treatment option (Gold, Wigram, & Elefant, 2010; Reschke-Hernandez, 2011). Whipple (2004) suggested that many models of music therapy have been useful in treating a variety of developmental areas for children with ASD. A commonly recognized music therapy approach for children with autism is the Nordoff-Robbins model, also known as creative music therapy. Creative music therapy utilizes improvised music to engage the child by meeting them where they are at in the moment. In other words, creative music therapy allows the child to lead the flow of the session by showing the therapist their ability to engage in the music making process (Bruscia, 1987; Wigram, 2004). Another music therapy approach known as neurologic music therapy (NMT), uses evidence-based treatment techniques to achieve specific clinical goals. A study conducted by Lim (2010) utilized a neurologic music therapy technique known as developmental speech and language training through music (DSLM) to test effectiveness of the techniques with children with ASD. Fifty-one children with ASD, aged three to five, were divided into four different groups. The groups included (a) DSLM training, (b) music video training, (c) speech video training (no music), and (d) no training. The groups participated in three sessions of their designated training. The results demonstrated that all the children exhibited at least some improvement of speech under all of the conditions; however, the most significant improvement was found in the group who had the DSLM training. Bruscia (1998) however, commented that while children with ASD have found improvement with music therapy treatments, evidenced-based protocols would need to be examined for reliability.

Among the various music therapy models Bruscia (1998) reported that the most common improvisational approaches to music therapy are creative music therapy and analytic music therapy. Table 2 displays the majority of the theoretical approaches used with various individuals in the western music therapy model.

Table 2

Theoretical Approaches to Music Therapy

Theoretical Approach	*Technique*	*Reference*
Creative Music Therapy	Improvised music, client centered	Nordoff & Robbins (1977)
Free Improvisation Music Therapy	Improvisational	Alvin (1975)
Behavioral Music Therapy	Behavioral	Madsen (1981)
The Bonny Method of Guided Imagery and Music	Receptive music therapy	Bonny (1978)
Medical Model (wellness model, biomedical model)	Biomedical, psychodynamic, holistic	Standley (2005)
Neurologic Music Therapy	Evidenced based interventions (i.e. melodic intonation therapy)	Thaut (2002)
Benenzon Music Therapy	Psychoanalytic	Benenzon (1981)
Analytic Music Therapy	Insight process oriented, improvised music	Priestley (1994)
Community Music Therapy	Music with community	Andsell & Palvcelic (2008)

Music Therapy and Autism

"Music contains many levels of structure yet provides variability and flexibility needed to counteract the more rigid characteristics of autism" (Wigram & Gold, 2005, p. 535). In contrast to traditional interventions, music therapy has allowed for successful outcomes for indiviuals with ASD (Gold & Wigram, 2006; Kim, Wigram, & Gold, 2008; Whipple, 2004; Wigram, 2002). Much of the current research using music therapy with autism can be difficult to evaluate, particularly as comorbidity between autism and other disorders is the norm rather than the exception. Kaplan and Steele (2005) suggested comorbidity might limit researchers in achieving large samples of clinically meaningful outcomes. Thus, the fewer variables that are involved in the research, the stronger the likelihood of replication and clinical usability.

Since Kanner (1943) first recognized musical abilities in children with autism, anecdotes have continued to emerge. Wing (1980) observed that many children with autism could sing, even if unable to speak and with a level of precision could verbally replicate melodies and television commercials. Thaut (1998) described how children with autism were able to play music more originally, rhythmically and adhere to temporal rigidity during improvised music making when compared to groups of typically developing and developmentally delayed children. Also, Militerni and colleagues (2002) stated that even though cognitive inflexibility or rigidity is a common characteristic among children with autism, such rigid behaviors seem to dissolve with musical engagement.

In a study conducted by Kim, Wigram, and Gold (2008), children with ASD (*N*=13) aged 3-5 with no previous music therapy experience participated in two different groups (a) 12 week 30 minute improvisational music therapy sessions (b) 12 week, 30 minute play sessions with toys. After each group completed their 12 sessions, participants swapped stimuli to attend 12 sessions of the opposite play or music group. Outcomes revealed that music therapy was more successful than the play sessions at improving joint attention behaviors and non-verbal social communication skills. The most outstanding result was the improvement in joint visual attention skills seen among the children during and after music therapy when compared to the play sessions. This finding is supported by other research that suggested improvised music (musical attunement) resulted in increased spontaneous eye contact and other behavioral improvements (see Bunt, 1994).

Brownell (2002) found that by using music in conjunction with a commonly used intervention known as social stories, children were more able to maintain active attention than without the music, and in turn were better able to prepare and adapt so social situations and reduce anxious behaviors. Along similar lines, Kern, Wakeford, and Aldridge (2007) found that songs could be an effective tool in teaching motor planning tasks for developing daily living skills, such as tooth brushing or hand washing and that song-based intervention could help with preparing children for transition with daily events. In addition, music offered a non-invasive and stimulating medium for the child to maintain attention while learning important tasks. Buday (1995) found that children with ASD were able to imitate more gestures that correspond with spoken words, when a song was added, as opposed to learning words and hand gestures without song; furthermore, children were able to focus more intently and increase appropriate behaviors with the music condition than without.

Watson (1979) reported that instrumental music making and singing could be effective in increasing spontaneous speech and communication in children with autism. Egerton (1994) found that during improvisational music therapy sessions, children with ASD engaged in 107 different communicative interactions, 91 musical, and 16 non-musical acts, far exceeding interactions in traditional settings for this group. Ma, Nagler, and Lee (2001) noted that in music therapy session’s children with autism demonstrated more expressive and receptive language interactions than in simple song activities and that music therapy offered more verbal prompting and musical stimulation than pure singing along groups.

A number of studies have demonstrated the effect of music in achieving social and communicative outcomes for children with autism through music-centered and music therapy techniques (see table 3). The sample size is generally small across studies, all of which have indicated the need for future research with larger participant samples.

Table 3

Music and Autism Research Studies

Reference	*Participants*	*Intervention*	*Goal*	*Outcomes*
Kim, Wigram, & Gold (2009)	10 children with autism, 3-6 y (5 non-verbal)	Music therapy group vs. play therapy group.	Increased joint attention and social reciprocity.	Increased joint attention.
Edgerton (1994)	11 children, age 6-9, with ASD.	10 weeks of improvised music therapy sessions.	Increased communication.	Increased communication
Finnigan & Starr (2010)	One female with ASD, aged 3 yr.	Alternating treatment music therapy vs. play.	Increased social responsiveness.	Increased social responsiveness.
Applebaum, Egel, Koegel, Imhoff (1979)	3 children with ASD, and three typical children.	Imitate with voice, synthesizer, and piano.	Identify imitation abilities.	Children with ASD performed just as well and better than the TD children.
Stephens (2008)	4 children with ASD aged 5-8 y	Repetitive imitation routine through music.	Social imitation.	Spontaneous imitation.
Buday (1994)	10 children with ASD, 4-9 y	Sign and speech with song	Increased speech	Increased speech and attention
Kern, Wakeford, & Aldridge (2007)	1 boy with ASD, aged 3	Embedded song intervention.	Improve self care task	Increased sequential learning and attention to task.
Kern, Wolery, & Aldridge (2007)	2 boys with ASD, aged 3	Embedding song morning routine.	Increase peer interaction.	Improved greeting and peer interaction.
Simpson & Keen (2010)	3 children with ASD	Language training, with picture and embedded song	Verbally label pictures	Increased picture labeling in music condition than with out.
Brownell (2002)	4 verbal boys with ASD	Musically Adapted social stories	Increase appropriate behavior.	Increased attention and reduced anxiety.
Wan et al. (2011)	6 non-verbal children with autism, aged 5-9	Auditory motor mapping training	Increased speech output	8-71% increased speech output

Imitation

Historical and Developmental Perspectives

Imitation plays an important role in cultural, historical, and social perspectives of human development. Equally as important, imitation is essential to the evolution of the human brain (Jones, 2009). Humans naturally tend to mimic one another's posture and sounds as a sign of empathy or understanding. This intrinsic social phenomenon is known as the chameleon effect. It has long been realized that imitation is essential to human social development. The study of imitation became increasingly popular in the 1970s when researchers and psychologists became increasingly interested in examining human development, particularly in children. Rogers (2006) pointed out that researchers have used terms such as mimic, copy, and emulate to describe an infants social behavior. Developmental psychologist, Jean Piaget (1962) highlighted the importance of imitative play in an infant's sensory motor development (cognitive development), which leads to understanding the representation and meaning of objects. With regards to personality development, Erikson (1959) said that during the toddler years when children struggle with autonomy versus shame and doubt, the central process relies on learning through imitation. Bandura (1962) broadened the context of imitation by developing a social learning theory. He suggested that, once actions or behaviors were observed, children could learn social mannerisms by imitating what they've seen. Tomasello, Kruger, and Ratner (1993) suggested that humans, when compared to other animal species, are able to learn through imitation because of their highly evolved abilities of cognition.

Imitation is primal to human development. Meltzoff and Moore (1977) were the first to identify very early imitation abilities observed in newborns. Their seminal investigation found that infants, 12-21 days of age, imitated manual and facial gestures, suggesting an innate human ability to imitate. Meltzoff (1988) later noted the same characteristics in children 14 months to two years of age. While pre-verbal infants are often challenging to study, Meltzoff was able to systematically establish that the precursors in social and communicative developments begin at a very early age.

Autism and Imitation

Various stages in human development rely on the ability to imitate. Without imitation the human ability for social reciprocity, theory of mind, and communication would be impaired (Colombi et al., 2009; Rogers, Young, Cook, Giolzetti, & Ozonoff, 2008; Rogers & Williams, 2006). Rogers and Williams (2006) stated that, "social functions of imitation may not be important or have relevance to children with autism" (p. 62). Wing and Gould (1979) noted that non-verbal children with autism rarely imitated the actions of others. Zachor, Ilanit, and Itzchak (2010) found that children with autism imitated actions better when the act had a functional meaning. For example the researchers found that the children showed better imitation if the examiner was modeling the use of an object versus simply moving without an object. Zachor and colleagues concluded, "Imitation is a complex developmental skill that requires intact motor, cognitive and social abilities. The mechanism that can explain why children with autism have imitation deficits is still an open question" (p. 442).

Nadel and colleagues (2011) used an observational learning design to study how well non-verbal children with autism (n = 20) compared to typical children (n = 20), aged 24-36 months, when asked to complete a sequence of steps to open a latched box. The children observed a live demonstration and video demonstration of a series of steps indicating how to open the box within four testing periods (two videos followed by two live demonstrations). The results showed that the typically developing children learned the sequence at least partially if not fully after two video presentations. The children with ASD learned the sequence either partially or fully by the second live demonstration. These results may suggest that children with autism can learn behaviors by observing the actions of others.

In a study that examined the cooperative performance required for social interactions, Colombi and colleagues (2009) compared children with ASD (*n*= 14) and children with developmental delays (*n*=15). Through a comparison of imitation, joint attention, and understanding of others' intentions, children with autism showed poorer response in imitation and joint attention tasks, which require a higher level of cooperation; however, they responded the same as the other groups in regard to understanding the intentions of others. Rogers, Young, Cook, Giolzetti, and Ozonoff (2008) examined how young children perform in immediate versus deferred imitation tasks by imitating a task directly after it has been modeled versus re-producing the task up to several days later. Participants included children with early onset ASD (*n*=16), children with regressive onset ASD (*n*=20), children with developmental delays (*n*=21), and typically developing children (*n*=20). Children in the immediate imitation condition were first called by name, then prompted to engage with an object after the investigator modeled the task while stating, "do this". In the deferred imitation condition, children were assessed on their engagement with an object 60 minutes after it was originally presented at baseline. The results of Rogers and colleagues (2008) study showed that all groups of children demonstrated poorer performance in the deferred task, which may indicate a need for increased memory required. Among the children with ASD, there was a significantly poorer response regarding immediate imitation, yet deferred imitation responses were equal to that of their peers.

In a related study, Gazebrook, Elliot, and Szatmari (2008) measured how well children with autism process information during task imitation and commented that, "when a person is unable to respond to another's actions in a timely fashion they will miss the positive reinforcement involved with interpersonal interaction," and "the combination of poor movement planning with problems using visual feedback has the potential to impede a developing child's ability to actively explore their physical and social environment" (p. 38). Glazebrook and colleagues (2008) believed that people with autism have difficulty using advanced information when it is of an abstract nature and that concrete instruction when combined with concrete visual images offered the best opportunity for imitation.

Poor imitation may have to do with how well one understands the intentions behind the action. Vanvuchelen, Roeyers, and Weerdt (2007) investigated this hypothesis by comparing how boys with LFA (n = 8), boys with HFA (n = 17), boys with mental retardation (MR) (n=13), and typically developing boys (n = 17) compared when asked to imitate sets of meaningful and non-meaningful gestures. The findings indicated that that the boys with LFA performed significantly worse than typically developing controls in the imitation of both meaningful and non-meaningful gestures. Both groups with ASD showed poorer abilities than the other groups; however, there was no correlation found among intelligence and performance levels. The authors suggested that motor imitation problems are likely common in children with ASD.

With the consideration of severity of autism, Zachor, Ilanit, and Itzchak (2010) examined whether severity of autism in fact played a role in how well a child with autism imitated motor tasks. Twenty-five children with autism participated in the study which indicated that that severity of diagnosis did not play a role in how well the children demonstrated motor imitation and that all children scored well below normal on all motor imitation tasks. Even though, all children scored higher on the imitation of meaningful gestures versus non-meaningful gestures, they still scored below average. A review from Vanvuchelen, Roeyers, and Weerdt (2011a) suggested that poor imitation might be an early indicator for autism; however, the authors noted that not all studies show that imitation is completely impaired in children with autism.

Hobson and Hobson (2008) compared how children with autism (*n* = 16) and IQ matched children with learning disabilities (*n* = 16), aged five to fifteen, and performed on dissociable imitation tasks. The tasks included imitating goal-directed and style-based imitation tasks. The researchers found that while none of the children were able to imitate goal-directed tasks, they differed when imitating a style or nuance of a task, with the autism group scoring lower. The concluding thought is that the diverging imitation qualities among these groups may have to do with how well they share joint attention and social engagement with the person initiating the tasks. With regard to joint attention, Vivanti, Nadig, Ozonoff, and Rogers (2008) compared what children with high functioning autism (*n* = 18) and typical children (*n* = 13), aged 8-15 years, look at when engaging in an imitation task. The participants were asked to imitate non-meaningful and meaningful gestures performed by a live demonstrator. Motor assessment and eye tracking imitation evaluation revealed that children with autism looked less at the face of the model than typically developing children, and those who demonstrated greater eye tracking of the action showed better imitation. The authors suggested that visual attention might indicate how well an action is imitated. Variables such as the use of a live demonstrator, the cognitive abilities of the children, and the personal meaning of the acts may have played a role in the outcome of this study.

Sevlever and Gillis (2010) commented that among the literature there is "conflicting theoretical explanations of imitative difficulties" (p. 976). When it comes to measuring imitation, the "extent of imitative difficulties in children with autism remains largely unknown" (p. 977). The authors reviewed a series of studies that tested imitation abilities among children with autism and pointed out that because of the variability in diagnosis, the definition of imitation is often subjectively defined in relation to autism, and suggested that defining a form of "true imitation" to offer a baseline for which all imitation research is measured; which at presently does not exist.

Musical Imitation

While imitation for motor tasks may be more impaired than not, when it comes to individuals with ASD, music may allow an opportunity to tap into imitation abilities. Applebaum and colleagues (1979) conducted the first study to measure musical imitation in children with autism. Six children matched by age, three typically developing and three with autism, were tested for their abilities to imitate individual as well as a series of tones produced by voice, piano and synthesizer. None of the children with ASD had received any musical training, though all of the typically developing children were reported to have a high level of musical ability. A test consisting of 20 levels of increasing difficulty began with single pitches and proceeded to sets of four tones in an atonal configuration. During each of the levels and example was played, followed by two variations; the variation involved changes in timbre, duration, pitch order or changes / additions in pitch. For each level, the examples were each given in a different mode: voice, piano, or synthesizer. Each participant was asked to listen to the example and variations, and then imitate the original example. Scoring was done on a scale of 0-5 and was based on accuracy of pitch, rhythm, and duration. The results showed that the child with autism scored just as well, if not better, than their musically trained, age-matched counterparts on 62% of the trials. The outcomes of the study showed that children with ASD might possess a special ability for pitch discrimination and musical memory. This investigation was also one of the first to indicate that children with ASD may possess a special ability for pitch discrimination and musical memory.

With the use of improvised music, Stephens (2008) used a multiple probe design to observed how four children with mild-moderate autism (two boys and two girls, aged 5-8 years-old), spontaneously imitated dancing, singing, and instrumental play compared to a series of one-on-one music play sessions. The goal of the study was not to analyze imitation but to use imitation as a tool to assess level of social interaction. Analysis indicated that the frequency of spontaneous imitations increased during the session. The author suggested developing an imitation procedure to allow for formal training of imitation skills and noted that children with autism respond well when engaged in reciprocal sharing activities.

The Mirror Neuron System

When considering the role of imitation in humans, Ramachandran (2000) suggested that the topic of mirror neuron system has been in the forefront. First brought to the attention of researchers in Parma, Italy, a special set of neurons, referred to as "mirror neurons" were noticed in the brain of a macaque monkey. Utilizing a single cell measurement system, which was embedded in the motor cortex of the monkey's brain, researchers were able to assess if and when the monkey's motor neurons fired as the monkey engaged in a motor act. Once this neural activation was recognized, the investigator, mainly by good luck, began to notice the same firing occurred, when the monkey saw the investigator completing an action and later when an action was heard. Neural firing occurred in the motor cortex of the monkey, even tough it just heard or saw the actions (di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992). Research has suggested that a homologous system may exist in the inferior parietal cortex and premotor cortex of humans (Fadiga, Fogassi, Pavesi, & Rizzolatti, 1995), indicated as the putative human mirror neuron system (pMNS). These cortices have been known to be responsible for pre-motor acts, empathy, and intentional understanding. Since individuals with autism show impairment in motor imitation responses, and mentally imagining the thoughts of possible actions of others, much attention has been given to understanding the role of the mirror neuron system among individuals with ASD. Often referred to as 'broken mirrors,' researchers have speculated that an impaired mirror neuron system may provide an explanation for problems with theory of mind, empathy, social acuity, imitation, and communication abilities among children with autism (Depretto et al., 2006; Martineau, Andersson, Barthélémy, Cottier, Destrieux, 2010; Oberman & Ramachandran, 2007; Williams, Whitten, Suddendorf, & Perrett, 2001). Ramachadran (2000) believed that "Mirror Neurons will do for psychology what DNA did for biology" (para. 1). Given the lack of validity for the existence of a human mirror neuron system, Ramanchadran's statement has ignited a topic for debate. Since that the biology of the macaque monkey is similar to that of human DNA, it is only suggested that the homologous brain regions exist in humans. The pMNS is not yet validated because of the invasive procedure required to measure single cell firing in the live human brain, yet its existence is assumed.

Auditory-Motor Action

The theory of the pMNS in humans is recognized throughout current behavioral imitation and neuroimaging literature. Studies examining the pMNS regularly consider the notion of action potential between the auditory-motor and visual-motor feedback loops in the brain. A popular discussion suggests that mirror neurons may be responsible for the reason why humans yawn when others yawn; this action is called 'contagious yawning.' In one study adults were asked to listen to yawning sounds while lying in an MRI. Imaging revealed that the area, which may involve the pMNS, was activated during hearing trials (Arnott, Singhal, & Goodale, 2009). Alternatively, a behavioral study that looked at imitative yawning among children with autism (n = 25) and typically developing children (n = 25), yielded divergent results. While all children yawned at some point during the study, typically developing children yawned significantly more. The authors pointed out that a lack of yawning among typical children in groups does not indicate a diagnosis of autism. Millen and Anderson (2010) found that infants did not yawn when their parents yawned and suggested that imitative yawning may develop sometime during childhood.

In a study that investigated action potential with musical sounds, Lahav and colleagues (2007) used fMRI to observe the neural activity of typical adults in listening to trained and untrained piano melodies. In one week's time, a group of adults with no previous musical instruction were taught short five-note melodies on the piano. While in an MRI scanner the participants listened to (a) learned melodies, (b) different melodies but in the same key and, (c) similar melodies in a different key. The investigators found that simply listening to any of the melodies activated Wierneke's area (listening and/or processing); which is responsible for receptive language, in addition to Broca's area (doing), which is responsible for expressive language. This activation highlights a connection between the auditory and motor pathways in the left hemisphere of the brain, known as the arcuate fasciculus (AF). While some activation occurred in all listening examples, the strongest activation occurred when listening to the trained melodies, particularly in the Broca's region. During the alternative melodies, greater activation occurred in Wiernecke's area and little in the Broca's area. Activation in these brain regions indicated that even when simply listening to the trained melodies or a variation of the melody, the brain either behaved as if it were playing the melodies or as if they were trying to be made sense of. Various research studies have indicated that the simple use of understanding semantics can activate action potential in the brain. Functional imaging has revealed that simply by saying or even thinking such phrases as 'grasp the concept,' or to 'costs an arm and a leg,' stimulates auditory actions in the somatosensory regions (Aziz-Zedeh & Damasio, 2008).

With the notion that music could stimulate auditory-action in the brain, Wan and colleagues (2010) proposed a tool called "auditory-motor mapping training" (AMMT) to help children with autism learn language through singing. AMMT protocol is similar to a speech training tool known as Melodic Intonation Therapy (MIT) first designed by

Sparks and Holland in 1976, to re-train speech through singing for individuals with non-fluent aphasia. Wan and colleagues (2010) suggested that music might otherwise engage an impaired imitation system in the brain, which the authors referred to as the putative human mirror neuron system (pMNS) which is suggested to be an underlying caused for poor imitation abilities. In a follow up, Wan and colleagues (2011) published a "proof of concept" study, showing the effectiveness of AMMT with six non-verbal children aged 5-9 diagnosed with autism. Each child received 45 minute AMMT sessions over eight weeks. AAMT involved one-on-one sessions that used imitation and repetition of sung words and phrases to help train language. As a result the children's ability to speak short words and phrases increased from 0% to between 8% and 71%. The authors attributed singing the phrases to the child's ability to develop new language.

Neural Theories of Autism

Depretto and colleagues (2006) have suggested that a broken or faulty mirror neuron system may be responsible the common impairments associated with ASD, designated as the "broken mirror theory". The basis mirror neuron system will be discussed later in this literature review. In the first study to use fMRI to examine such action potential among children with autism, ten children with HFA (*M* age =12) and ten typically developing children (*M* age =12), were presented with visual stimuli magnet compatible goggles. The stimuli were comprised of 80 human faces expressing 5 different emotions: anger, fear, happiness, neutrality, and sadness. Expressions were random in order and separated by blank screens to increase statistical efficiency. In two different trials, participants were first asked to imitate the facial expressions, and second to simply look at the expression. Imaging revealed that typically developing children had extensive bi-lateral activation of the mirror neuron system (MNS) during emotional expression imitation. In contrast children with ASD showed more activity than the typical children in left anterior parietal and right visual areas as well as robust activity in primary motor and pre-motor areas during the imitation task only. The activation of these brain regions signifies a motor response as the individual was imitating the face. All participants showed more activation in the left anterior parietal and visual areas as well as the motor and pre motor areas during imitation tasks; however, the area known as the putative human mirror neuron system were not engaged in the individuals with ASD. Lack of activation in the pMNS regions indicated that perhaps the emotional significance of the facial expression was not experienced and suggested a cause of the core of social deficits observed in autism. Typically developing children can rely on the supposed MNS to connect to the limbic system to engage emotional understanding through the amygdale, however, for the children with autism, this interaction was simply not observed (Depretto et al., 2006).

Hamilton, Brindley, and Frith (2007) argued that the mirror neuron system explanation might not account for all of the deficits in autism. While the theory has gained momentum among caregivers and scientific groups alike, Southgage and Hamilton (2008) commented that “imitation is more than just mirroring… but requires several different cognitive processes,” (p. 225) thus the mirror neuron theory cannot be the key to understanding the core deficits of the disorder. There remains to be no clear understanding to the cause of autism or the definitive existence of the mirror neuron system. Hickok (2010) disputed the claim that the mirror neuron system is responsible for actions related to speech production and language semantics and suggested that the sensory-motor action networks make up much of the processes involved in speech output and processing of word semantics.

Meltzoff and Decety (2003) suggested that imitation might be the missing link between the putative human mirror neuron system and theory of mind; without the MNS imitation would not exist. It is believed that monkeys (who have the MNS) do not possess theory of mind; however "through imitating others, the human young come to understand that others not only share behavioral states, but are 'like me' in deeper ways as well" (Meltzoff & Decety, 2003, p. 491). Molnar-Szakacs and colleagues (2009) noted that while children with ASD show impaired imitation and understanding of emotions, research in music as a clinical intervention has been stimulate such abilities. Thus, the authors suggested that music might have the ability to circumvent the compilations that may be associated with the broken mirrors theory, and thus allow for an opportunity to develop the skills that are often complicated by poor imitation abilities.

Summary of the Literature

The neurodevelopmental disorder known as ASD has reached global epidemic standards affecting 1 out of every 88 children in the United States (Centers for Disease Control, 2012). Poor imitation abilities likely play a key underlying factor for the core characteristics that mark the diagnosis of ASD. With out the ability for imitation children with autism are not able to develop the important steps for communication and social development. Lack of communication between a person with autism and the community at large only widens the gap in understanding the people with the disorder.

Often the only mode of verbal speech among individuals with ASD is echolalia. Historically, echolalia has been deemed a non-meaningful form of verbal imitation.

Nearly 85% of children with autism demonstrate echolalia at some point (Autism Society of America, 2011). Research has suggested that echolalia is beneficial to language development (Prizant & Duchan, 1981) while others view it as a nonfunctional symptom of the diagnosis (Fay & Butler, 1968).

Increased diagnosis among familial lines has suggested that autism may be prone to genetic susceptibility. Research indicating enlarged brains and more neural activity in the pre-frontal cortex found in individuals with ASD may explain the dysfunctions in cognition, imitation, impulse control that children with ASD have (Herbert, 2005). These dysfunctions complicate opportunities for communication and social modeling.

Children with autism can reportedly sing when unable to speak (Wing, 1980), and singing can stimulate auditory-motor action between the temporal and pre-frontal cortex in the brains of children with ASD (Wan et al., 2010; 2011). A relationship between autism and music has been evident since autism was first diagnosed (Asperger, 1944; Kanner, 1943). Musical abilities in the areas of perception, musical memory, and performance have been noted among individuals with autism spectrum disorders (Applebaum et al., 1979; Demaine, 2009; Heaton, Pring, & Hermelin, 1999a; Mottron, Peretz, & Menard, 2000; Heaton, 2005; 2003; Thaut, 1989). Music may be more intrinsically meaningful than language for individuals with autism (Lai, 2011), which has allowed music therapy to serve as an important clinical tool for these children (Wigram, 2004). Music therapy has helped in the development of areas such as communication and sensory integration that cannot be reached through traditional forms of therapy (Heaton, Pring, & Hermelin, 1999b; Kaplan & Steele, 2005; Kim, Wigram & Gold, 2008; Wigram & Gold, 2005; Whipple, 2004). Music allows children with autism to engage in interactions that encourage reciprocity and pre-language skills such as musical dialoging and call and response activities often found in music therapy practices (Bruscia, 1987; Thaut, 1989; Wigram, 2004).

While research has indicated that the neurologic underpinnings of autism show an inability to mirror or imitation and understand meaning in another persons interactions through visual stimuli (Depretto et al., 2006; Martineau, Andersson, Barthélémy, Cottier, & Destrieux, 2010; Oberman, & Ramachandran, 2007; Williams, Whitten, Suddendorf, & Perrett, 2001), music may provide a key to circumvent and / or remediate abnormal perceptual and cognitive processing (Wan et al., 2010; 2011). Music is able to engage various regions of the sensory motor cortex (Lahav, Saltzman, & Schlaug, 2007; Peretz, 2002; Peretz & Kolinsky, 1993; Zatorre et al, 2002), and stimulate the auditory feedback loop (Lahav, Saltzman, & Schlaug, 2007), important in seeing / hearing and doing tasks. Since children with autism are able to process musical stimuli better than other forms of auditory stimuli (Kellerman, Fan, & Gorman, 2005), and since the components of prosody (pitch) and rhythm exist both in music and in language (Patel, Iverson & Rosenberg, 2006; Patel, 2008; Telkemeyer et al., 2009), music may offer an important link to language development for the child with ASD (Finnigan & Star, 2010; Kim, Wigram, and Gold, 2009; Wan et al., 2010; 2011; Whipple 2004).

This literature review has laid the foundation for the research study to be described in chapter 3. Chapter three will detail the methods used in identifying musical imitation among non-verbal children diagnosed with classic autism. While nearly 40% of individuals with ASD never fully develop any language at all, the remaining individuals often are challenged in using language as a means of communicative expression. Since music has shown improvement for children with ASD in developing in cognitive, communicative, and social domains (Wigram, 2004; Whipple, 2004), and since echolalia may have the potential for functional outcomes (Prizant & Duchan, 1981; Prizant, 1983); the utilization of music to encourage imitation as a form of functional echolalia may result in more socially engaged effects.

CHAPTER 3

Methods

This current study observed how non-verbal children diagnosed with classic autism imitated improvised musical phrases produced live by an investigator, who was a board-certified music therapist. The observation occurred from a single one-on-one music therapy session that employed live improvised music. The goals were to (a) identify how non-verbal children with autism imitated music, (b) identify types of musical echolalia produced by non-verbal children with autism that expand upon the findings of a pilot study produced by this author, (c) develop a coding system for accurately measuring frequency and duration of musical echolalia during an observational period, and (d) identify social responses that occurred in response to musical echolalia.

This study defined and measured the term “musical echolalia.” The author hypothesized that occurrences of musical echolalia could lead to functional social responses that could serve as precursors for communication and / or socialization. While speech echolalia is noted as a form of imitation among children with autism, it often does not lead to functional communicative and /or social outcomes. This author is hopeful that the term musical echolalia may be added to an autism and / or musical lexicon. Much like braille, which offers people with visual impairment an enhanced opportunity to communicate functionally, music may also be capable of providing improved functional communication for individuals with autism (Demaine, 2009).

Twelve non-verbal children (aged 4-8 years) diagnosed with autism were recruited to participate in this research study. Data from three of the children (child #1, #2, and #3) who participated in the pilot study that preceded this current study was included in this current study. The procedures and data collected from the pilot study were identical to the methods used in this current study. Nine new children were included to increase the sample size of this current study. Each child participated in a one-time individual music therapy session that utilized improvised music techniques. This investigator hypothesized that non-verbal children with autism would imitate musical phrases or examples produced by the investigator and that the interaction would lead to functional social outcomes.

Participants

This exploratory study was the first of its kind to research musical echolalia among non-verbal children with autism. Participants included 12 non-verbal children diagnosed with classic autism, aged 4-8 (six boys and six girls, M = 5.66 years, SD = 0.47). All participants were recruited through an email advertisement (see Appendix A) distributed by the Autism Support Center and sent to hundreds of families within the Northern New England region. Rather than random sampling of children with ASD the investigator that in order to maximize the possibility of musical engagement the study would target children who enjoyed music. The email advertisement for this study requested responses from families with non-verbal children, aged four to eleven, diagnosed with autism, who enjoyed music, and could participate in a single music therapy session August 22 - September 6, 2011. Those interested were asked to reply within four-weeks after receiving the email. Attrition from the initial respondents (N = 32) was because of eligibility exclusions including motor limitations, co-morbidity, seizure disorder, functional verbal abilities, visual or hearing impairments, previous musical training, and / or previous music therapy experience, travel limitations, and inability to participate on the allocated session dates and / or location. Among the eligible candidates, four potential participants cancelled on their scheduled day citing scheduling conflicts. All of the participants met the diagnostic criteria for autism (American Psychiatric Association [DSM-IV-TR], 2000) and had been previously diagnosed by an outside professional expert. The "non-verbal" criteria were defined by the child's inability to produce meaningful expressive verbal language as reported by their parents.

One parent for each child provided written informed consent, and each child non-verbally provided assent by showing engagement in the music. It was assumed that the children seemed engaged in the music when they began to independently play or sing with a musical instrument or musical sound. Before each session, parents were informed that if their child showed extreme distress or an eagerness to leave the session, the investigator would walk with the child to the waiting room to meet his or her parent. The Lesley University Institutional Review Board approved all facets of this study.

Settings and Materials

The music therapy session took place in a large conference room at the Autism Support Center. Some of the parents and children had received support services from the Autism Support Center prior to this study, but none had ever participated in music therapy or had any previous familiarity with the investigator. Parents were asked to schedule a 45-minute time block (between 10:00 am and 5:00 pm) to allow for an optimum level of participation for their child. Since the sessions occurred in mid-August, families were not bound to a typical school day schedule. The sessions were provided by the investigator, who is a board certified music therapist, with over 12 years of clinical experience using music therapy as an intervention to treat the communicative and social limitations of children diagnosed with autism spectrum disorders. The procedure room, where the music therapy sessions took place, used non-florescent overhead lighting and had no windows. The room contained several folding chairs and two folding tables. Two folding chairs were set up in the mid-point of the room near a long folding table, and the remaining chairs were stacked in a corner of the room. The folding table was placed next to the wall and two chairs stood in front. The orientation of the procedure room is illustrated in figure 1. Various musical instruments and a bag of colored scarves were laid on the table which stood at a fixed height of 25" which allowed all of the children ability to reach and see the instruments. The musical materials included four rhythm sticks, one cabasa, one thunder tube, four jingle bell bracelets, four chickita shakers, two soft mallets, two paddle drums (head size, 10 and 12 inches), one 10 inch tambourine, one 12 inch ocean drum, and six colorful scarves (see figure 2). Placed on the floor approximately one foot from the table were three tubano drums (head size, 10, 12 and 14 inches), and one ¾ sized acoustic guitar.

Figure 1. Orientation of Procedure Room

Figure 2. Percussion Instruments and Scarves

Each session was videotaped using a Sony HD digital video camera and 8mm, digital videotapes. The camera was positioned on a tri-pod against at wall and facing out to the procedure space to allow for optimal reviewing for coding of each child's behavior.

Procedure

On the day of the scheduled music therapy session, each child and parent(s) were invited to walk through the procedure room before the session started. Once each child appeared acclimated to the space (i.e., touching musical instruments and / or exploring the room independently), the parent(s) left the room and stayed in an adjacent waiting room until the music therapy session was finished. While in the waiting room, the parents were asked to complete a questionnaire that requested information regarding their child's familial background, developmental history, and current treatments and / or therapies (see Appendix B).

Music Therapy Session Structure

The music therapy session involved 15-25 minutes of active music making. The length of the session was determined by the child's level of interest and desire to stay in the room, but was restricted to 30 minutes total in length. Each session included a loose structure that incorporated the following elements: (a) greeting chant, (b) improvised singing and instrumental playing, (c) two pre-determined familiar songs, and (d) goodbye chant. The pre-determined songs "*Happy Birthday to You*" and "*Twinkle, Twinkle Little Star,"* were played by the investigator during the session but were not included as part of the observational period. The observational period strictly focused on element (b) of the session – the improvised music – noted as the musical stimuli. With the exclusion of the other session elements, the observational period ranged from 11.45 min – 19.25 min (*M* = 15.35, SD = 5.51).

Determining Musical Stimuli

All of the musical stimuli presented during the observational period was in the form of improvised music. The investigator initiated the stimuli in response to the child's actions, vocalizations, and / or instrumental play. For example, if the child began to run around the room at a fast tempo, the investigator played the drum at the same tempo; on the other hand, if the child began to sing and shake the maracas, the investigator imitated his / or her behavior. These types of imitative interactions are typical of an improvised music therapy session.

The investigator expressed three different types of musical stimuli: (a) voice only, (b) instrument only, and / or (c) voice and instrument simultaneously. When voice was used, the pitch origins were determined by the child's natural vocal intonations. Melodies were sung from a five-note-pentatonic scale and began with two pitches and little melodic contour; for example, the investigator sang the pitches do, do, me, or do, mi, do – using the syllable "ma" or "ah." As the duration of an interaction increased, the complexity of the music was augmented by larger melodic intervals – up to a perfect fifth (do to sol), as well as more diverse rhythmic structures. Instrumental play occurred in a similar fashion. Instrumental stimuli were initially presented with a brief ostinato tempo, and if the interaction progressed, rhythmic structure and syncopation were added.

Definition of Terms

While the term musical echolalia might possibly exist prior to this study, a literature search by this author has not yielded any conclusive indication of the term as named. For the purpose of this study, musical echolalia was defined as the demonstration of immediate, relative imitation of pitch, melody, or rhythm sequence from a musical phrase performed through vocal, instrumental, or physical expression. Musical echolalia does not include non-musical utterances or noises such as echoic or imitative speech sounds or unrelated motor movements. The literature review uncovered other types of musical exchanges that have been reported in the context of music therapy among children with autism and other developmental disabilities, but to current date the term musical echolalia seems yet to be coined in the literature. It is important to note that while deferred musical echolalia likely exists, this study focused on the use of immediate musical echolalia. Alternative to speech echolalia, musical echolalia may offer a meaningful and usable medium for communication.

Terms such as “musical exchange,” “communicative musicality,” or “musical dialogue,” and techniques such as turn taking, mirroring, or call-and-response as noted in the literature review has helped to identify the need for the term musical echolalia as term specific to the autism lexicon. This research study in essence will build upon a pre-existing skill (musical echolalia) and observe how it occurred. This current research study hypothesized that musical echolalia is different than other forms of musical exchanges outlined in related music therapy research. Specifically, during musical echolalia, the children are naturally imitating without any prompting and without the purpose of achieving a specific clinical goal.

This study required that all participants be non-verbal. Non-verbal meant that each child had no functional use of expressive language. Lack of functional language could have ranged from the ability to express some single words or word approximations to having no language or verbal expression at all.

Coding and Scoring

After the music therapy sessions, the videotaped recordings were digitized and viewed on a laptop computer. The investigator transcribed each session in narrative format, noting the session process, behavioral interactions between the child and the investigator, and the duration of the session. Once the narrative module was complete, the investigator viewed the videos a second time to note the musical stimuli that was used, occurrences of musical echolalia, and the social outcomes.

Coding Musical Stimuli

Musical stimuli presented by the investigator were documented on a hand-written chart. Each instance of musical stimuli was coded. Musical stimuli were coded as voice, instrument, or both voice and instrument. For example, if the investigator played two beats on the drum for musical stimuli #1, the word "instrument" was written in the box labeled "stimuli #1." Musical stimuli that received an ongoing imitative response from the child was recorded as only one presentation of stimuli, otherwise each new presentation of musical stimuli was documented, whether or not the child showed a musical or non-musical response.

Coding Musical Echolalia

The initial process of viewing the music therapy sessions made it clear to the investigator that musical echolalia was not something that could be measured for holistic accuracy, but only for accuracy of imitation of specific musical elements. Responses that were not deemed acts of musical echolalia, such as non-musical sounds or speech utterances, were not recorded. Thus, only acts that were imitative of a musical component, such as pitch or rhythm were noted. Following this method of measurement, musical echolalia emerged as hearing specific types; these types were described the use of pitch, and / or rhythm imitation with voice, musical instrument, and / or physical movement. For example, if the musical stimulus was presented as two beats on a drum and the child played two beats on the drum, musical echolalia would be recorded on a hand-written sheet as "rhythm and instrument." Alternatively, if the child responded by singing two beats, "la, la", imitative of the rhythmic structure of the drum, then the musical echolalia would be documented as "rhythm and voice." If the child did not respond musically (i.e. ran away) or responded musically in a way that was not imitative of the musical stimuli, the musical echolalia response would be kept blank on the chart. Each type of musical echolalia was assigned an acronym that reflected the names of the musical elements that were involved. Musical echolalia was also recorded for duration as some of the musical echolalia lasted for several back and forth interactions between the child and investigator.

Coding Social Responses

Social responses were recorded on the coding chart only after musical echolalia occurred. In other words, if musical echolalia did not occur, then social responses were not recorded. After social responses were recorded on the chart, they were categorized as "appropriate" social responses and "inappropriate". Appropriate social responses were those that allowed for continued meaningful and functional social engagement, such as shared visual attention, socially appropriate affective responses, or continued attention to task. Inappropriate social responses were those that did not lead to any meaningful social interaction, such as atypical manipulation of the musical instrument, or non-shared musical interactions.

Methods of Analysis

Analysis of musical stimuli, types of musical echolalia, social responses and possible associations between ages and genders were considered. Musical stimuli were tallied for each session by stimuli type and for overall occurrences. Similarly, musical echolalia was tallied for overall occurrences by each child and by specific type of musical echolalia. *Frequency scores* for musical echolalia were measured by tallying the number of musical echolalia that occurred for each child during their observation period and then were divided by the number of musical stimuli that were produced initially by the investigator. The duration of each musical echolalia was also recorded. *Duration scores* were measured by dividing the duration of sum of the musical echolalia acts that occurred by the total observational period of time for each individual child.

Only social responses that occurred after musical echolalia were tallied and categorized as appropriate or inappropriate. Descriptions of social responses and their potential relationship to potential social inclinations were discussed. Descriptive statistics and repeated measures analysis of variance (ANOVA) were used to examine for possible trends in the data. Because of the exploratory nature of this study, results are interpreted with caution.

Inter-Rater Reliability

In order to establish inter-rater reliability, 50 percent of the music therapy session videos were randomly selected and rated by two independent raters. The investigator, who was also the primary coder, trained the raters. Both raters were musically trained undergraduate college students who majored in expressive arts therapy, and were able to identify pitch and rhythm in music. The raters were trained how to code the materials by watching one of the recorded sessions with the primary coder. The primary coder demonstrated how to record musical stimuli, clock time, identify musical echolalia, and social responses and record these elements on the inter-rater reliability transcription form (see appendix C). This form was developed in response to the initial coding completed by the investigator, initially done free hand on a self-designed chart.

The raters were trained on a video that was not used as part of the inter-rater results. The primary coder instructed the raters to identify if voice, instrument, or both instrument and voice were used as musical stimuli and to note the clock time on the video. The primary coder then read the working definition for musical echolalia and asked the raters to note how the child imitated the musical stimuli either with voice, body, instrument, pitch, rhythm, and / or none (written as a dash "-"). The raters were then asked to note if the child demonstrated a social response, but only after the musical echolalia occurred. The primary coder showed examples of social responses from the video. Finally, the raters were asked to note only the improvised musical stimuli and improvised musical echolalia and to ignore pre-composed songs, the hello chant, and the goodbye chant. Thus the raters were encouraged to focus only on the improvised music between the investigator and the child, and to filter out the other elements of the session. The training session lasted for approximately one hour with the raters asking questions and practicing a demonstration of their knowledge of how to identify musical stimuli and musical echolalia.

The raters were randomly assigned three videos and were asked to complete the inter-rater reliability transcription form for each video. Each video took the rater between one to two hours to complete coding, culminating a six hour session that occurred in one day. The raters viewed the videos on two of the investigator's laptop computers. After the raters completed their coding, they were asked to tally up the number of same type of musical stimuli and same type of musical echolalia and write the sum at the bottom of their transcription form.

Inter-rater reliability for the musical stimuli produced in each music therapy session was analyzed for 50% of the data. Rater agreement for musical stimuli ranged between 65% and 85%. Rater agreement for musical stimuli is presented on table 4.

Table 4

Inter-rater Reliability of Musical Stimuli

Musical stimuli	*Percentage of agreement*
Voice only	67%
Instrument only	83%
Voice and instrument	83%
Total stimuli	50%

Inter-rater reliability for the musical echolalia types produced by each child was analyzed for 50% of the data. Rater agreement for musical echolalia types ranged from 85% to 100%. Rater agreement for musical echolalia is displayed on table 5.

Table 5

Inter-Rater Reliability for Musical Echolalia Types

Musical Echolalia	*Percentage of agreement*
Pitch with voice only (POV)	83%
Rhythm only with voice (ROV)	83%
Pitch and rhythm with voice (PRV)	100%
Rhythm with instrument only (RIO)	100%
Pitch and rhythm with instrument and voice (PRIV)	85%
Rhythm with body movement (RB)	100%
Rhythm with body and voice (RBV)	100%
Total Stimuli	50%

CHAPTER 4

Results

This research study explored the phenomenon coined, musical echolalia among 12 non-verbal children with autism. Among this group seven different types of musical echolalia were identified. Descriptive statistics and repeated measures analysis of variance (ANOVA) were used to analyze musical stimuli, musical echolalia, and each child's social responses that followed musical echolalia. Inferential statistics were used to investigate potential trends in the data. Because of to the sample size and the exploratory nature of this study however, the results are interpreted with caution.

Characteristics of Participants

Parents completed a two-page questionnaire regarding the familial background, developmental history, and current therapies for their child (see Appendix B). The directive to parents was to complete as much as they would like to answer; each questionnaire however, was completed in its entirety. Relevant characteristics for each child are presented in Table 6. It is important to note that parents reported that five of the 12 children did not express any functional vocalizations, but the other seven children collectively spoke between 10-100 single words or word approximations. None of the children used verbal communication entirely functionally nor could they pair words into sentences. All but one child reportedly exhibited speech echolalia. All but one child used some form of augmentative and alternative communication (AAC). Examples of these alternates included the Picture Exchange Communication System (PECS), American Sign Language (ASL), iPad (digital choice making programs), and gestures. The parent of the one child who did not use AAC commented that she was determined for her child to develop functional expressive language and that her child's language seemed to be emerging. This parent felt that if her child became reliant on AAC, this would impede any opportunity to learn functional expressive language.

All of the children were equally musically inexperienced; none of the children had received music therapy or private music instruction. All of the parents reported that their child listened to music at home and / or that they sang with their child. One parent reported that she played guitar with her child. Two parents reported that relatives of the child were trained musicians. None of the parents were professional musicians, but several had musical training in their youth. One of the parents thought that her child might have absolute pitch (child # 11), but no parents definitively reported if a family member had absolute pitch. Two suggested it was a possibility.

Table 6

Participant Characteristics

Child	*Gender*	*Age*	*Freq. of Speech*	*Nature of Communication*	*Age Diagnosed*	*Speech Echolalia*	*Class-room type*
1	M	4	None	PECS, iPad, ASL	18 mos.	No	Integrated
2	M	4.5	None	PECS, iPad	10 mos.	Yes	Contained
3	F	8	None	PECS	18 mos.	Yes	Contained
4	F	8.75	None	PECS	24 mos.	Yes	Contained
5	F	7.5	20-30 words	PECS, gestures	13 mos.	Yes	Contained
6	F	6.5	20 words	PECS	24 mos.	Yes	Contained
7	F	4	10-15 words	None	18 mos.	Yes	Contained
8	M	7	50-100 words	PECS	48 mos.	Yes	Contained
9	M	5	None	PECS	35 mos.	Yes	Contained
10	M	6	12-20 words	PECS	24 mos.	No	Contained
11	M	4	50-100 words	None	18 mos.	Yes	Integrated
12	F	4	3-4 words	None	36 mos.	Yes	Contained

Descriptive Behavioral Analysis

Lengthy narratives from the videotaped sessions described each child's behavioral interactions with the investigator, musical and non-musical participation, and social responses. Abridged versions of each child's narrative description are presented to reveal a brief sketch of their participation in the music therapy session. Among the group of children, frequency of musical echolalia for each child ranged between 30.76% - 94.44% (M = 60.88, SD = 20.85), and the overall duration that each child engaged in musical echolalia for the entire session (sum of musical echolalia for each child) ranged between 3 min 35 s – 14 min 5 s (M = 8.25, SD = 1.21).

Participant 1

Child 1 showed immediate engagement with the musical instruments and the investigator. He smiled and made eye contact with the investigator, independently chose musical instruments, and drew closer to the investigator when they performed music together. At one point, he climbed into the investigator's lap (faced away from the investigator) where he hummed the melody to various chants and rocked to the tempo of the musical stimuli. He exhibited increasing eye contact for most of the session and his overall social interactions increased when the investigator imitated his musical expressions. The overall frequency of musical echolalia for child 1 was 61.11%, and the overall duration he engaged in musical echolalia was 12 min 50 s.

Participant 2

During the first half of his session child 2 showed only brief attention to both the musical instruments and the investigator as he moved swiftly around the room. His responsiveness to musical stimuli increased when he sat on the floor and began to imitate vocal sounds and play the drums in a pattern that matched that of the investigator. His increased musical imitations resulted in increased social attention to the investigator. This social attention was manifested through engaged eye contact, smiles, and laughter. The overall frequency of musical echolalia for child 2 was 55%, and the overall duration he engaged in musical echolalia was 4 min 25 s.

Participant 3

For most of the session, child 3 vocalized high-pitched speech sounds and scripted phrases as she moved in a steady pace around the room. She showed little social engagement or awareness of the investigator until her vocalizations were imitated. When imitated, she decreased scripted and echolalia vocalizations and showed eye contact. When offered a bag of colored, mesh fabric scarves, she appeared to become calm and began to move to the rhythm of the investigator's soft guitar music. She gradually engaged in vocal music imitations with the investigator as the session progressed. The overall frequency of musical echolalia for child 3 was 38.46%, and the overall duration she engaged in musical echolalia was 4 min 50 s.

Participant 4

Child 4 showed instant attention toward the musical instruments and scarves. She uttered vocal sounds and moved around the room in a leisurely way with objects in hand as she engaged in intermittent eye contact with the investigator. She maintained a grasp on various musical instruments (mostly the paddle drum) for nearly the entire session. When the investigator played the guitar to imitate the child's walking pace, her body movements ultimately matched the tempo of the music. She smiled and moved as if dancing to the music, but showed little eye contact with the investigator. Child 4 appeared generally active in movement and instrumental play, and when she seemed to lose interest in the current musical experience, she freely gravitated to a new musical instrument. The overall frequency of musical echolalia for child 4 was 75%, and the overall duration she engaged in musical echolalia was 12 min 25 s.

Participant 5

Child 5 began to cry as soon as her parent left the room and the session began. She appeared calmer when the guitar began to play and her name was chanted. For the first half of the session, she sat quietly in the chair across from the investigator and showed little desire to explore the musical instruments unless the investigator used them first. Half way through the session, she stood up and followed the investigator to the instrument table. She independently played the drum, maraca, and bells and appeared to wait for the investigator to imitate her. Thus, she seemingly reversed the imitation leadership role. This reversal lasted for less than a minute, when she stood behind the investigator and without the musical stimuli (played on the tubano drum and with voice) in her field of vision; she imitated the musical phrases with both her voice and a musical instrument (a second tubano drum). Her vocalizations and musical instrument play seemed to expand when she was not in direct visual line with the investigator. The overall frequency of musical echolalia for child 5 was 50 %, and the overall duration she engaged in musical echolalia was 8 min 5 s.

Participant 6

At the beginning of the session, child 6 stood approximately 10 feet from the investigator and maintained a steady eye gaze. When the music began, she quickly imitated vocal stimuli that continued in a stream of vocal call and responses. When the investigator sang a chant, the child imitated the sounds with her voice and swayed to the tempo of the stimuli produced. She showed almost immediate and independent interest in the musical instruments and imitated the examiner with instrument choices and style of play. She seemed to notice a "follow the leader" type of interaction emerging, vocalized "meme," and began to lead the interaction. She seemed engaged when the investigator imitated her musical phrases. Toward the end of the session, when the familiar song "*Twinkle, Twinkle Little* Star" was sung, participant 6 began to cry, covered her eyes, and did not stop her "sad" response until the investigator stopped performing the song. The overall frequency of musical echolalia for child 6 was 94.44%, and the overall duration she engaged in musical echolalia was 14 min 5 s.

Participant 7

Child 7 showed immediate attraction to the musical instruments; she walked over to the tubano drum and maracas and without hesitation played them appropriately. When the investigator started to match her tempo with guitar strumming, the child flapped her arms quickly and began to play the drum with an alternated gaze that switched between the investigator and her own drum play. She displayed immediate tempo matching with the drum and eventually rhythm and pitch matching with her voice. On her questionnaire her parents indicated that, "she could imitate anything." When not imitating she maintained an active eye gaze on the musical task and sometimes she was engaged in either hand flapping or squeezing her arms in tightly to either side of her chin. It is important to note that much of her imitation on a musical instrument involved matched tempo, but not rhythm and was sustained for up to two minutes of active play at times.

The overall frequency of musical echolalia for child 7 was 78.57%, and the overall duration she engaged in musical echolalia was 13 min 50 sec.

Participant 8

For most of the session, child 8 moved around the room rapidly with heavy feet and wide strides while simultaneously flapping his arms and uttering high-pitched vocalizations. He picked up the maracas at the beginning of the session and maintained a strong grasp for most of the first half of the session. He showed little initial interest in music. However, he inspected the video camera several times during the session. He also intermittently shut off the lights in the room but when asked to turn them back on responded accordingly. He showed intermittent musical participation when the investigator moved closer to him with the guitar; he reached to touch the instrument, moved to the rhythm of the music, and eventually demonstrated rhythmic imitation with the maracas. The overall frequency of musical echolalia for child 8 was 30.76%, and the overall duration he engaged in musical echolalia was 2 min 35 s.

Participant 9

Child 9 quickly grasped the maracas at the beginning of his session and began to move around the room as he vocalized and whistled a steady ostinato rhythm. The examiner imitated his rhythm and movement with maraca play and vocalizations. Child 9 showed brief imitation of musical phrases and showed little visual acknowledgement of the investigator and maintained a generally blunted affect. When the investigator chose a new musical instrument to play, he drew closer but maintained only brief interest. Ultimately, the investigator presented musical stimuli 11 times (the least among all the sessions), and the child showed five brief acts of musical echolalia. The overall frequency of musical echolalia for child 9 was 45.35%, and the overall duration he engaged in musical echolalia was 3 min 5 s.

Participant 10

Child 10 seemed initially motivated by the music that was played. As the guitar was played and chants were sung, he laughed, smiled, and drew closer to the examiner. He maintained steady eye contact and imitated the rhythm of the musical stimuli. Shortly after he imitated musical stimuli, he stood up on a chair and laughed, then jumped to the floor, where he lay for the next minute and maintained eye contact with the investigator. When the investigator began to chant a new song, he stood up, moved around the room, and appeared to dance and smile as a direct result of the musical stimuli. The overall frequency of musical echolalia for child 10 was 42.85%, and the overall duration he engaged in musical echolalia was 6 min 50 s.

Participant 11

Child 11 showed initial attraction toward the tubano drum, which he brought to a chair and played appropriately. He smiled, played, and moved to the rhythm of the musical accompaniment played by using the investigator's voice and a drum. The child imitated both pitch and rhythm, using his voice and a musical instrument. During some of the musical exchanges, the child seemed to want the investigator to imitate him, observed in his alteration of the musical phrase followed by smiling and gazing at the investigator. The child independently informed the investigator when he was done by pointing to the door and stating, "mama". The overall frequency of musical echolalia for child 11 was 92.30%, and the overall duration he engaged in musical echolalia was 9 min 45 sec.

Participant 12

Child 12 showed immediate attraction to the tubano drum. She played it with alternating arms and seemed to sing the pitches of a chant unknown to the investigator. When the investigator began to imitate her performance, she abruptly stopped and next chose to play the maracas. She then played with various other musical instruments (chimes, bells, ocean drum, and paddle drums). The investigator imitated the rhythmic phrases that child 12 produced using the same various musical instruments. The child only began to show musical echolalia when the investigator played the guitar. Musical echolalia with the guitar resulted in several spontaneous, yet unified performances with the investigator. These mini-performances generated sustained attention, increased eye contact, and longer durations of musical imitation from child 12. The overall frequency of musical echolalia for child 12 was 66.66%, and the overall duration she engaged in musical echolalia was 7 min 25 s.

Quantitative Analysis of Outcomes

Analysis of Musical Stimuli

The child's own spontaneous musical expressions and interests determined the musical stimuli that were used in each session. Thus, the frequency and stimuli type were different for each child. The rate of musical stimuli produced by the investigator ranged from 11 to 20 times per session ($M = 14.66$, $SD = 2.99$). Types of stimuli included use of (a) voice only, (b) instrument only, and (c) voice and instrument simultaneously. Descriptive statics indicated that the most frequently utilized musical stimuli were produced solely with musical instruments. Musical instrument stimuli occurred 81 times across all sessions ($M = 6.75$, $SD = 3.86$), followed by voice utilized

53 times ($M = 4.42$, $SD = 2.35$), and voice and instrument simultaneously occurring 47 times ($M = 3.91$, $SD = 2.19$). The lack of significant difference across the means of the different types of stimuli indicated that there is no effect among stimuli type utilized for each individual session. Single factor ANOVA was used to test the frequency of use among the three types of musical stimuli for the whole group $F(2, 33), = 3.25, p < .051$, indicating a significant difference in frequency for musical stimuli produced by a musical instrument (with out voice) when compared to the other types of stimuli used across all sessions. Analysis of musical stimuli by type is illustrated on table 7.

Table 7

Types of Musical Stimuli

Musical Stimuli	*N*	*M*	*SD*	*Range*	*Frequency*
# Voice only	12	4.42	2.35	7	30.1
# Instrument only	12	6.75	3.86	14	46.2
# Voice and instrument	12	3.92	2.19	6	26.2

Analysis of Musical Echolalia

Occurrences of musical echolalia were determined by the child's ability to imitate music with accuracy of pitch or rhythm through voice, musical instrument, and /or physical movement. Based on these criteria, seven types of musical echolalia were identified, these included (a) imitation of pitch with voice only (POV), (b) imitation of rhythm with voice only (ROV), (c) imitation of pitch and rhythm simultaneous with voice (PRV), (d) imitation of rhythm only on a musical instrument (RIO), (e) imitation of pitch and rhythm with instrument and voice simultaneous (PRIV), (f) imitation of rhythm with body (RB), and (g) imitation of rhythm with body and voice (RBV). These types of echolalia built upon the previous pilot study data, which identified the first five types of musical echolalia, observed in four non-verbal children with autism.

Descriptive statistics indicated that the most frequently occurring type of musical echolalia was RIO. RIO occurred 48 times across the participant group (*M* = 4, SD = 2.21). The least observed type of musical echolalia was RBV, which occurred only 5 times (*M* = .42, *SD* = .66). Table 8 illustrates the occurrence and frequency of musical echolalia by type for each session.

Table 8

Types of Musical Echolalia

Musical Echolalia Types	*N*	*M*	*SD*	*Sum*	*Frequency*
Pitch with voice only (POV)	12	1.17	1.33	14	12.84%
Rhythm only with voice (ROV)	12	.75	.96	9	8.25%
Pitch and rhythm with voice (PRV)	12	.83	1.11	10	9.17%
Rhythm with instrument only (RIO)	12	4.00	2.21	48	44.04%
Pitch and rhythm with instrument and voice (PRIV)	12	.75	1.35	9	8.25%
Rhythm with body movement (RB)	12	1.08	1.16	13	11.29%
Rhythm with body and voice (RBV)	12	.42	.66	5	4.58%

Repeated measures ANOVA indicated a statistically significant effect for the repeated factor (imitation type) $F(6,66) = 10.196$, $p < .001$. Tukey post hoc analysis showed that the occurrences for the musical echolalia type RIO (rhythm on a musical instrument) was significantly different (at .05 level) from the other types of musical echolalia, and no occurrences for the other types were significantly different from each other.

Analysis of Social Responses

Social responses were recorded only after occurrences of musical echolalia. In other words, if musical echolalia did not occur then social responses were not recorded. While some children may have engaged in social responses during other elements of the session, these responses were not included with this current analysis. The recorded social responses were described and categorized into two different types indicated as "appropriate social responses" and "inappropriate social responses." Appropriate social responses were described as behaviors that lead to meaningful social engagement and/or non-verbal and/or pre-verbal communications. Appropriate social responses included eye contact, smiling, laughter, continued musical echolalia, drawing closer to the investigator, and leading turn taking or imitation. Inappropriate social responses were categorized as behaviors that did not lead to meaningful social engagement or communicative acts. Inappropriate social responses include hand flapping, spinning, flipping or spinning a musical instrument, climbing on the furniture (with eye contact), flopping on the floor (with eye contact), running around the room (with eye contact), or looking down or away form the task. All of the children showed both appropriate and inappropriate social responses during the music therapy session. Table 9 displays the social responses that were observed and categorized as appropriate or inappropriate. Some of the social responses that were deemed inappropriate may have had some implications for appropriate social initiatives. For example, "climbing on furniture" was deemed an inappropriate social response, yet the child maintained eye contact with investigator. Eye contact could be considered a social initiation; however, based on the objective opinion of the investigator, the primary behavior "climbing on the furniture" was determined inappropriate in the social context.

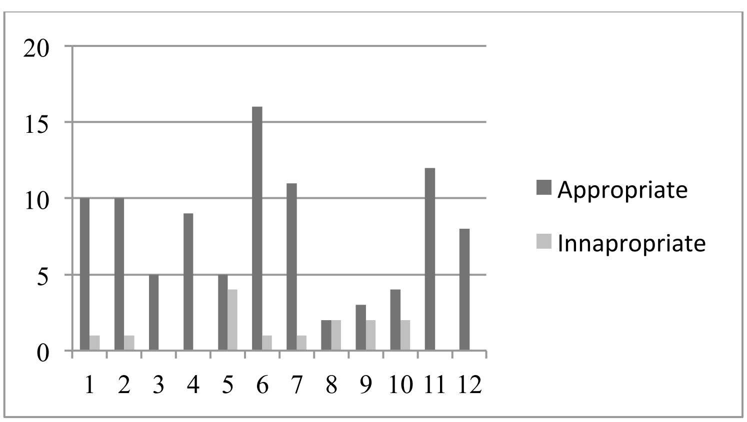
Table 9

Social Responses After Musical Echolalia

Appropriate Social Responses	*Inappropriate Social Responses*
Eye contact	Hand flapping / spinning
Smiling	Flipping or spinning musical instrument
Laughter	Climbing on furniture (with eye contact)
Continued musical echolalia	Flopping on floor (with eye contact)
Drawing closer to investigator	Running around room (with eye contact)
Leading turn taking / leading imitation	Looks down or away from task

Across all of the sessions the children showed a variety of social responses. When the social responses were tallied 95 were considered appropriate social responses occurring 87.15% of the time (M = 2.91, SD = 1.21). Fourteen inappropriate social responses were tallied, occurring for 12.84% of the time (M = 1.16, SD = 0.34). These results indicated that children generally showed more frequent appropriate social responses than inappropriate social responses. Figure 3 illustrates the sum of social responses by type for each child.

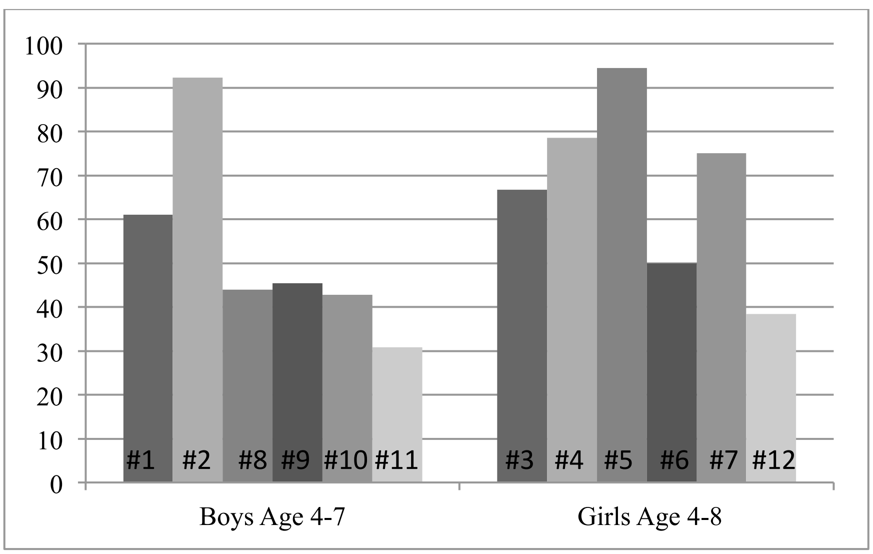
Figure 3. Social Responses for Each Child



Analysis of Associations between Age and Gender

Musical echolalia per session occurred more frequently among girls (*M* = 67.18 *SD* = 20.26) than boys (*M* = 54.57, *SD* = 21.23). Single factor ANOVA was used to compare these frequencies and found that these measures did not have a significant enough difference to cause an effect, $F(1, 10) = 1.10$; $p < 0.31$. Boy participants (*M* = 5.08, *SD* = 1.20) were on average younger than girl participants (*M* = 6.25, *SD* = 1.89) by about one year. When ages were compared, the younger children showed a slightly greater frequency of musical echolalia, but there was no significant difference. Figure 4 illustrates the frequency of musical echolalia for each child (participant #) organized by gender and age.

Figure 4. Frequency of Musical Echolalia by Age and Gender



Summary of the Results

To summarize, the results of this present study identified seven different types of musical echolalia produced by 12 non-verbal children with autism in a single music therapy session. All of the children who participated in this study demonstrated at least two of the identified types of musical echolalia. Musical echolalia was preceded by live musical stimuli provided by the investigator. Musical echolalia did not occur after each time musical stimuli was presented. After musical echolalia occurred all of the children expressed different social responses, which were categorized as appropriate or inappropriate.

Musical stimuli were presented 11-20 times for each individual session (M = 14.66, SD = 2.99). Types of stimuli included the use of (a) voice only, (b) instrument only, and (c) voice and instrument simultaneously. The musical stimuli types were presented in response to the child's initial musical interests and expressions observed by the investigator; thus, the frequency and musical stimuli type differed for each participant. Descriptive statistics indicated that there was no significant effect among the types of musical stimuli that were used for each session. Single factor ANOVA, however, indicated a statistically significant difference the overall use of stimuli presented on a musical instrument across all sessions ($F(2, 33)$, = 3.25, $p < .051$) when compared to the other forms of musical stimuli.

The musical echolalia that occurred in response to the musical stimuli was identified as seven different types. The musical echolalia types were determined by the child's use of voice, musical instrument, and / or physical body with an accuracy of pitch or rhythm imitation. ANOVA indicated a statistically significant effect for the repeated factor (musical echolalia) $F(6,66) = 10.19$, $p < .001$. Tukey post hoc analysis showed that only imitation of rhythm on a musical instrument (RIO) was significantly different (at .05 level) from the other types of musical echolalia. There was no significant different in frequency occurrence when the other types of musical echolalia were compared to each other.

Social responses to musical echolalia were tallied, measured for frequency, and categorized as appropriate (*n* = 95) or inappropriate (*n* = 14). Appropriate social responses occurred more frequently among all of the children than inappropriate responses did. Single factor ANOVA was used to compare possible associations between gender and age. No significant difference was indicated among these groups.

The major findings in identifying different types of musical echolalia may provide new information to the field. The term musical echolalia has been defined in this current study. The analysis of musical echolalia among 12 non-verbal children with autism was reliant on the definition of the term musical echolalia. Although significant differences were found when comparing the three types of musical stimuli and also when comparing the types of musical echolalia, it is important to consider the variables that may have played a role in these results. Nevertheless, the analyses reported here are meant to indicate possible trends in the data and therefore are to be interpreted with caution. Additional implications and cautions for these outcomes of this study will be discussed in chapter 5.

CHAPTER 5

Discussion

The research study investigated the ability for musical echolalia among twelve non-verbal children with classic autism. Musical echolalia was presented as a new term in this study, and defined as the demonstration of immediate relative imitation of a melodic or rhythmic sequence from a musical phrase, performed through singing, instrumental, or physical expression. Musical echolalia does not include non-musical utterances or noises such as echoic or imitative speech sounds or unrelated motor movements. Based on this definition seven types of musical echolalia were identified. Analyses of musical echolalia types, musical stimuli, social response, and potential associations informed a rationale for the possible future implications of musical echolalia practices. Potential implications for cultivating musical echolalia among non-verbal children with autism and other children with ASD may play a role in the treatment of delayed social and communication development among this population.

Musical Echolalia Types

Analysis of observational data identified seven different types of musical echolalia: (a) imitation of pitch with voice only (POV), (b) imitation of rhythm with voice only (ROV), (c) imitation of pitch and rhythm simultaneous with voice (PRV), (d) imitation of rhythm only on a musical instrument (ROI), (e) imitation of pitch and rhythm with instrument and voice simultaneous (PRIV), (f) imitation of rhythm with body (RB), and (g) imitation of rhythm with body and voice (RBV).

Tukey post hoc showed a statistically significant difference for the frequency of the musical echolalia type involving rhythm imitation with a musical instrument (RIO) when compared to the other types of musical echolalia. Various possible factors may have contributed to this outcome. First, since the children were all non-verbal, reluctance to sing might have possibly reflected his / her lack of experience in vocalizing with others (as in non-verbal children). Secondly, the children's preference may have favored the musical instrumental stimuli versus the vocal stimuli. Some of the children were observed to show immediate attraction to the musical instruments when compared to musical stimuli that used voice. Since children with autism often show little eye contact and / or little interest in the human face (Vivanti, Nadig, Ozonoff, & Rogers, 2008), it could be assumed that the use of the face in singing could have played a role in the instrument choice. Furthermore, the voice may require more social encumbrances for the children, which could be more burdensome than playing with a musical instrument alone. A third reason for the frequency of RIO could be attributed to the rater's musical perception when coding the musical stimuli. Since the coding methods were based on observational criteria, it is possible that the rater's personal musical acuity may have been more inclined to rhythm than pitch. A fourth possible reason for the frequency of RIO may be attributed to the child's seeking a sensory experience (tactile, visual, and auditory) that is offered more through the use of a musical instrument then through voice alone. There is no evidence to support the idea that children with autism receive more sensory stimuli from a musical instrument than with voice, but it could be possible. Finally, and possibly the most notable reason for the frequency of RIO was that the most frequent form of musical stimuli presented was on a musical instrument. It is important to note that the investigator chose the stimuli based on the child's natural musical inclinations. In the majority of instances, the children favored a musical instrument, which might suggests that most of the children may have been inherently drawn to the musical instruments. Nevertheless, this inference is merely an observational hypothesis. Currently, there is no reliable evidence to suggest that musical instruments produced a greater, and, therefore, more favored multi-sensory experience when compared to the voice. It is vital to emphasize that these results are indicative of this particular sample and can only suggest potential trends.

Potential Associations

A comparison of musical echolalia types across genders and ages did not yield any significant results in this study, primarily due to the small sample size. Descriptive statistics indicated that girls slightly outperformed boys in frequency of musical echolalia; nonetheless, there was no significant difference between the means based on gender that could result in a generalization. Similarly the younger children (both boys and girls) demonstrated higher levels of musical echolalia than the older children, yet the difference was not statistically significant. According to the Autism Society for America (2011), boys have a higher rate of diagnosis than girls when it comes to autism spectrum disorders; approximately 75% of diagnosed individuals are male; yet diagnosed females have a higher incidence of more severe symptoms of autism.

The current study focused on children aged four – eight years. Notably, the youngest children (the four-years-olds) showed a slightly greater frequency of musical echolalia when compared to the older children. Since the younger children outperformed the older children for musical echolalia frequency may support the research that children with autism may show greater ability for social development at an earlier age (Autism Society for America, 2010), and this supports the importance of early intervention (see review Warren et al., 2011). Nonetheless, various research studies have shown that music therapy and other related treatment interventions (like speech and language therapy) have produced positive outcomes for language development in older children as well (Finnigan & Starr, 2010; Kim, Wigram, & Gold, 2009; Whipple, 2004).

Autism research, assessment, and diagnosis have been heavily reliant on behavioral indicators and measures (Lord et al., 1989). In this current investigation all of the children demonstrated an imitation of musical sounds, yet each child imitated the music in his / her unique, personal style. Thus, all of the observed imitations varied slightly, and this factor informed the rationale for an observational research model that allowed for the identification of different types of musical echolalia.

Observational measures and descriptions are important for determining the severity of diagnosis and / or differential of diagnosis. Observational data collection allows for the child to indicate to the investigator which stimuli they choose to respond to and his or her preferred method of doing so. Emerging research in the neurosciences has allowed researchers the opportunity to use magnetic imaging to view the brains of children with autism. Researchers have been able to identify neurologic links that may lead to another form of diagnosis (Herbert, 2011; Kaiser et al., 2010).

Since children with autism show poor ability for imitation skills in relation to meaningful and non-meaningful gestures and motor tasks (Vanvuchelen, Roeyers, & Weerdt, 2007; 2011a) the utilization of music as the imitation stimuli has been identified in this study to yield contradictory results in terms of imitation abilities. Nadel (2006) suggested that imitation is a good predictor for social skills. In the case of music as the stimuli, children with autism are able to engage in both social and pre-communicative acts (Kim, Wigram, & Gold, 2008; Stephens, 2008).

In addition to the noted theoretical implications for the use of improvised music in this study, it was a vital consideration to ensure that the musical stimuli would engage rote memory abilities (Boucher & Bowler, 2008). The improvised music used in this study was intended to allow the child to respond freely and without restrictions. Thaut (1998) indicated that children with autism performed just as well as typical children when it came to improvising music in terms of rhythm production, restriction, and originality. Creative potentials for alternative expression were permitted in the improvised music. Kim, Wigram, and Gold (2009) suggested that improvisational music making led to more frequent acts of joint attention behaviors than did play therapy among children with autism. Gold, Wigram, and Elephant (2010) proposed that it is not just the music therapy but the use of improvised music that allows children with autism to relate and begin to engage socially and communicatively with a music therapist.

In this current study, the social responses that occurred after musical echolalia were categorized as appropriate or inappropriate. Whipple (2004) noted that ability to demonstrate a social connection or awareness between the child and the therapist is an important goal in music therapy, regardless if the interaction was deemed appropriate or not. Appropriateness in this study was determined by observing whether or not the social act led to functional socially appropriate and / or socially inappropriate interactions (see table 9). The results indicated that the children showed more frequent acts of appropriate social responses than inappropriate. These results are supportive of literature that has suggested that improvised music allows children with autism to show spontaneous social expression (Kim, Wigram, & Gold, 2009; Stephens, 2008; Whipple 2004; Wigram, 2004). The actions that were termed as inappropriate paralleled many of the sensory processing behaviors noted by Kranowitz (1994) who suggested that the children might have found the music over stimulating. An additional reason for inappropriate social responses may have been contributed to by hidden distractions such as, biological and / or physiological needs, or the child's general disinterest in the stimuli. Although some of the children's responses were categorized as inappropriate, they appeared excited or they ran around the room after musical echolalia occurred. Alternatively, the child may have used the inappropriate behavior as a way of reaching out for social interaction. For example even when the child s maintaining eye contact while flopping to the floor, it was deemed inappropriate, this action could have been the child's way of looking for a social response form the investigator. Nevertheless, the children for the most part showed some type of social response whether it was appropriate or inappropriate. Further investigation and analysis could yield different outcomes such as changes in frequency and different categories of social responses to musical echolalia.

Echolalia among individuals with ASD has been viewed as generally non-functional in the communication and social context (Prizant, 1983). All of the children in this present study displayed at least one of the seven types of musical echolalia, and all were able to demonstrate at least one socially appropriate response. Unlike speech echolalia, musical echolalia has functional potential for the development of social reciprocity and communication. Prizant and Duchan (1981) considered that there might be positive cognitive and language functions associated with immediate speech echolalia. Charlop (1986) suggested that frequency echolalia might have something to do with the environment, stimuli, and person; and indicated that children might show greater echolalia with unfamiliar people and unfamiliar stimuli. Kanner (1943) suggested that echolalia might be the child's drive to express something. It could be inferred that children with autism show greater interest or expression in novel environment, and that typical environments are less likely to engage vocalization. Nevertheless, the literature on echolalia is quite vague in its origins and conflicting in its functionality for children with autism. Based on the findings of this current study, when it comes to the imitation of improvised music and its inherent social interactions, it seems that musical echolalia should be encouraged. Furthermore, music seems to have a legitimate meaning for individuals with autism, one that verbal language may not be able to share.

Limitations and Recommendations

Because this research is exploratory and the first of its kind, it is extremely important to note that the results have indicated possible trends and associations cannot be generalized without further investigation. The limitations of this study focus on the small sample size and the lack of standardized coding methods. Additional limitations are discussed.

Historically, literature that has examined the use of music and music therapy for children with ASD has employed small sample sizes (see table 3) and commonly lacks evidence-based research (Gold, Wigram, & Elefant, 2010). A review conducted by Simpson and Keen (2011) noted that among 20 popular studies on the topic of music therapy for children with ASD, the largest sample size was 12 children, and occurred in only one study. Similarly, Reschke-Hernandez (2011) produced a systematic review on the history of music therapy treatment interventions for children with autism in which the authors also noted a lack of evidence-based research in the literature. The authors also noted that the majority of literature on music therapy and autism has been in the form of case studies.

While research testing small sizes can be interesting and produce new ideas, follow-up studies that employ larger sample sizes are necessary to express the validity of the work. Music therapists are traditionally trained solely as clinicians; however, there has ben drive to document the profound and meaningful moments found in clinical experiences with clients. Music therapists are not trained in such a way to apply evidence-based research methods their work. Thus, their collaborations with scientists play an instrumental role in employing reliability and validity to the field of music therapy.

In one of the first studies to examine the use of musical imitation, Applebaum and colleagues (1979) recorded how only three children with ASD compared to the three typically developing children. While the findings indicated that children with autism were able to imitate musical sounds just as well as and sometimes better than three typical children, the small sample size limited the reliability of the research. Furthermore, Applebaum and colleagues' study utilized the voice, synthesizer, and piano as the musical stimuli. These instrumental choices could have also influenced the results. The musical instruments that were chosen for this present study resemble those that are common to a typical music therapy session or are found in someone's home, contrasted with the keyboard / piano based instruments used in Applebaum and colleagues study.

Another limitation of this current study was that the measurement of musical echolalia was not based on standardized criteria. Previous investigations that measured imitation abilities among children with autism have received criticism based on the reliability of the protocol for measurement. Sevlever and Gillis (2010) suggested that that the term ‘imitation’ has been defined differently in research literature and recommended that a standard to define “true imitation” should be developed to aide in reliability measurements. In this present study, musical echolalia was identified and defined through the observation of the phenomenon that occurred in the music therapy sessions. The term musical echolalia evolved through the observational of its use in the music therapy sessions. In other words, the definition of musical echolalia was informed by how the children imitated the musical sounds and not established prior to the initiation of the study. Thus, musical echolalia was not measured as a uniform echolalia, but rather measured by the echolalia of specific musical characteristics. Measuring musical echolalia as a holistically accurate process could have posed greater problems in identifying its validity or occurrence.

Based on the coding methods for musical echolalia, seven different types of musical echolalia were identified. Since each child engaged in musical echolalia unique to his or her personality, it would have been challenging to find a method of coding that would be suitable for all participants. Furthermore, one of the aims of this study was not to identify how well each child engaged in musical echolalia, but rather to identify how musical echolalia was expressed.

Another limitation of this study was that musical elements such as musical timbre, tempo, and dynamics were not considered in the identification of the musical echolalia types. Pitch and rhythm were chosen simply because they represent the two primary musical elements (Krumhansl, 2000) and not, including timbre, serve as key elements in verbal speech production (see Patel, 2008).

The participants in this study had no prior experience with the setting, investigator, or music therapy protocol. If the participants had had experience with some of these elements, there would likely be different outcomes. Since the children did not have any experience with the setting, a precedent was set for a new experience as opposed to the possibility for a set of expectations that could have occurred in a familiar setting. All of the participants were equally musically inexperienced. None of the participants had any previous involvement with any form of music therapy protocol or musical training. Previous training may have set up expectations for specific types of responses from the children. Lack of music and / or music therapy experience served to ensure novel experiences and guaranteed natural and / or untrained responses. While novel experiences and responses played an important role in the goals of the study, familiarity with the setting and examiner could have possibly shortened the time for each child to become eased in the space. Setting familiarity may also have allowed for more appropriate social responses and / or more frequent acts of musical echolalia.

Success of the study was dependent on the condition that the participants possess at least some level of interest in music. All of the parents had reported that their child noted an interest in music. Much of the assumption was derived from the parents' observations of their child's response when listening to recorded music. The results of the autism questionnaire developed for this study indicated the parents' level of involvement regarding musical participation with their child. This participation was often reported as singing together or listening to music together.

At the completion of the music therapy sessions, the parents were eager to hear how their child responded to the music, and they all wanted to know if music therapy might be a suitable future treatment option. Parents reported that they had initially wanted to participate in the research study to learn how music might be able to benefit their child and to see if they showed interest in music therapy. Ultimately, all parents and children seemed to show, at the very least, a general interest and enthusiasm in participating in this research study.

The limitations in this current study weighed heavily on the sample size, methods of coding, but also on the type of musical stimuli, and the determination of the definition of musical echolalia. Generating evidence-based research is crucial to the field of music therapy. Limitations in sample size have spanned much of the current music therapy literature. For this current study, the exploratory nature did not present too strong a threat in identifying relatively convincing outcomes. Future recommendations would allow for a larger sample size and a more refined definition of musical echolalia in order to allow for greater validity across the study.

Future Directions

When it comes to imitation, music may be intrinsically more meaningful than other forms of stimuli, such as speech or motor tasks. Musical echolalia, compared to speech echolalia might be a usable form of echolalia for children with autism to develop meaningful reciprocal communication. A cultivation of musical echolalia may serve to enhance and / or initiate the development of communication and social skills for individuals diagnosed with autism. In order to identify a general ability, interest, or possible clinical potential for musical echolalia further investigation is required. A number of different follow-up studies that could use the same or similar protocol used in this study could be employed with a larger sample size. Five different suggested follow-up studies are presented in order to offer more usability and feasibility for musical echolalia research.

The first follow up study should employ the same protocol used in this current study with a larger sample of children. This type of follow-up study could possibly help to identification of additional types of musical echolalia and perhaps a generalization of ability. Additional analysis of the duration of musical echolalia could support the claim of increased attention abilities when a child is engaged in musical echolalia. Furthermore, a more comprehensive analysis of the social outcomes relevant to each child could lead to the identification of methods to utilize musical echolalia as an aide for social and / or communication development. Standardized tests that could compare the child's musical echolalia ability to the severity of autism or sensory abnormalities, will contribute to the understanding of musical echolalia ability across groups of children with autism.

A second follow-up study could use the protocol presented in this current study for administration by conducted by caregivers, parents, or teachers. This type of implementation could allow for an ongoing musical echolalia practice for the child in a familiar environment. Practice could more likely encourage promising outcomes for the child's social and communicative development. In order to replicate this experiment with individuals other than music therapists, a brief protocol has been designed (see appendix D). The protocol encourages the administrator to keep a data record of the musical echolalia practice session. Since all of the children in this current study demonstrated musical echolalia, the development of a treatment approach could effectively and efficiently access a child's musical echolalia abilities and should provide an enjoyable and rewarding intervention for both children and treatment providers alike.

A third study, comparative in nature, could explore musical echolalia with non-verbal children with autism who dislike music. This current study found that non-verbal children with autism who liked music demonstrated musical echolalia, and thus their musical interest might have encouraged the children to respond to music more readily. A comparison of this study with a group of children who reportedly dislike music could rule out musical interest as a factor in musical echolalia and could support the reliability of musical echolalia practice for non-verbal children with autism.

A fourth potential study could compare a computer generated music stimulus to a live investigator. Research has indicated that children with autism often know how to use a computer (Massaro & Bosseler, 2006) and show interest in recorded audio music (Bruscia, 1998; Whipple, 2004). A study that could produce the musical stimuli, either through a robot or through a computer-based application, might provide intriguing results different than those achieved through human contact. The use of such technology-based devices is commonly utilized in classroom and therapeutic settings and may take precedence for children with autism in the near future. A comparative study on the use of musical echolalia with a live person or computer (robot) could yield some important results in how children build relationships and develop cognitive social acts. The benefits that children with autism receive by engaging in social human contact may play a vital role in their cognitive development. A study that would compare musical echolalia through live or computer-based music (without a person) could potentially yield very significant results for the child's cognitive development.

Finally, a fifth study could compare the frequency of musical echolalia to speech echolalia. Participants could be divided into two groups; one group could be music based, the other non-music based. It would also be important use the same improvisational session structure (i.e. greeting phrase, good bye phrase). Elements such as, social responses, frequency of echolalia, and duration of the session could all be compared. Instances of musical echolalia could be recorded for the music group and speech echolalia could be recorded for the non-musical group. A correlation of the children's echolalia scores in the non-musical setting with their scores in the music therapy setting could refine the definition of musical echolalia. A correlation would tell weather the levels of echolalia are stable within individuals across settings.

These five follow-up studies suggest that the study of musical echolalia could take many directions and explore a variety of important discussions (i.e. comparison of musical echolalia vs. speech echolalia or computerized music vs. live music). The employment of these suggested studies could yield rich and intriguing results. The most important task of this research is to build a larger cohort of participants, which would support the likelihood of the existence of musical echolalia among non-verbal children with autism. Additionally, testing batteries that would indicate sensory profiles, intelligence, and cognitive abilities would better support the generalization of musical echolalia among this heterogeneous population and could play a role in better understanding the child's engagement with musical echolalia types and the social responses.

Conclusions

In conclusion, this study identified that 12 non-verbal children with autism demonstrated the imitation of musical phrases, termed musical echolalia. Seven different types of musical echolalia were identified. These findings were not elicited or prompted, but rather emerged through observational analysis based on descriptions of the 12 children. Research has indicated that children with autism commonly show poor imitation abilities in terms of gestural, meaningful, and non-meaningful motor movements (Vanvuchelen, Roeyers, & Weerdt; 2007; 2011a; 2011b; Zachor, Ilanit, & Itzchak, 2010). This study showed that when musical stimuli were present, children with autism were able to express music through three mediums: using their voice, through musical instrument play, and with physical movement. These mediums, paired with accuracy of pitch and / or rhythm resulted in the identification of seven types of musical echolalia.

The use of improvised music without social prompts allowed each of the children to explore music freely. Free musical exploration allowed the child to show the investigator how he or she spontaneously responded to / imitated music. Analysis for potential associations between genders and ages indicated that the girls showed greater frequency for musical echolalia and that the younger children (both boys and girls) showed more musical echolalia than the older children. All of the children showed social responses, termed as either appropriate or inappropriate, after musical echolalia occurred. These findings are novel to the field of observational research in music and autism and have the potential to make a meaningful contribution to the emerging field of social imitation, music, and autism.

Limitations outlined in this study noted the need for a larger sample size in addition to examining the use of musical stimuli and coding and analysis mechanisms for musical echolalia. Future directions suggested employing a larger sample of children with a possible utilization of the protocol for home or classroom use. Comparative studies that may examine the role of computer-based musical stimuli versus traditional human interaction may make a significant impact in the study of social cognitive development among children with autism. A final comparison suggested developing a protocol to compare speech (without musical associations) in comparison to musical echolalia.

This exploratory study is the first of its kind. While the results are to be interpreted with caution, the preliminary outcomes support the current literature, which suggests that children with autism show an interest in music. Music therapy interventions using improvised music have offered positive results in the goal areas of communication and social skills for children with autism (Bruscia, 1987; Kaplan & Steele, 2005; Whipple, 2004; Wigram & Gold, 2006). Musical echolalia can be a marker for the development of the commonly impaired imitation abilities among children with ASD and could rationalize cultivating a use for echolalia as proposed by Prizant and Duchan (1981). Musical stimuli offered a fun and engaging incentive for the children who participated in this study and yielded outcomes that demonstrated social reciprocity and joint attention, which are important precursors to language development. Furthermore, music is intrinsically more meaningful for individuals with ASD than language is. In addition, music offers a multi-sensory motor experience that may be able to facilitate stimulation and organization to the disordered sensory system. Thus, musical echolalia has much more meaning than verbal echolalia. Future research directed toward exploring musical echolalia abilities among larger samples of children and in comparative studies will yield some intriguing and potentially important results for non-verbal children with autism. Ultimately, musical echolalia could offer an addition to the musical and / or autism lexicon as a type of functional echolalia that can be used to develop functional social and / or communicative abilities among non-verbal children with autism.

APPENDIX A

RECRUITMENT FLYER

Seeking Children ages 4-11, who are non-verbal, enjoy music, and are diagnosed with classic autism. Participants must be willing to attend <u>one 20-30 minute one-on-one music therapy session</u> at the Autism Support Center in Danvers, MA during August 22-September 6, 2011.

This music therapy session is free of charge.

Please direct all inquiries to Krystal Demaine
Board Certified Neurologic Music Therapist
email: kdemaine@lesley.edu

RESEARCH STUDY: MUSIC THERAPY AND CHILDREN WITH AUTISM

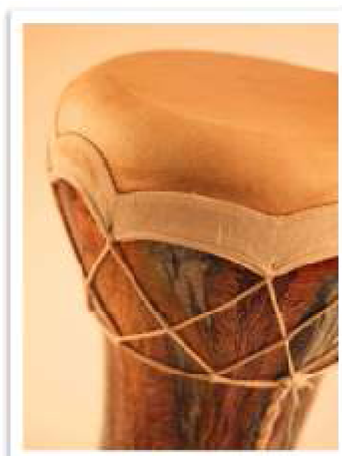
Investigator:
Krystal Demaine, M.Ed., MT-BC, NMT-Fellow

Where:
The Autism Support Center / NE– ARC
6 Southside Rd.
Danvers, MA

When:
August 22 – September 6, 2011

Krystal Demaine is a board certified neurologic music therapist. She has been providing music therapy interventions for children with autism since 2001. Krystal is a doctoral candidate in Expressive Therapies at Lesley University in Cambridge, MA.

For inquiries about approval for this study please contact:
Dr. Michele Forinash, MT-BC, LMHC forinasm@lesley.edu



This study is approved by the Lesley University Intuitional Review Board

APPENDIX B

AUTISM QUESTIONNAIRE

Autism and Music Therapy Research Questionnaire

Date: __________________

Child's name: ____

Date of Birth: ________/________/_________ Age: _________

Classroom type: _ Mainstream _ Contained

Services or therapies received:

☐ Occupational Therapy _____x/wk ☐ Physical Therapy _____x/wk ☐ Speech-Language Therapy _____x/wk

☐ ABA (Applied Behavior Analysis) _____x/wk ☐ Other _____x/wk

Parent / Guardian Name: ____

Address:______________________________ City______________________ State_____ Zip___________

Phone:_____________________________ Email:____

Does your child have any siblings? *If so, please list.*

Name	Gender	Age	Date of Birth	Learning Needs?

Child's Handedness: ☐ *Right* ☐ *Left* ☐ *no difference*

At what age did your child begin: ***walking?*** _________ ***talking?*** _________

Did your child lose speech at any point? YES / NO age: ___________

About how many words does your child speak? _________________

About how many word approximations does your child speak? _____________________

Does your child demonstrate speech echolalia? ___________________

Demaine Autism Questionnaire 1/1/2012

At what age was your child diagnosed with ASD? __________

Who diagnosed your child?____

Does your child use any alternative or augmentative communication (AAC) tools, such as a communication book or signs?

____

Describe your child's particular interests or abilities (mathematics, puzzles, art, music, television, toys).

Has your child ever attended any music therapy? YES / NO
Frequency / Duration: _________

Has your child ever attended private music class / lessons? YES / NO
Frequency / Duration: _________

Did/does anyone in your family:

- *Play a musical instrument or sing?* YES / NO
- *Have perfect pitch?* YES / NO

Do you spend time singing with your child? YES / NO frequency: _____

Do you play music in your home (radio, CD's, etc.)? YES / NO

What language(s) are used in your home?____

How did you hear about this study? ____

What made you want to participate?____

THANK YOU!!!

Demaine Autism Questionnaire 1/1/2012

APPENDIX C

INTER-RATER RELIABILITY TRANSCRIPTION FORM

Inter-Rater Reliability
Data Transcription

Child Name: ____

Rater Name: ____ Date: ____________

Please note the following information in the identified columns:

- **Musical Stimuli**: Instrumental, Vocal, Both
- **Musical Echolalia** (ME): Voice, Instrument, or Body, and Pitch or Rhythm
  * If no ME is seen simply write --
- **Social Response**, example: smile, laugh, run around, hand flap, rock
  ** Only note social response if ME occurred

	#1	#2	#3	#4	#5
Musical Stimuli					
Clock Time					
Musical Echolalia					
Clock Time					
ME Type (investigator only)					
Social Response					
SR Type (investigator only)					

#6-15 on other side

Notes:

	#6	#7	#8	#9	#10
Musical Stimuli					
Clock Time					
Musical Echolalia					
Clock Time					
ME Type (investigator only)					
Social Response					
SR Type (investigator only)					
	#11	#12	#13	#14	#15
Musical Stimuli					
Clock Time					
Musical Echolalia					
Clock Time					
ME Type (investigator only)					
Social Response					
SR Type (investigator only)					

APPENDIX D

MUSICAL ECHOLALIA PROTOCOL

Musical Echolalia Protocol

Designed by Krystal Demaine, M.Ed., MT-BC, NMT-Fellow
Board Certified Music Therapist

This improvised music-centered protocol is designed for administration by parents, teachers, and caregivers of children with autism who are non-verbal. This protocol is designed for use with one child and to be administered in the least restrictive and least distractive environment.

The goals of musical echolalia tasks are to improve spontaneous imitation thus increasing social reciprocity and cognitive relating through the use of improvised singing and instrumental play.

Musical echolalia is: *the demonstration of immediate relative imitation of a melodic or rhythmic sequence from a musical phrase, performed through singing, instrumental, or physical expression. This does not include non-musical utterances or noises such as echoic or imitative speech sounds or unrelated motor movements*.

Preparation:

- Identify space where you and the child can move around freely in a contained environment with limited restrictions or distractions.
- Prepare a choice of percussive musical instruments that are appropriate for interactive play with you and the child (i.e. drums, maracas, jingle bells).
- Set up two chairs or seating spaces for you and the child to face one another.

Duration:
5-20 minutes of active music making. Begin working with the child for five minutes until the child gains time to attend to the task.

Steps:

A. Greeting Chant: Sing brief melodic chant to initiate the acknowledgement of "music time", include the phrase "time for music" or "time to sing, time to play."
B. Instrumental Improvisation: Begin playing musical instruments and / or singing the musical instrument play you are engaging in (i.e. "I play the drum", "shake, shake, shake the bells"). If the child begins to imitate follow this act, and continue non-verbally engaging in the musical dialogue.
C. Movement Improvisation: Move to an organized fashion that would allow your body to make music, maybe sing or chant the process (clap the chant, "clap my hands").
D. Vocal Improvisation: Vocalize short melodies (2-3 pitches with 2-4 beats), utilizing babble (jazz scat singing) type sounds (i.e. "ba, ba, ba, do").
E. Goodbye Chant: Sing a brief melodic chant with little words that includes the phrase "music is done" or "lets clean up".
F. Keep Record: Use the musical echolalia data sheet (see below) to record the elements of your session: how long the child engaged in music making, what instruments were chosen, the child's social response, and the child's use of musical echolalia through: voice, musical instrument, or physical body. This will help indicate any changes for future music making (i.e. increase / decrease in attention, preference for musical sounds, and most importantly showing the adult how the child imitates music).

* Steps B, C, and D can be used in any order and can be replicated through out the music making.

Important notes:

- Allow the child to move freely around the room, yet model returning to the seating space as needed.
- Do not verbally prompt music making but allow the child to respond freely as needed
- Music making offers an intrinsic reward for the child, be mindful to not or overly praise the child's actions with verbal rewards.
- When the child seems to
- Imitation and repetition are key to language and social learning – the more practice in musical echolalia the more skilled one will become in developing an awareness of social reciprocity and pre-communicative skills.
- Model your enjoyment of making music (i.e. smile, play, have fun!)

Use this musical echolalia data sheet to record the outcomes of each time you and the child practice musical echolalia. Create a new chart for each new session.

Musical Echolalia Data Sheet Date: Childs Name:
Musical Stimuli produced by adult (voice, instrument, combination)
Musical Echolalia produced by child (voice, instrument, physical body, with use of rhythm or pitch)
Social Responses produced by the child (i.e. laugh, cry, run around, eye contact, play)
Duration of session:
Additional comments:

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