THE EFFECT OF RHYTHM AND MELODY ON LANGUAGE DEVELOPMENT AND SENSORY ORGANIZATION IN CHILDREN WITH AUTISM

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THE EFFECT OF RHYTHM AND MELODY ON LANGUAGE DEVELOPMENT AND SENSORY ORGANIZATION IN CHILDREN WITH AUTISM

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ABSTRACT

Research in language, neurology, and music suggests that constructs of music to provide organization, such as rhythm and melody, may facilitate language skill development and sensory organization for children with autism. This project inquired whether rhythmic speech or melody during free-play and intervention sessions could help increase language production and organize sensory systems, displayed by Restricted, Repetitive Stereotypical behaviors (RRS), for children diagnosed with autism. Statistical analysis of the data determined that neither language skills nor RRS behaviors were significantly influenced by rhythmic speech or rhythmic speech with melody. While statistical analysis did not suggest an effect, observational data collected during the sessions did suggest that auditory perception and orientation toward language might have been positively effected by rhythm and melody. Further research is necessary to determine how the organizing principles of rhythm and melody might affect the language development of children with autism. Anecdotal evidence is discussed to support future research in this field.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the Conservatory of Music and Dance have examined a thesis titled "The Effect of Rhythm and Melody on Language Development and Sensory Organization in Children with Autism," presented by Sarah M. Lillie, candidate for the Master of Music Education degree, and certify that in their opinion it is worthy of acceptance.

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CHAPTER 1

INTRODUCTION

Children with disabilities are a significant population within public education schools. Data from 2009 reported 5.8 million children with disabilities received services under the Individuals with Disabilities Education Improvement Act (IDEIA) in public schools, with over 3.4 million of these students spending 80% or more of the school day in general education classrooms (Data Accountability Center, 2007). IDEIA (2004) law stipulates that all students receive an appropriate education in the least restrictive environment. Students may not be excluded from educational services due to a disability, no matter how severe the disability may be.

Music has been a component of special education since the 1800s; presently children with special needs are often included in general music classrooms (Adamek & Darrow, 2010). However, many music educators feel unprepared to address the needs of individuals with disabilities in the general music classrooms (Hourigan & Hourigan, 2009). Preservice music teachers were found to be inexperienced in working with children with special needs, and felt uncomfortable with the students and the special education processes and terminology (Hourigan, 2009). Exposure to, and directed field experience with, students with special needs in the music classroom may improve conceptions of preservice music teachers to the special education process and special education students (Hourigan, 2009). Music educators may also feel more capable in including individuals with disabilities in the music classroom with more education regarding students with disabilities (Wilson & McCrary, 1996). Raising awareness of the physical needs and adaptive possibilities of students with disabilities may provide more options for the inclusion of instrumental music teachers in a band or orchestra. Music educators may also feel more capable in including individuals with disabilities after training and education regarding unique needs of this population (Nabb & Balcetis, 2010; Wilson & McCrary, 1996). Music educators must be familiar with the functional needs of children with special needs in order to provide appropriate musical learning to this population of students. One diagnosis that is growing in prevalence in the public schools is autism. Music educators can be better prepared to meet the needs of students with autism by understanding the diagnosis and how music can be effective to musically educate children with autism in the general music classroom.

Autism is a developmental disorder, where disabilities can range from mild to severe. Autism is marked by impairments in social interaction and language, and the occurrence of restricted repetitive and stereotyped behaviors (4th ed., text rev.; DSM–IV–TR; American Psychiatric Association, 2000). This population of students is growing in the public education system of the United States. In 2004, 6 million children were served under IDEIA. This number declined to 5.8 million in the fall of 2009. However, in 2004, 165,552 children were served under IDEIA with the classification of autism, while in 2009, 333,022 children with autism were served under IDEIA (Data Accountability Center, 2007). This demonstrates a 101% increase of students with autism in schools, thus music educators must understand how they can address the needs of these students.

Pairing music and children with autism is not a new approach. Music therapy has long been used as an intervention technique for individuals with autism (Reschke-

Hernandez, 2011). There is a growing body of research in the field of music therapy to support using music as a tool to address the functional needs of an individual with autism (Kaplan & Steele 2005; Wan, Demaine, Zipse, Norton & Schlaug, 2010; Whipple, 2004). While music education focuses on teaching musical skill, music therapy uses music as a tool to affect the mental and physical state of an individual, with an aim to change unwanted behaviors and encourage appropriate behaviors through music stimuli (Davis & Gfeller, 1992). One of the key diagnostic qualifiers of autism is language and communication impairment, and research suggests that music therapy is frequently used as an intervention for facilitating expressive and receptive language for individuals with autism (Braithwaite & Sigafoos, 1998; Kern, Wakeford & Aldridge, 2007; Kern, Wolery & Aldridge, 2007; Thaut, 1992). Neuroscientists have also extensively studied the mechanics of music and language. Research suggests that while the organization of language may not be readily perceived in the brain, rhythm and melody in music may provide a sense of structure to facilitate perception and production (Patel, 2007). Perhaps music can be used to intentionally address language and musical development simultaneously.

Individuals with autism also demonstrate deficits in sensory processing. Sensory input could be described as, “a constant stream of electrical impulses flow[ing] through sensory receptors along the spinal cord up to the brain” (Berger, 2002, p.36). When a sensory stimulus is present, an individual with autism may perceive the stimulus as more or less intense compared to the perception of typically developing individuals, invoking an inappropriate response to the stimulus. Sensory integration therapy explores ways to calm the sensory system, so that sensory stimuli may not be perceived as a threat, but instead facilitate an appropriate response to a stimuli, allowing for the information to be encoded, decoded and used (Iarocci & McDonald, 2006). Music therapists have explored incorporating music into sensory integration in order to facilitate a calming of the sensory system (Thaut, 1992). Playing instruments, singing, and moving to the music may assist in the development of cognitive and intuitive responses to sensory stimuli (Berger, 2002). It may be that music can facilitate a sense of well-being and sensory balance.

While research grows in the realm of music therapy and autism, music education has neglected empirical research regarding the needs of students with autism within the music classroom. Music education researchers may utilize the research in music therapy to address the needs of students with autism through music activity, which may facilitate education of musical concepts for this population. In addition, the scientific community is demonstrating a strong connection between music and language. The music educator can improve the education of a child with autism in the general music classroom by better understanding how music can influence these children's language development and sensory needs.

If music educators can combine elements of rhythm with language in the general music class, the sense of organization around a predictable rhythm may lead to a sense of sensory organization and better language perception. This in turn may facilitate music learning for a student with autism. In music education, researchers have explored the most effective ways to teach rhythm to young students. Studies suggest that multi-sensory representations of rhythms may facilitate the acquisition of rhythmic patterns

(Persellin, 1992) and that often, typically developing children have higher levels of dictation and performance of rhythmic patterns by using language to correspond to the rhythmic pattern (Colley, 1987). For example, a young student may more readily perform and identify 16th notes if the word “wa-ter-mel-lon” is attached to the rhythm, rather than beat counting.

Educators who utilize the Orff-Schulwerk approach of music education also recognize the importance of using language in music education. Language is incorporated into the rhythmic playing of instruments, spoken ostinati, and singing in the Orff-Schulwerk (Frazee & Kreuter, 1987). High quality poetry and nursery rhymes native to the child’s culture are advocated for use in movement, instrument arrangements, and speech pieces. Orff-Schulwerk teachers advocate that music “sticks with the sensuality of the sound and organizes it to ‘make sense’” (Goodkin, 2004, p. 18). The importance of language in music education is emphasized in the Orff-Schulwerk in that “the speech exercise comes at the beginning of all musical practice, both rhythmic and melodic… In speech exercises it becomes easy to teach duple and triple time, the meaning of bar-lines and upbeats, and sudden time-signature changes” (Orff & Keetman, 1958, p.141). Carl Orff was also a proponent of rhythmic music education; “I saw in a flash where rhythmical education really ought to begin: when a child enters school – or earlier still, at preschool age” (Orff, 1963, p.72). This approach to music education is designed around the marriage of rhythm and language, which could be a way for music educators to link rhythm and language for students with autism who are included in the general music classroom.

In a music education environment, the main emphasis should be providing all students with an education in the elements of music. Music education activities informed by a strong theoretical framework that encompasses the literature on sensory input, music, language, autism, and neurology, may better address the musical learning and functional needs of a student with autism in the music classroom. In addition, the music educator may more effectively use the unique qualities of melody and rhythm in music to facilitate language and sensory organization for these children. While the population of students with autism grows, music educators can respond by exploring strategies in the music classroom that have been supported by research. Teaching elements of rhythm and melody through performance and demonstration may allow the student with autism to better organize his or her world or more readily process and use language, thus leading to improved functionality in language and musical development. Therefore, this study will examine how melody and rhythm may affect the sensory needs and language development of an individual with autism.

CHAPTER 2

REVIEW OF LITERATURE

A music educator is frequently required to teach every student at his or her school, but often does not receive specific training to best address the needs of an individual with autism. According to the Diagnostic Statistical Manual of Mental Disorders, individuals with autism often demonstrate language and social impairments and a presence of restricted, repetitive stereotyped behaviors (4th ed., text rev.; DSM–IV–TR; American Psychiatric Association, 2000). Music therapy has long been used as an intervention to address these concerns (Reschke-Hernandez, 2011); however, music education research rarely explores how to apply music-based strategies to better meet the needs of individuals with autism. Music activities grounded in a strong research base to address the concerns of an individual with autism may facilitate language perception and development and sensory organization in the music classroom. Translational research provides a means to examine music activities that can be utilized in the music education classroom. Therefore, the purpose of this study is to compare the effectiveness of conversational speech, rhythm-based speech, and rhythm-based speech paired with melody to improve sensory impairments and language deficits for children with autism.

Autism Disorder is one of the disorders classified as Pervasive Developmental Disorders (PDD). Severe impairment of social interaction and communication skills, and the presence of stereotyped behavior, interests and activities are the markers of Pervasive Developmental Disorders (4th ed., text rev.; *DSM–IV–TR*; American Psychiatric Association, 2000). Four other disorders are characterized as PDDs: Rhett's syndrome, Child Degenerative Disorder, Asperger's Disorder and Pervasive Developmental Disorder – Not Otherwise Specified. Autism is distinguished from other PDDs based on gender, how the symptoms present, and the path of development (4th ed., text rev.; *DSM–IV–TR*; American Psychiatric Association, 2000). Autism affects one in 110 children; occurrence is four times more prevalent in males than in females (National Institute on Deafness and other Communication Disorders [NIDCD], 2010). Skills and behaviors characteristic of the disorder can vary greatly in severity on a continuum of mild to profound (Groen, Zwiers, van der Gaag, & Buitelaar, 2008; Hourigan & Hourigan, 2009; Tecchio et al., 2003).

Three characteristics mark autism disorder: impaired social interaction; language and communication deficits; and restricted repetitive and stereotyped behaviors, interests and activities (4th ed., text rev.; *DSM–IV–TR*; American Psychiatric Association, 2000; Hourigan & Hourigan, 2009). A child must demonstrate abnormal characteristics in at least one of the three diagnostic categories before the age of three to be medically diagnosed with autism. Social interaction impairments are observed through a child's lack of interest in developing friendships, limited participation in social games and play, and a limited awareness of others. Thus, a child with autism may demonstrate a preference for solitary play (4th ed., text rev.; *DSM–IV–TR*; American Psychiatric Association, 2000).

Autism impairs language and communication skills in both verbal and nonverbal domains. A child may demonstrate a complete absence of language, or language skills may be delayed compared to his or her peers, particularly in the appropriate use of language for social interaction, as well as the proper inflection, stress, rate, and rhythm of speech (4th ed., text rev.; *DSM–IV–TR*; American Psychiatric Association, 2000). Restricted repetitive stereotyped (RRS) behaviors, interests and activities are demonstrated through strict adherence to routines, preoccupation and fascination with objects, and a demonstrated narrow range of interests. Stereotyped body movements such as hand flapping, finger flicking, rocking, spinning or swaying of the whole body are common (4th ed., text rev.; *DSM–IV–TR*; American Psychiatric Association, 2000). Though not a diagnostic qualifier, many individuals with autism also have sensory impairments, such as experiencing over stimulation or under stimulation from sensory input, or seeking sensory input to calm the sensory systems. Research suggests that sensory dysfunction may result in RRS behaviors due to the inability to appropriately respond to sensory stimulation (Boyd, McBee, Holtzclaw, Baranek, & Bodfish, 2009; Boyd et al., 2010; Chen, Rodgers, & McConachie, 2009; Gabriels et al., 2008).

Providing educational services to an individual with autism is highly governed by the federal law, Individuals with Disabilities Education Improvement Act (IDEIA) (2004). When children with autism enter public school, special education teams will assess and create an Individualized Educational Program (IEP). Though a child may have a medical diagnosis of autism, special education services will only be provided if the disorder adversely affects the child's educational performance (Individuals with Disabilities Education Improvement Act, 2004). IEPs include present levels of performance strengths, needs and measurable goals for children receiving special education services (McCord & Watts, 2006). In 1990, the original law, the Individuals with Disabilities Act, stipulated that all children must be educated in the least restrictive environment, thus children with disabilities are to be included with typically developing peers to the maximum extent that is appropriately possible (Adamek & Darrow, 2010; Individuals with Disabilities Education Improvement Act, 2004). Regulation of the least restrictive environment led to the practice of mainstreaming; students with disabilities are included with typically developing peers in specified regular classroom subjects and provided supplementary services or aids that support their learning in this environment. This practice creates a continuum of classroom situations for children with exceptionalities (Adamek & Darrow, 2010).

In the late 1980s, many education reformers promoted the practice of inclusion. Special and general education teachers would co-teach in the same classroom, educating all children in the general classroom for the entire school day, despite exceptionalities (Zigmond, Kloo & Volonino, 2009). Recently, the No Child Left Behind educational act called for the standardized assessment of students with disabilities, which has led to more schools moving toward full inclusion in the general education classroom (Zigmond et al., 2009). An ongoing debate continues regarding inclusion; some believe students should be fully included regardless of the severity of a disability, while others advocate for the availability of a continuum of services to meet the needs of students who cannot appropriately learn in the general classroom (Damer, 2001; Individual with Disabilities Education Improvement Act, 2004; Zigmond et al., 2009).

Whether a school supports full inclusion of mainstreaming, music educators are often called on to teach students with exceptionalities. In many schools, the amount of time a child with autism is included in the general classroom depends on specific strengths and needs of each individual child. However, children with autism may frequently attend music class with typically developing peers despite their level of ability. Inclusion in the music classroom may prove to be a struggle for many music educators. Music educators are increasingly expected to teach music to children with autism while receiving little training or experience in autism (Adamek, 2001; Hourigan & Hourigan, 2009; McCord & Watts, 2006). Without an understanding of autism, music educators may often find that the behaviors of children with autism can interrupt the learning and performance of other children in the music class (Hourigan & Hourigan, 2009). This may cause music educators to resist including children with autism in the music classroom despite the federal regulation requiring the inclusion of children to the maximum extent possible. Music educators may improve the lives of children with autism through appropriate teaching strategies in the music classroom (Patterson, 2003), but the instruction must address their functional needs in order to support learning.

While music education research has often overlooked addressing the needs of students with autism, research in music therapy could provide a better understanding to support music education with this population. Music therapy has long been used as an intervention technique for individuals with autism (Reschke-Hernández, 2011) and there is a growing body of evidence suggesting that music therapy may be an effective intervention for individuals with autism (Kaplan & Steele 2005; Wan, Demaine, Zipse, Norton & Schlaug, 2010; Whipple, 2004). An understanding of music-based interventions applied within the context of a music education environment may support growth in sensory and language development while continuing to facilitate music learning. Based on the findings of neurological, linguistic, sensory integration and musical rhythm and melodic research, music activity may promote the development of linguistic skills and sensory organization for individuals with autism.

Impairments in Autism

Sensory Organization

Sensory modulation is the ability of an individual to regulate the degree, intensity, and nature of stimulation in their sensory systems (tactile, vestibular, olfactory, gustatory, auditory, visual) (Dunn, 2006). Sensory stimulation is processed in the central nervous system producing an appropriate response to an incoming sensation (Dunn, 2006; Kern et al., 2008). The central nervous system of typically developing individuals is able to modulate, respond appropriately, and habituate when stimulation to a sensory system is present. For example, if an individual walks into bright sunlight, an appropriate response would be squinting to shield light.

Individuals with autism often display impairments in sensory processing compared to their typically developing peers (Ashburner, Ziviani, & Rodger, 2008; Ben-Sasson et al., 2009; Boyd et al., 2010; Houchhauser & Engel-Yeger, 2010; Leekman, Nieto, Libby, Wing, & Gould, 2007; Minshew & Hobson, 2008). Though sensory dysfunction is not a diagnostic qualifier of autism, the display of RRS behaviors is one of the three characteristics of autism. Research suggests that RRS behaviors, such as hand flapping, spinning, and self-injurious behaviors, may be a result of sensory dysfunction, with the severity of dysfunction in sensory processing related to the frequency of RRS behaviors (Boyd et al., 2010; Chen et al., 2009; Gabriels et al., 2008). These RRS behaviors can also encompass elements such as a focus on rituals or routines, suggesting that these behaviors may also be an element of dysfunctional cortical processing (Chen et al., 2009). Individuals with autism may focus on and generate RRS behaviors in order to induce a sensory experience or to calm a hyper-aroused sensory system (Liss, Saulneir, Fein, & Kinsbourne, 2006). By addressing the sensory needs of an individual with autism, RRS behaviors may reduce in frequency.

Research has demonstrated patterns in sensory dysfunction in individuals with autism. There are three profiles of sensory processing impairments demonstrated by individuals with autism: over-responsive to stimulation, meaning that tolerance for sensory stimulation is low; under-stimulated, in that tolerance for sensory stimulation is high; or sensory-seeking, where individual feels under-stimulated and seeks stimulation for a feeling of balance (Ben-Sasson et al., 2009; Chen et al., 2009; Dunn, 2006). Research suggests children with autism might most commonly display under-responsiveness to sensory stimulation, followed by over-responsiveness and sensory seeking behaviors (Ben-Sasson et al., 2009). The inability to regulate these responses can lead to a feeling of disorganization and stress for an individual with autism. For example, Therese Jolliffe, an adult with autism, describes the effect of sensory impairments:

> Reality to an autistic person is a confusing and interacting mass of events, people, places, sounds and sights. There seem to be no clear boundaries, order or meaning to anything. A large part of my life is spent just trying to work out the pattern behind everything. Set routines, times, particular routes and rituals all help to get order into an unbearably chaotic life (Joliffe, Lakesdown, & Robinson, 2001, p.50).

When an individual is not able to organize sensations in the world around him or her self, a feeling of well-being will be sought before higher-level thinking and skills may develop. Therefore, it is important to address the sensory regulation of an individual with autism in order to more effectively address his or her needs.

The nervous systems (central, sympathetic, and parasympathetic) all may contribute to the processing of sensory stimuli. While a growing body of research suggests the central nervous system is important in the modulation of stimuli (Dunn, 2006), the sympathetic and parasympathetic nervous systems may also play into sensory dysfunction compared to typically developing peers (Schaff et al., 2010; Schoen, Miller, Brett-Green, & Nielsen, 2009). The sympathetic nervous system activates in the body during stress (fight or flight reaction) where the parasympathetic system activates while the body is in rest (Bard & Bard, 2002). Children with autism may show lower sympathetic nervous system arousal at a baseline measurement, and atypical arousal when presented with stimuli than typically developing peers (Schoen et al., 2009). Children diagnosed with sensory modulation dysfunction may also show lower parasympathetic activity at a baseline measurement and when presented with auditory stimuli (Schaaf et al., 2010). Sensory dysfunction may be the result of abnormalities in general arousal levels (Rogers & Ozonoff, 2005), or abnormal points at which sensory stimulation is tolerated (Dunn, 2006).

Several contrasting theories have been presented to explain the cause, effect and neurological outcomes of sensory processing impairments seen in people with autism. A consensus has yet to be reached whether impairment is a result of either a structural or functional problem in the brain. The impairment may affect the sensory and cognitive domains, yet it is uncertain whether the impairment is within or across these domains. It is also unclear whether the impairments are a result of abnormalities within brain activity, the integration of the nervous system, the feedback of senses in the brain, or connectivity within the brain (Iarocci & McDonald, 2006). While the explanation for sensory impairments is still contested, the effect of sensory processing on the behaviors of a person with autism has been documented through various studies.

Sensory processing dysfunction may impact many areas of the life of a child with autism, such as his or her adaptive behaviors, anxiety, and social skills. Sensory processing abnormalities are suggested to predict communication performance and maladaptive behaviors (Lane, Young, Baker, & Angley, 2010). Several relationships may also exist between sensory processing and decreased adaptive behaviors; such as a strong inverse relationship between hypersensitivity and social skills, a strong positive relationship between anxiety and sensory defensiveness, and an increase in sensory dysfunction (Pfeiffer, Kinnealey, Reed, & Herzberg, 2005). Research also suggests connection between leisure activity and sensory impairment (Hochhauser & Engel-Yeger, 2010). Children with high functioning autism and severe sensory processing impairment may demonstrate less diversity and intensity in participation of leisure activity than typically developing peers. Moreover, these children may participate more frequently in solitary activities, and activities in their homes. The more severe the sensory impairment, the less a child may enjoy activities in which he or she participates compared to typically developing peers.

Sensory dysfunction may also affect the behavior and learning of an individual with autism. Behavior problems typically seen in individuals with autism may not originate from a behavioral standpoint, but instead may be a result of the internal disorganization from sensory dysfunction (Kern et al., 2008). These impairments may also affect a child's educational experience. In her firsthand account of living with autism, Temple Grandin (2006) suggests that when one or more senses are impaired, the ability to learn and process information from the environment is compromised. Research supports Grandin's experience, suggesting that the difficulty in auditory filtering and processing could contribute to lower academic achievement, in that students with under-responsive and sensory-seeking behaviors are unable to process verbal instructions with other background noise present (Ashburner, Ziviani, & Rodger, 2008). The sensory needs of a child with autism are an important consideration in the educational process. If a child experiences his or her "systems constantly being bombarded with sensory inputs that seem to come into the brain with no apparent rhyme or reason – no sequence, no temporal sense and no identifiable order" (Berger, 2002, p.42), it will be difficult for the child to learn.

While sensory dysfunction is not a diagnostic qualifier, it may be that individuals with autism cope with the feeling of disorganization by displaying RRS behaviors. When an individual experiences sensory impairments, behavior, learning, social skills, language perception and adaptive behaviors may all be affected. Interventions that address other areas of concern for individuals with autism should also examine how sensory impairments may be alleviated as well.

Language

Language, speech and communication are central to the human race. Language can be defined as "a socially shared code or conventional system for representing concepts through the use of arbitrary symbols and rule-governed combinations of those symbols" (Owens, 2012, p.6). Comparatively, communication is the intentional exchange of information, thoughts and wishes through the processes of encoding, transmitting and decoding linguistic and non-linguistic cues (Owens, 2012). Speech is the vocalized form in which to convey meaning to another individual (Owens, 2012). Typically developing infants begin the process of communication through sounds like crying and laughing to convey needs and wants, developing over the following five to seven years, resulting in the ability to convey thoughts and ideas through speech (Allen & Marotz, 2010).

Language deficits are one of the key defining characteristics of autism (Eigsti, de Marchena, Schuh, & Kelley, 2011 Geurts & Embrechts, 2008; Groen et al., 2008; Kellerman, Fan, & Gorman, 2005). Just as autism is a spectrum disorder, a spectrum of language impairments is present across the disorder. Some children may not speak; other children may display language skills, but struggle with using language effectively to communicate. For example, a child may have a large vocabulary, but frequently use repetitive or rigid language, focus conversation with others on narrow interests, unevenly develop language, or struggle to perceive and use nonverbal communication skills (NIDCD, 2010). Most commonly children with autism who do have language skills have impairments in pragmatics, syntax, morphology, semantics, phonology and prosody

(Eigsti et al., 2011). In an analysis of studies previously conducted in language impairments of individuals with autism, Groen et al. (2008) suggests specifics in language skill deficits to include: delayed, but not necessarily impaired phonology; difficulties in understanding and expressing semantics; specific syntactic deficits, sparse expressive language and undeveloped syntactic skills; and most commonly, pragmatic and prosodic deficits, often remaining a linguistic impairment throughout life.

A growing body of research continues to try to identify specific areas of language impairment in individuals with autism. In examining speech, syntax, semantics, coherence, inappropriate initiation, stereotyped language, use of context, nonverbal communication, social relationships and interests, children with autism may demonstrate more language deficits than typically developing peers in all areas (Geurts & Embrechts, 2008). In comparing children with autism to children with specific language impairment (SLI) and typically developing preschoolers, a profound deficit of language skills for children with autism compared to typically developing peers may exist, and children with SLI and children with autism may display similar impairments (Geurts & Embrechts, 2008).

Whitehouse, Barry and Bishop (2008) compared language profiles, oromotor skills and autism-related behaviors between children with autism and children with SLI. Assessments measuring language and memory suggested no shared visible characteristics for language deficits in children with autism and SLI, suggesting a difference in language dysfunction between individuals with an SLI and autism. Yet, two or more impairments across autism-related domains were suggested to lead to low scores in non-word repetition, similar to the language profile of an individual with SLI. While the profiles are different between an individual with SLI and individuals with autism, there may be an underlying shared system between these two groups.

In addition to speech production, auditory perception is an important element of language development. The process of following sounds through a sequence, such as words in a sentence, may be impaired in an individual with autism, therefore reducing the comprehension of conversational speech (Berger, 2002). Instead, an individual with autism may perceive chaos from the plethora of auditory stimuli around him or her. Research has explored why auditory perception may be impaired in autism. Suggestions include delayed processing of speech sound in the brain within the left temporal area and the left auditory cortex (Kasai et al., 2005), intact sound processing structures, but impaired elements such as orientation to sound changes in speech (Ceponiene et al., 2003; Whitehouse & Bishop, 2008) or discrimination between different sound stimuli (Tecchio et al., 2003). Individuals with autism also may passively listen to speech, perceiving it as strange noise rather than functional language (Boddaert et al., 2003).

Despite the reason for the impairment, when perception of language is impaired, language skills will likely be slow to develop, and searching for mediums to promote auditory perception is important for facilitating language, speech and communication. Music could be one such medium in that it may be perceived and processed more readily in the brain of an individual with autism. In a study investigating the focus of attention toward speech, Whitehouse and Bishop (2008) suggested that the process of encoding speech sounds is impaired in individuals with autism, perhaps due to an active aversion to speech sounds. The researchers measured the neural activity in the brain of individuals with autism as they were presented with speech sounds and non-speech tones. Results indicated that while speech sounds did produce processing levels on brain output imaging, novel tones generally caught the attention more effectively. Thus an individual with autism may process speech tones in the brain, but behaviorally produce greater attention to the auditory stimulation of novel tones. Comparatively, Dawson, Meltzoff, Osterling, Rinaldi and Brown (1998) explored orientation toward sound stimulus in children without a disability, children with Down syndrome, and children with autism. Compared to typically developing children and children with Down syndrome, the children with autism struggled to orient toward the sound of their name and hand clapping; however, they did demonstrate fewer orienting errors toward non-speech stimuli, such as a rattle or musical toy. These studies suggest that using novel sounds, possibly with musical characteristics, may provide more effective means for an individual with autism to process auditory stimulation.

Researchers have sought correlations between language skills and other developmental skills. Studies in the field of language development for children with autism have suggested that play skills may be a predictor of language skills, and as an intervention may cultivate language in children with autism. Correlations were found between toy play ability and language skill growth suggesting that play skills may affect language development (Toth, Munson, Meltzoff & Dawson, 2006). Other studies have supported the relationship between language and play skills in children with autism (Pry, Peterson & Bahgdadli, 2009) and researchers suggest that young children with autism can be taught these play skills, possibly in turn developing language skills (Kasari, Paparella, Freeman & Jahromi, 2008). For children with autism, it may be beneficial to use a measurement tool that will address language development through an authentic experience like play. The Individual Growth Development Indicator (IGDI) Early Communication Indicator (ECI) assessment utilizes play and communication between a child and adult to measure current levels of language development, creating an ideal measurement tool to assess communication skills (http://www.igdi.ku.edu/).

In addition to sensory processing challenges, language deficits can affect a child's educational experience. Temple Grandin discusses education for a child with autism, writing, "the different thinking patterns of individuals with autism require parents and educators to teach from a new frame of reference, one aligned with their autism way of thinking. Expecting children with autism to learn via the conventional curriculum and teaching methods that 'have always worked' for typical children is to set everyone up for failure from the start" (Grandin, 2008, p.25). Language impairment affects many domains of an individual with autism's life. While production of language is often impaired for an individual with autism, the perception of language may also be impaired. Speech may not be the most readily perceived form of language for an individual with autism, and other ways of producing language should be explored. In addition to academic skills, music learning skills may be affected by this impairment. Both sensory impairments and language skill deficits may affect the learning outcomes, active participation and musical learning possibilities for a student with autism in the music classroom.

Prosody

Prosody is an element of language and communication that utilizes cues of duration, intensity and frequency (Boutsen, 2003), including emphasis, pitch accenting, rhythm, and intonation (Wagner & Watson, 2010). Prosody encompasses many levels of deep organization and grouping, functioning both internally (perception) and externally (production) (Groen et al., 2008). Perception of prosody makes use of language systems to organize and group speech gestures to provide meaning, where production of prosody is the intentional choices in speech of emphasis, inflection, rhythm, and word stress in order to convey meaning (Bousten, 2003). Though prosody is important in language use, prosodic rhythm and intonation of speech is not a primary element, but rather a secondary formation of speech (Pitt & Samuel, 1990). Prosody in speech is a by-product of language, not a construct upon which it is built (Patel, 2008).

Prosody is frequently utilized in speech perception. Though our language is not organized through prosodic production and perception, it may assist a listener in attending to speech, in that cues of normal sentence rhythm may aid in the perceptual process (Pitt & Samuel, 1990). A classical theoretical framework of prosody advocates classifying languages based on prosodic elements, such as stress-timed (English), syllabic-timed (romantic languages such as French and Italian) and mora-timed (Japanese) (Pike, 1945). This theory is contested with both proponents and opponents to the perception of these classifications. Nazzi, Bertoncini and Mehler (1998) explored how infants perceive language based on prosody. Results indicated that the infants could discriminate English from Japanese sentences, however, could not discriminate between

English and Dutch, two languages from the same prosodic categories. This study suggests that rhythmic information may be an important element in acquisition and perception of speech, even at the very early stages of language development.

Though prosodic groupings can aid in speech perception, individuals with autism may display language impairments in the both the perception and production of prosody. Compared to typically developing peers, children with high functioning autism matched on verbal and mental age showed a significant difference in prosodic ability, demonstrating much lower prosody development (McCann, Peppe, Gibbon, O'Hare & Rutherford, 2007). Children with autism may also demonstrate less appropriate phrasing, and resonance qualities compared to typically developing peers (Shriberg, Paul, McSweeny, Klin & Cohen, 2001). Perception and production of tasks involving stress may be the most significantly impaired element of prosody for children with autism (Paul, Augstyn, Klin, & Volkmar, 2005). Children with autism often struggle with this unstructured, but important element of speech perception. Possibly, through a predictable and temporal system, prosody may be more readily perceived for individuals with autism.

While prosody does help a listener organize thoughts and ideas through rhythmic and melodic cues, prosody becomes a by-product of language opposed to a true organizing principle. Individuals with autism may struggle with prosodic perception, and may require a stronger organization. Rhythmic qualities of speech may be important in the acquisition of speech, and if a stronger and predictable pattern could be applied to speech, individuals with autism may be better able to organize both sensory systems and information from language.

Elements of Music

Music contains many elements, such as rhythm, pitch, melody, harmony, timbre, texture and expressive qualities. Like language, music is also made of sound sequences that are complex and meaningful, but music organizes pitch and rhythm differently than language, though language provides specificity through semantic meaning that music lacks (Patel, 2008). By examining two aspects of music – rhythm and melody – there may be a framework to theorize why music may be an effective tool to address the sensory organization and prosodic language needs of individuals with autism.

Rhythm

Rhythm is present in language and communication, and in music. The rhythm of language and communication is prosody, which can be compared to the rhythm present in music. Through analysis of many studies on the rhythm of language, Patel (2008) suggests that prosody is not an organizing principle of language. Instead, it is an outcome of communication rather than a systematic structure. Prosody is perceptually adaptive in speech through phrases and accents, but it does not occur at regular intervals. There are, however, similarities between the rhythm of language and music. Both systems utilize rhythm to reinforce grouping, or perception of boundaries, where the elements between the boundaries come together in order to form a unit that is based in time (Wagner & Watson, 2010). Research indicates that the perception of rhythmic grouping may share cognitive resources in both the linguistic and nonlinguistic (musical) domains (Patel, Peretz, Tramo & Labreque, 1998) and instrumental music may reflect the speech rhythm patterns of a composer's native language (Patel & Daniele, 2002).

Though there appears to be a basis for similarities of the rhythmic elements across the domains of language and music, this study suggests that the unique organizing principles of the rhythm of music supports a framework for using music to develop language skills for individuals with autism.

Predictable patterns in rhythm are common in children's music; therefore, the discussion on rhythm will be limited to music with predictable patterns and a temporal structure. When a steady beat is present in a musical work, the rhythm is a construct of the composition, providing a temporally predictable periodic structure (Patel, 2008). This is unlike language where periodic rhythm is not the foundational structure of speech. According to Large and Jones (1999), attention is more readily allocated when events are tracked within a temporal system and can be predictable within an internal rhythmic structure. Comparatively, predictability in rhythmic stress of language may contribute to better detection of sounds within words (Pitt & Samuel, 1990). When a predictable pattern is present, attention to language and sound detection may improve. Thus a predictable pattern could more readily facilitate language skills. Therese Jolliffe, an adult with autism, describes her enjoyment of Baroque music and cantering on horseback. The rhythmic quality of music and the rocking motion of the horse both provide a steady rhythmic element (Joliffe, et al., 2001). Musical rhythm may be able to provide this predictable, temporal system that language lacks, offering an internal sense of stabilization to an individual with autism by providing a temporally predictable system. The rhythmic drive of music may facilitate an organization of the sensory systems and lead to appropriate perception and use of language.

Rhythmic perception may not require intense music training to accurately perceive rhythmic elements. Both musically trained and untrained individuals are able to perceive meter and rhythmic change in a similar way (Geiser, Ziegler, Jancke, & Meyer, 2009), indicating that rhythm may be accessible to young children not trained in music. In fact, rhythm may provide a significant role in how music is perceived for young children, in that young children were able to perceive rhythmic information more readily than melodic material (Demorest & Serlin, 1997). The uniqueness of music's predictable, temporal rhythm may explain why individuals with autism may respond well to music.

Melody

Similarly, melody also exists in language and communication, and music. In communication, prosody is similar to musical language through intonation, pitch accents, and inflection. Often, a speaker uses changes in the fundamental frequency over time to convey meaning. Speech intonation can be used to imply related ideas in a spoken expression, as well as conveying emphasis, attitude and emotional state (Patel et al., 1998). Based on the prosodic processing and musical intonation perception in patients with brain damage, Patel et al. (1998) suggests that perception of speech intonation and melodic contour share cognitive and neural resources. Comparatively, Doherty, Fitzsimons, Asenbauer and Staunton (1999) suggest that though they are closely related processes, melodic contour and prosody undergo distinct processing as well. Through the emphasis in musical intonation and melodic contour, the neural processes for linguistic intonation may develop more readily.

Much like the rhythm of speech, the melody of speech is perceptually adaptive, but important in helping to organize ideas one is attempting to communicate. In conversational speech, it is suggested that the pitch intervals and fundamental frequency of conversation can vary across speakers and within sentences of the same speaker (Bousten, 2003). This variance does not provide a stable framework that a listener can utilize for organization of sound. However, melodies with stable tonality, and pitches that occur at regular intervals, are more easily remembered than melodies that function in an atonal framework (Boltz, 1991). Providing a stable, tonal melody to conversational speech may assist in the comprehension and allocation of intention.

Melodies with a tonal center are common in children's music; therefore the discussion on melody will be limited to music with a tonal center. Research indicates when the melody of a piece is highly organized around a single pitch, known as the tonal center, a strong foundational reference point is provided, with all other pitches related to the tonal center (Krumhansl & Kessler, 1982). The tonal center creates a perceptual gravitational pull to all the other pitches within the melody. A growing body of research suggests that other pitches are perceived in relation to the tone center in a hierarchical fashion (Janata, Birk, Tillmann & Bharucha, 2003; Krumhansl & Kessler, 1982; Patel, 2003; Stinke, Cuddy & Holden, 1997). For example, Stinke et al., (1997) suggest that listeners perceive the fifth and the third of a scale to be more closely related to the tonal center than the other diatonic notes, and chromatic notes are perceived least related to the tonic center. These relations within a musical melody create a highly organized structure, which may facilitate a strong set of perceptual relations that can lead to even more cognitive processes (Patel, 2003; Patel, 2008). Individuals with autism often perceive chaos from conversational speech, thus if the strong tonal organizational principle of melody could be applied to speech, it could aid in auditory organization for an individual with autism. This point of reference could aid in the perception and memory of language, creating a possibility for better comprehension and application of the meaning in conversations.

The loose framework of rhythm and melody in linguistics may not provide the same sense of organization that music can offer through a steady beat and tonal center. However, the ability of music to provide a temporally predictable and perceptually constant grouping structure through rhythm and melody may benefit an individual with autism. While rhythm and melody in language is adaptive and unstable, a predictable pattern in music may support detection of sound and attention to language. The temporal organization and gravitational pull to a tonal center may assist in the sensory organization for an individual with autism, helping to calm sensory systems, and leading to better perception and processing of speech and language in addition to academic and musical learning.

Neurological Perspectives

Though many studies have examined the use of music for individuals with autism, a possible rationale for the success of music-based interventions is rarely explored. Neurological research in sensory systems, language, music and autism may suggest a theoretical framework to explain why music might stimulate and aid in the development of language skills and sensory organization. Current theories of autism support the notion that the disorder can be explored from a neurological perspective, in that development process, structure, and connectivity of the brain may differ from typically developing individuals. Two theories to be discussed are weak central coherence theory and temporal binding.

Weak Central Coherence Theory

The theory of weak central coherence (WCC) suggests an explanation for the processing abilities in the brain and the cognitive style of an individual with autism (Frith, 1989). Information processing may be impaired in individuals with autism (Frith & Happé, 1994). Typical processing of information consists of the brain sending incoming stimuli to varying local areas of the brain. These local areas weave information together to be processed globally throughout the brain, resulting in the ability to create higher-level meanings. Frith and Happé term this process as "central coherence" (1994, p.121).

The weak central coherence theory asserts that individuals with autism are deficient in central coherence, demonstrating impairment in global processing, and instead succeed more readily in tasks that only require processing in local areas of the brain. WCC occurs in autism when, "the ability to integrate information across a variety of contexts (perception, attention, linguistic, semantic) for higher-level meaning is impaired" (Iarocci & McDonald, 2006, p.80). When an individual with autism receives information, WCC suggests that instead of being able to make a representation of the whole picture that would lead to a higher-level cognitive process, the small, and often unimportant, details of the information become the focus (Frith & Happé, 1994). WCC theory may also explain the deficit of sensory processing, in that neural networks are not able to communicate across the brain in order to provide an appropriate response to sensory stimuli. A consensus has yet to be reached on the validity of WCC and various studies have presented contrasting findings to support other theories in how the brain of an individual with autism may perceive and process information.

Enhanced Perceptual Functioning proposes an alternate theory, suggesting that perceptual operations explain general processing abilities. The Enhanced Perceptual Functioning theory suggests that individuals with autism display superior performance in perceptual abilities in one sensory stimulus (typically auditory or visual). This theory supports locally oriented functioning like WCC, but argues neural-networks are overspecialized, enhancing perceptual processing in localized networks through tasks like pitch and semantic recognition (Järvinen-Pasley, Wallace, Ramus, Happé, & Heaton, 2008). This suggests a greater freedom of discrimination between higher-level functions, contrasting WCC's claim that high-level functions are impaired (Mottron, Dawson, Souliéres, Hubert & Burack, 2006).

Contrasting theories suggest differences in the impairment or enhancement of local or global processing. WCC theory assumes impaired global processing and normal local processing. Other researchers speculate that local processing may be enhanced, but global processing is not impaired (Iarocci & McDonald, 2006; Kellerman et al., 2005), where different studies report normal local and global processing abilities in individuals with high functioning autism (Mottron, Burack, Iarocci, Belleville, & Enns, 2003). WCC may also be present in some individuals with autism, but it may not be a universal impairment across the disorder (Lopez, Leekam, & Arts, 2008). While there is not an agreement regarding WCC, a growing body of research supports it in auditory (Foxton et al. 2003) and visual tasks (Happé, 1999), through the theory of underconnectivity between brain areas in the brains of individuals with autism (Just, Cherkassky, Keller, Kana & Minshew, 2007) and through temporal binding.

Temporal Binding

The theory of temporal binding provides a neural framework to explain the WCC theory. Temporal binding in typically developing individuals may be responsible for "the flexible integration of information, allowing the perception and representation of novel object and environment" (Brock, Brown, Boucher, & Rippon, 2002, p. 214). In comparison, "combination coding" represents the integration of well-learned information (Brock, Brown, Boucher, & Rippon, 2002, p. 214). Individuals with autism may have a deficit in temporal binding, and rely heavily on combination coding, resulting in difficulty integrating novel information. Thus, while processing *within* local networks may be intact, (explaining proposed standard local processing abilities) the impairment in temporal binding may exist *between* local networks, resolving the proposed impairment in global processing of the WCC theory (Brock et al., 2002; Rippon, Brock, Brown & Boucher, 2007).

The temporal binding deficit in autism may be understood through brain activity. The gamma frequency band is a measurement of brain activity, appearing at the occurrence of higher-level processing, recorded through the use of an electroencephalography (EEG). The gamma frequency band has been observed in response to visual perception of illusionary shapes (Tallon-Buandry, Bertrand, Delpeuch, & Pernier, 1996). The gamma band may also create representation of objects that originate from sensory input (Tallon-Buandry & Bertrand, 1999). The temporal binding deficit theory hypothesizes that one of the causes of the deficit is due to abnormal gamma activation in individuals with autism (Brock et al., 2002). Preliminary studies using EEGs have reported abnormalities of sensory stimulated gamma activity in the brain of an individual with autism in visual perception (Grice et al., 2001). Research also suggests that gamma band activity plays a role in auditory functions as well. Gamma band activity may result from auditory stimuli and be variable within time. Through this variability, the gamma band may reflect expectancies for pulse and meter, and able to be synchronize with outside stimuli (Zanto, Synder, & Large, 2006).

Drawing conclusions from these research projects, the use of rhythm could manipulate the frequency of gamma band activity, and assist in increased gamma band activity in the brains of individuals with autism. This might allow neural networks to communicate across domains (which according to the WCC theory, is impaired), and bring about more high-level cognitive processes, resulting in a less severe temporal binding deficit. As musical rhythm is presented to an individual with autism, the gamma band may synchronize to the outside, predictable stimuli, leading to sensory organization and in turn facilitate language skills. The proposed hypothesis is based on many theories that do not yet have a strong consensus; much more research is required to thoroughly explore this idea.

The Brain, Language and Music Connection

Research indicates a neurological reasoning for language impairments in autism. Certain brain areas in an individual with autism may follow a different developmental process than those of typically developing individuals (Groen et al., 2008). This may be due to structural abnormalities in the language systems of the brains of individuals with autism (Alexander et al., 2007; Bigler et al., 2007; Groen et al., 2008; Jou, Minshew, Keshavan, Vitale, & Hardan, 2010). In typically developing individuals, the cerebellum (located in the back portion of the brain) contains more than 10% of the brain's total volume, and more than 50% of neurons in the entire nervous system and is responsible for maintaining equilibrium, muscle tone and the coordination of muscle movement (Bard & Bard, 2002). Recent studies have also suggested the cerebellum may be responsible for language processing (Booth, Wood, Lu, Houk & Bitan, 2007). For individuals with autism, functional magnetic resonance imaging has suggested an abnormality in the structure of the cerebellum as a factor for language impairments in autism (Allen, Müeller & Corchesne, 2004). Changes in brain structure create differences in the function of these structures. Understanding changes in brain structure and function may further support a rationale for the use of music to enhance language development for children with autism. Of note for individuals with autism and in consideration of music processing, are the brain's gray matter, hemispheric functions, the corpus callosum, and superior temporal gyrus.

The brain's gray matter, also known as the cerebral cortex and located at the front of the brain, contains over 50 billion nerve cell bodies, with ridge-like bulges called gyri, and small grooves called sulci and fissures. The gray matter is where memory, creative thought, and intelligence are based (Bard & Bard, 2002). Brains of professional musicians are reported to have increased density of gray matter in regions of the frontal cortex (Patel, 2008). Gray and white matter is also reported to increase in the brain of a child with autism during the second to third year of life (Groen et al., 2008). Since the brain makeup of both individuals with autism and professional musicians is densely packed with nerve cell bodies, this may provide some clues as to the responsiveness to music by individuals with autism reported in music therapy literature (Reschke-Hernandez, 2011; Whipple, 2004; Kaplan & Steele 2005; Wan, et al., 2010).

Hemispheric findings.

The brain is divided into the right and left hemispheres, and neurologists have suggested that these sides process different categories of information. Investigations reveal that individuals with autism may demonstrate a reversed hemispheric dominance in language processing, in that language processing for an individual with autism might reside in the right hemisphere, unlike typically developing individuals whose brains process language in the left hemisphere (Boddaert et al., 2003; de Fossé et al., 2004; Groen et al., 2008; Müller et al., 1999; Zatorre, 2005). In typically developing individuals, Wernicke's areas is associated with speech processing, where Broca's areas is typically associated with the production of speech (Bard & Bard, 2002). The brain of an individual with autism may also function differently, such as a greater reliance on

Wernicke's area than Broca's area compared to typically developing individuals in sentence comprehension. This suggests that individuals with autism focus more on individual words within a sentence compared to the meaning of the whole sentence (Just, Cherkassky, Keller, & Minshew 2004). Such findings continue to support the notion of deficient integration across language processing systems in the brain.

While language processes, such as phoneme perception and mapping, and speech sound processing, activate areas of the left hemisphere, musical elements, such as pitch and melodic contour, activate the right hemisphere (Patel, 2008). Investigations also indicate that rhythmic processing takes place in the right hemisphere (Thaut, 2003). Studies on individuals with brain lesions support these notions, such as Peretz (1990), in which data indicated the left hemisphere perceives local features of melody such as specific pitches, while the right hemisphere works to represent global aspects of a melody such as melodic contour and pitch relationships. Other studies also indicate that processing of melodic material is strongly influenced by the right hemisphere of the brain (Dennis & Hopyan, 2001; Peretz, Gagnon, Hébert, & Macoir, 2004). Therefore, if music is primarily processed in the right hemisphere and it is believed that children with autism also process language in the right hemisphere, music-based stimulation may be effective in activating language processing in children with autism.

The corpus callosum.

The corpus callosum is made up of nerve fibers and functions as a bridge to connect processing between the left and right hemisphere of the brain. A stronger connection in the corpus callosum can aid in bilateral processing, where the two hemispheres of the brain share information (Bard & Bard, 2002). Neurological findings regarding the corpus callosum indicate a connection between music and autism. Research has explored processing between both hemispheres of the brain, termed bilateral activation, in the brains of musicians. When right-handed musicians and right-handed non-musicians were given visual stimuli in the right and left visual fields, EEG data suggested that musicians displayed more bilateral neural connectivity than non-musicians. The non-musicians demonstrated asymmetry between the right and left brain, suggesting that non-musicians may not process information across the areas of the brain as readily as musicians might (Patston, Kirk, Rolfe, Corballis & Tippett, 2007). More recently, Ono et al. (2011) explored how tasks involving pitch, chord structure, timbre and rhythm might affect hemispheric laterality in musicians and non-musicians. Through measures of brain activity, data suggested that musicians showed symmetrical amplitudes in all musical tasks in both hemispheres while non-musicians displayed right-hemispheric dominance.

It has also been reported that the size of the corpus callosum of male professional musicians might be larger than those of male non-musicians (Lee, Chen, & Schlaug, 2003), while the size of the corpus callosum in individuals with autism has been shown to have smaller total volume (Alexander et al., 2007). This smaller volume may inhibit the ability to share information across the two hemispheres. However, the corpus callosum size of young children might increase due to musical training (Schlaug et al., 2009). Considering the previous research, musical training may stimulate the corpus callosum in young children with autism, leading to an ability to engage the corpus callosum to facilitate processing across both hemispheres of the brain, which may otherwise be absent.

Superior temporal gyrus.

Individuals with normal brain function utilize the left superior temporal gyrus (STG) for language, while the right STG controls social perception. The brains of individuals with autism may show abnormalities in the STG (Bigler et al., 2007; Jou et al., 2010). Differing opinions from the result of studies question the abnormalities of the STG. In Bigler et al. (2007) MRI images comparing individuals with autism and typically developing individuals indicated no volumetric differences in the STG. Conversely, other MRI images have indicated statistically significant enlargement of the STG in the participants with autism after controlling for age and total brain volume. Post-hoc results also indicated a reduction in the right posterior STG (Jou et al., 2010).

From a musical standpoint, the STG processes melody. In an examination of individuals who have undergone surgical excisions in the STG for relief from seizures, Liégeois-Chauvel, Peretz, Babaï, Laguitton, & Chauvel (1998), indicated that damage to the right STG results in a total processing disruption to melody. However, if the left STG is compromised while the right side remains intact, melody may still be processed efficiently. If the STG in individuals with autism is indeed enlarged on the right side (Jou et al., 2010), where music is processed, an individual can perceive melody more readily than language.

These neurological findings support a strong framework to use music as an intervention for individuals with autism. Research in the neurological foundations of music tend to point toward music's ability to stimulate or activate areas of the brain often found to be abnormal in individuals with autism. Research also suggests shared cognitive processes exist between language and music. Many of these cognitive processes may be deficient in the brain of an individual with autism, and music might provide a different approach to stimulating these processes, which might in turn stimulate language development centers. Further neurological research in music, autism and language should be geared to address these hypotheses.

Conclusion

In conclusion, a strong theoretical framework exists to utilize music as an intervention for individuals with autism. Findings in the organizational principles of music rhythm and melody suggest a stronger concrete organizational structure that is not perceptually or temporally adaptive, compared to that of language. This may facilitate a better response to language presented musically compared to speech. Neurological research suggests that music may relate or stimulate areas of the brain that are abnormal in individuals with autism, especially in the areas of connectivity across the brain and language development centers. While these conclusions from a large body of research can be suggested, additional research in neurology and music interventions should be conducted to explore these areas further.

Music educators must respond to these possibilities that exist between music, brain development, autism and language. Music educators may help individuals with autism succeed in the music classroom through the use of rhythm and music. When an individual with autism enters the music classroom, many elements of the child's needs must be addressed, particularly in the areas of sensory organization and language perception and speech production. It is the music educator's job to address these needs in order to provide the best and most appropriate musical instruction for the child. Fortunately, as revealed through the strong theoretical foundation of previous neurological, linguistic, musical, and autism research, elements of music may be able to address these needs of a child with autism. However, the music educator must be willing to explore ways to specifically target rhythm and melody for the students with autism in the general music classroom. When sensory organization and language development is targeted through music, musical learning may more readily take place. This study will further explore how music may facilitate learning experiences to address the needs of children with autism, and make practical suggestions for music educators to use in the general music classroom.

Based on the examination of research in autism, language, music, and neurology, this study will address the following research questions:

1) Does rhythm-based speech enhance sensory organization more effectively than conversational speech for children with autism spectrum disorders?
2) Does rhythm-based speech plus melody enhance sensory organization more effectively than conversational speech and rhythm alone?
3) Does rhythm-based speech enhance language production more effectively than conversational speech for children with autism spectrum disorders?
4) Does rhythm-based speech plus melody enhance language production more effectively than conversational speech and rhythm alone?

CHAPTER 3

METHOD

This study used a counterbalanced measures design randomized for the first condition to address the following research questions:

1) Does rhythm-based speech enhance sensory organization more effectively than conversational speech for children with autism spectrum disorders?
2) Does rhythm-based speech plus melody enhance sensory organization more effectively than conversational speech and rhythm alone?
3) Does rhythm-based speech enhance language production more effectively than conversational speech for children with autism spectrum disorders?
4) Does rhythm-based speech plus melody enhance language production more effectively than conversational speech and rhythm alone?

Participant Characteristics

Participants were a convenience sample (N = 5) of male children aged five to nine with an educational diagnosis of Autism Spectrum Disorder. Participants were recruited from those being taught by the researcher prior to the study, and were in a specialized instructional program for autism at a large suburban public elementary school. The school receives federal funds through the Title I program due to the high population of students that receive free or reduced lunch. The school has 468 students enrolled, including 43 students who receive special education services, and 17 students who are in the specialized instructional program.

In addition to the educational diagnosis of autism, eligible participants received special education services documented on an Individual Education Plan (IEP) and spent at least 20% of the school day in a specialized program as indicated on the IEP. Eligible students also attended music class with typically developing peers for 45 minutes once a week. Prior to the study, these students attended a weekly 20-minute specialized music instruction class designed to address academic, language and social goals, and to provide sensory organization. Eligible students demonstrated below average language abilities for their age. Permission was given by the building principal and the district Director of Elementary Education to conduct the study in the school. Subsequent review was conducted by the University of Missouri-Kansas City Social Sciences Internal Review Board, which granted approval.

Sampling Procedures

The researcher contacted the special education teachers and speech language pathologist (SLP) at the elementary school to determine which students met eligibility for the study. The teachers and SLP provided the student-researcher with a list of names of students in the program who meet eligibility. Five students were identified by the school administration as appropriate for recruitment. All eligible participants were male.

Following approval from the University of Missouri – Kansas City's SSIRB (see Appendix A) the researcher contacted all five families with a letter sent home to request participation in the research study, followed by a telephone call to discuss the informed consent. All five families granted permission for their children to participate in the study.

Recruitment

After receiving approval from the SSIRB (see Appendix A) a letter briefly introducing the study was sent home with the child to the parent(s) of each eligible child, notifying the parent of the study and eligibility (see Appendix B). Two days after sending the letter, the parent of an eligible child was contacted by telephone to arrange a time to meet privately with the researcher at the school to discuss the study. Protocol determined if the parent(s) stated "no" they would not like for their child to participate, then the researcher thanked them for their time and consideration. If the parent(s) expressed interest in the meeting, the researcher arranged a time to present the informed consent.

At the meeting time, an invitation was extended for the child to participate in the study and the parent was given the opportunity to sign the informed consent or decline the invitation to participate. It was communicated that the child's opportunity to participate in regularly scheduled classroom and specialized music classes would not be affected if a parent chose not give permission for the child to participate in the study. Students were enrolled in the study after obtaining informed consent from the student's parent(s). All parents expressed an interest to discuss the informed consent in a telephone call. The informed consent was sent home for the scheduled telephone meeting. During the phone meeting, the research project and letter of informed consent (see Appendix C) were presented to the parent(s). The researcher read the consent form with the parent(s) and stopped after each section to check for understanding and give the opportunity for the parent(s) to ask questions. When the informed consent document was fully read with the parent, the researcher asked if the parent had any other questions. Once questions were clarified or if there were no additional questions, the researcher asked, "Will you allow your child to participate in this study?" If the parent(s) stated, "yes," the parent was asked to sign the informed consent document, send it back to school with his or her child, and was given a copy for their records. If the parent stated that he or she was unsure or would like to think about it, the researcher sent home a self-addressed stamped envelope and asked them to mail the consent if they decide to participate. If the parent(s) declined to have the child participate, the researcher thanked them for their time and consideration. If at any time during this meeting the parent(s) stated that they were not interested, the parent(s) were thanked for their time and the meeting ended. All parents contacted agreed to participation in the research study.

Measures and Covariates

The study measured a demonstration of sensory organization and language production pre-, during and post intervention for three conditions (conversational speech, rhythmic speech, and rhythmic speech plus melody). The dependent variable measures for sensory organization were frequency of unrelated vocal noises and restricted repetitive stereotyped (RRS) behavior. For this study, RRS behavior was defined as inappropriate hand movement, head motion, or body movements. Inappropriate hand movements were operationally defined as flapping, waving, clasping or squeezing the hands. Inappropriate head motion was defined as rolling, shaking or nodding the head. Inappropriate body movement was operationally defined as rocking, spinning, jumping, or leaving the area of intervention.

The dependent variable measures for language were frequency of gestures, vocalizations, single word utterances and multiple word utterances. For this study, gestures, vocalizations, single word utterances and multiple word utterances were defined by the assessment for communication skills definitions from the Early Communication Indicator (ECI) of the Individual Growth and Development Indicators (IGDI) (http://www.igdi.ku.edu/). Gestures were defined as physical movements made by a child in an attempt to communicate. Vocalizations were defined as non-word verbal utterances, occurring alone or with gestures. Single word utterances were individual words voiced by the child that are recognized and understood by the person hearing them. Multiple word utterances were two or more different words voiced by the child that are understood by the person hearing them.

The sensory and language data were recorded during the study protocol using naturalistic observation. Volunteers recruited from the special education aides and special education teachers at the school were baseline and intervention data collectors. All data collectors were familiar with the participants. Those scoring the data ($N = 2$) were trained in the terminology for measuring sensory organization and pre-linguistic skills and achieved reliability, greater than or equal to .8. Linguistic and behavioral data were gathered during protocol implementation by recording frequency of unrelated vocal noises and RRS behavior for sensory organization using event recording (see Appendix D).

The free-play pre- and post-test was modified from the Individual Growth Development Indicator (IDGI) Early Communication Indicator (ECI) assessment (http://www.idgi.ku.edu). The ECI assessment is conducted using a toy barn, where the child plays alongside an adult and communication skills are observed. Research indicates that toy play ability may be associated with future and current language skills for individuals with Autism Spectrum Disorders (Kasari, et al., 2008; Pry, Peterson, & Bahgdadlim, 2009; Toth, Munson, Meltzoff & Dawson, 2006). This assessment is designed to measure gestures, vocalizations, single-word utterances and multiple-word utterances. The IGDI and ECI have had limited use as data collection tools for children with autism and the researcher observed concerns for reliability without video recording. Permission to video record was not granted by the school district and was therefore not used for this study. As a result, the IGDI and ECI assessment data collection tools were not used as written for the study and only the response definitions of pre-linguistic language skills were utilized. The researcher developed a data collection tool to accommodate event recording of RSS and linguistic behavior data within the context of naturalistic observations (see Appendix D).

Research Design

Each participant served as his own control in a counterbalanced design randomized for the first condition as seen in Table 1.

Table 1

Order of Interventions By Participant, Randomized for the First Condition

Subjects	Conversational Speech	Rhythmic speech	Rhythmic speech plus melody
A	1	2	3
B	2	3	1
C	3	1	2
D	2	1	3
E	1	3	2

The participants were assigned the order of the interventions based upon the order of his enrollment in the study. Every intervention occurred with a single participant, the researcher, and two data collectors (who did not interact with the child). Each participant experienced the intervention in one condition three times over the course of one week, followed by three times in the other two conditions in subsequent weeks. Each protocol lasted eight minutes with pre-assessment, intervention, and post-assessment where behavioral and language data were observed and recorded using naturalistic observation. Outcomes from each participant were clustered by condition type for statistical analysis.

Experimental Interventions

Intervention Theory

A foundational theoretical framework may support the use of music as an effective intervention for children with autism. Rhythm and melody may be an avenue to facilitate sensory organization through the organization and temporal sense of music. Research suggests that children with autism may experience a feeling of chaos from sensory stimuli, affecting the educational experience for a child with autism (Grandin, 2006; Joliffe, et al., 2001; Lane, et al., 2010; Pfeiffer, Kinnealey, et al., 2005). If music can facilitate a sense of order for the child, it may provide a more ready state for learning (Kern et al., 2008). Linguistic organization through prosody can be perceptually adaptive, where the same sentence often varies across individual speakers (Bousten, 2003). Musical organization through rhythmic and tonal elements can be the constant across multiple presentations of the same song (Boltz, 1991; Janata, et al., 2003; Krumhansl & Kessler, 1982; Patel, 2003; Steinke, et al., 1997). This unique sense of organization of music through tonal and rhythmic foundations may assist in the perception of language for a child with autism.

The suggestion of using music to facilitate sensory organization and language development is not solely based on previous behavioral studies. Neurological research in linguistics, music, and autism may provide a strong theoretical framework for the effective use of music to address these needs. The structure, developmental process, and functioning of the brain for a child with autism may differ compared to typically developing individuals (Alexander et al., 2007; Bigler et al., 2007; Groen et al., 2008; Jou, et al., 2010). Also, language processing may function differently in the brain of an individual with autism compared to the brain of a typically developing individual (Berger, 2002; Boddaert et al., 2003; Ceponiene et al., 2003; Kasai et al., 2005; Tecchio et al., 2003; Whitehouse & Bishop, 2008). These differences suggest the brain of an individual with autism may perceive and process music more readily due to physical properties of the brain and the avenues through which sensory stimuli, specifically auditory stimuli, are processed. Therefore, two independent variables were present in this study: rhythm-based speech and rhythm-based speech with melody. The control condition was conversational speech.

Intervention Content

Matched-difficulty and tailored word combinations were composed and delivered in three conditions: conversational speech, rhythm-based speech, and rhythm-based speech plus melody (see Appendix E). The music used in the interventions was originally composed and aimed to reflect the natural prosody of speech. The researcher recorded three individuals reading the sentences for rhythmic-speech and rhythmic-speech plus melody, notating natural inflections, intonation and rhythm of the speech. The researcher then composed a rhythm or rhythm and melody for each sentence. The inflection and rhythm of the speech reflected the melodic line and rhythmic meter and beat of the music. Due to the purpose of increasing language skills, by intentionally matching musical elements to natural qualities of speech, generalization of the music to language may more readily occur.

The study was conducted in the school's music classroom during each student's regularly scheduled daily sensory break in the specialized instruction classroom. One goal of the study was to promote sensory organization. At this elementary school, sensory breaks are built into these students' schedule every day after lunch. Instead of participating in the 10-minute sensory break with the rest of the class, the participant received his sensory break with the researcher. Typically, the students participate in sensory organization methods to organize senses, such as a yoga DVD or a music-based activity from the specialized music class led by the special education teachers. The participants did not participate in the typical sensory break, but went to the music classroom and participated in the research protocol for three days a week across three weeks. Parents received notification through the informed consent that protocol minutes would not be accounted for in the IEP as requested by the district elementary education director.

Prior to the beginning of the study, eligible participants attended a weekly specialized music class with the researcher in addition to attending general music with typically developing peers, where the researcher was the music instructor. The researcher had offered this class for the previous four school years. In this class, students interacted in small groups with the researcher to develop language, sensory and social skills through music.

The protocol lasted eight minutes, with most of the time in the music room of the school. The room was located away from other classrooms at the end of a main hallway of the school. The classroom's door was closed in order to reduce ambient noise and distractions from others in the building. The room was set up with the Fisher-Price Little People Animal Sounds Barn® on the floor in the middle of the room and the participant and student researcher sat on the floor during the protocol. Two chairs were set up away from, but visible to, the barn. In the chairs, two data collectors were present to record the frequency of restricted, repetitive, stereotyped (RSS) behaviors and language output. One data collector recorded RRS behaviors of inappropriate hand, head and body movements and unrelated vocal noises. The other data collector recorded gestures, vocalizations, single-word utterances and multiple-word utterances. Each data collector was employed at the school in the specialized instruction program and therefore familiar with the participants.

The protocol began when the researcher went to the participant's classroom and asked that the child come with her to play with the barn. The participant followed the researcher to the music classroom. The transition from the classroom to the music classroom was estimated to take one minute and was a familiar routine to the participants. On the way to the classroom, the researcher asked the student about his day or weekend. Upon entering the room, each child participated in a baseline play-based assessment of language skills and sensory organization behaviors for two minutes. The researcher facilitated the transition into the play-based assessment period when she gave the student a picture icon from the picture exchange communication system that said "My Turn" and told the student "It's your turn." The participant was directed to the toy barn, instructed to sit by the barn toy, and was provided prompts to play freely with the animals. Prompt phrases included: "It's [participant's name] turn to play," "What does the cow (sheep, horse, etc) do?" or "Show me the sheep (horse, cow, etc.)."

After two minutes of free play, the researcher picked up the picture icon and said, "It's my turn." During the following two minutes, matched-difficulty and tailored word combinations were developed and were delivered in one of three conditions: conversational speech, rhythm-based speech, and rhythm-based speech plus melody (see Appendix E). Each animal in the barn toy was assigned a word combination delivered by the researcher in a live presentation to the individual student. Each condition included two sentences that were composed for two corresponding animals in the toy barn. During each intervention, the researcher delivered the word combinations and encouraged the child to repeat the sentences in the style of the current condition in order to facilitate language skills. The interventionist spoke or sang the sentence twice, and encouraged the child to repeat each sentence for one minute. The researcher repeated and prompted the student to echo each sentence for one minute per sentence for a total of two minutes of instruction. If the sentence was a rhythmic or melodic sentence, the researcher also tapped the animal with the rhythm while the sentence was delivered.

Following two demonstrations of the sentence, the researcher gave the animal to the student and asked him to repeat the sentence. If the student struggled with the sentence, the researcher held the animal again and repeated the sentence. If the student was unresponsive, the researcher took his hand to touch the animal, and repeated the sentence again. If the student continued to be unresponsive, the researcher continued to the other animal. During the intervention sequence, the data collectors recorded RRS behaviors and language output.

Following the intervention, the researcher gave the picture icon back to the student and said “It’s your turn,” and the student was given another two minute free-play opportunity, where RRS and language skills were again be recorded in the same manner as previously stated. The students were cued to end playtime, when the researcher sang the familiar goodbye song to signal the conclusion of the regular specialized music class. The student was escorted back to his classroom by the researcher.

Intervention Delivery Schedule

The delivery schedule was consistent across each condition and student. Each participant was presented one condition on three separate days across a single week, followed by three sessions for each of the other two conditions in subsequent weeks. The protocol lasted for approximately eight minutes: one minute transition from the classroom to music room, two minute free play (pre-test), two minute intervention, two minute free play (post-test) and one minute transition from music room to classroom. Each protocol session occurred with the researcher and a single participant. Interventions occurred at the same time every day to provide consistency.

Interventionist

The researcher served as the sole interventionist. She currently holds a Bachelor of Music Education with a minor in special education and is currently completing a Masters of Music Education degree. The researcher has taught music for four complete school years, all at the participating autism magnet school. In addition to general music classes, she has offered specialized music instruction for all four years at the participating school. Prior to her employment as a general music educator, she was employed as a paraeducator in an autism program for 5 months. The researcher has daily interaction with the children with autism, where each child attends a music class with typically developing peers in addition to a specialized music class with activities geared toward children with autism.

Treatment Fidelity

Due to the small sample size and the familiarity of the researcher and data collectors to the participant, it may be difficult to protect the identity of the child.

However, each participant was assigned a letter based on his or her enrollment in the study. The letter identifier, not the child's name, was used on the data collection forms. The list of participant names and associated letter identifier was stored in a locked closet in the music room in order to protect the participant's identity outside of the school district. All data and the signed informed consent documents were stored in a locked file cabinet in the principal investigator's (faculty advisor) university office. If the study is published in the future, no identifying information to the school or the child will be indicated.

Setting

Participants were recruited from a specialized instructional program at a public elementary school in a large metropolitan area, where the researcher taught. The school receives federal funds through the Title I program due to the high population of students that receive free or reduced lunch. The school has 468 students enrolled, including 43 students who receive special education services, and 17 students who are in the specialized instructional program.

The interventions occurred in a classroom familiar to the students within the school. The classroom was away from other students, with only the interventionist, data recorders and child participant present. The classroom had a door that was closed in order to reduce ambient noise and distractions from others in the building.

CHAPTER 4

RESULTS

This study examined the following research questions:

1. Does rhythm-based speech enhance sensory organization more effectively than conversational speech for children with autism spectrum disorders?
2. Does rhythm-based speech plus melody enhance sensory organization more effectively than conversational speech and rhythm alone?
3. Does rhythm-based speech enhance language production more effectively than conversational speech for children with autism spectrum disorders?
4. Does rhythm-based speech plus melody enhance language production more effectively than conversational speech and rhythm alone?

Participant Flow

Students were recruited from a specialized instructional program for autism at a large suburban public elementary school. Participants were recruited from a convenience sample (*N* = 5) of children aged five to nine with an educational diagnosis of Autism Spectrum Disorder. Five participants enrolled for the study and four participants were able to fully complete the study. One student could not complete 1 of the 9 sessions due to an absence from school. Table 2 displays the grade level for each participant and the spontaneous expressive language abilities in the areas of syntax and semantics compared to developmental age level norms as assessed by the school's speech language pathologist.

Table 2

Participant Demographics

Participant	Current Grade	Syntax Language Age	Semantic Language Age
A	1	3 years	3 years
B	K	4 years	4 years
C	1	5.5 years	6 years
D	K	5 years	4.5 years
E	3	2 years	2.5 years

This small sample limited the statistical power, but the counterbalanced design alleviated the statistical limitations of a convenience sample. This sample is also reflective of current music education classrooms and may provide information in an area that is under explored in the music education literature.

For these participants, obtaining assent for each child was accomplished through observation of behaviors. During the music sessions, the researcher was attuned to any behaviors that could indicate that the student no longer wished to participate (e.g. left the music room, verbally or non-verbally indicated they no longer wish to participate, screamed, or demonstrated physical resistance). Protocol for assent stated that if any of these behaviors were exhibited, the current activity would be stopped, the child supported to a calm state, and the activity would resume. If the child continued to be upset, the child would be given an opportunity to stop the activity and continue at a later date. No sessions were stopped due to the child demonstrating his desire to no longer participate through behaviors. One child politely stated that he did not want to go to the music room, but when the child's teacher asked him to go with the researcher, the child said he would like to go.

Data Analysis

This study considered multiple dependent variables (sensory organization and language skill) across the three conditions. Therefore, a one-way MANOVA was calculated examining the effect of conversational speech, rhythmic speech, and rhythmic speech plus melody on the language skills and RRS behaviors of a child with autism. The Wilkes's lambda of .095 did not indicate significant differences, F (64, 122) = 0.96, $p > .05$. Neither language skills nor RRS were significantly influenced by rhythmic speech or rhythmic speech with melody (see Table 3).

Table 3

MANOVA Results

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0.974	93.092[a]	8	20	0
	Wilks' Lambda	0.026	93.092[a]	8	20	0
	Hotelling's Trace	37.237	93.092[a]	8	20	0
	Roy's Largest Root	37.237	93.092[a]	8	20	0
Group	Pillai's Trace	1.749	0.944	64	216	0.597
	Wilks' Lambda	0.095	0.959	64	121.848	0.566
	Hotelling's Trace	3.356	0.957	64	146	0.571
	Roy's Largest Root	1.4	4.726[b]	8	27	0.001

Ancillary descriptive analyses were conducted to evaluate any differences that may indicate educational value. The post-intervention free-play data means in each condition were compared to the assessment baseline free-play for each child to determine changes in language skills and RSS behaviors across time and condition. Percent of change, or the relative change in a variable, was calculated to indicate pre-post outcome differences for Participants B, C, D, & E. Participant A was not added to the calculation, as he did not finish the melodic condition. The formula ((post-test mean - pre-test mean)/pre-test mean)*100) was calculated to indicate the ratio of change between the pre-test and the post-test. In order for the rhythm or rhythm plus melody conditions to be more effective than conversational speech alone, language score percent of change means would increase, while RRS behaviors would decrease. Percent of change means for each condition are documented in Table 4 and graphically illustrated in Figure 1. Based on the absence of significant change, no further data analysis was conducted.

Table 4

Percent of Change Means with Raw Data from Pre-Intervention to Post-Intervention

Participant	Speech Pre-Test	Speech Post-test	Rhythm Pre-Test	Rhythm Post-test	Melody Pre-test	Melody Post-test
B	68	58	71	82	66	62
C	74	66	58	47	62	57
D	71	64	32	39	73	66
E	69	79	71	68	91	61
Language Percent of Change	-5.32%		1.72%		-15.75%	

Participant	Speech Pre-Test	Speech Post-test	Rhythm Pre-Test	Rhythm Post-test	Melody Pre-test	Melody Post-test
B	20	31	24	26	0	4
C	3	1	1	4	7	9
D	0	2	0	1	0	0
E	43	81	53	99	66	92
RRS Behavior Percent of Change	74.24%		66.66%		43.84%	

Note. Language scores are the sum of all observed language behaviors (vocalizations, gestures, single word utterances and multiple word utterances) of the pre-test or post-test in each condition. RRS behaviors scores are the sum of all observed RRS behaviors (unrelated vocal noises and inappropriate head, hand, and body movements) of the pre-test or post-test in each condition. See Appendix F for raw data.

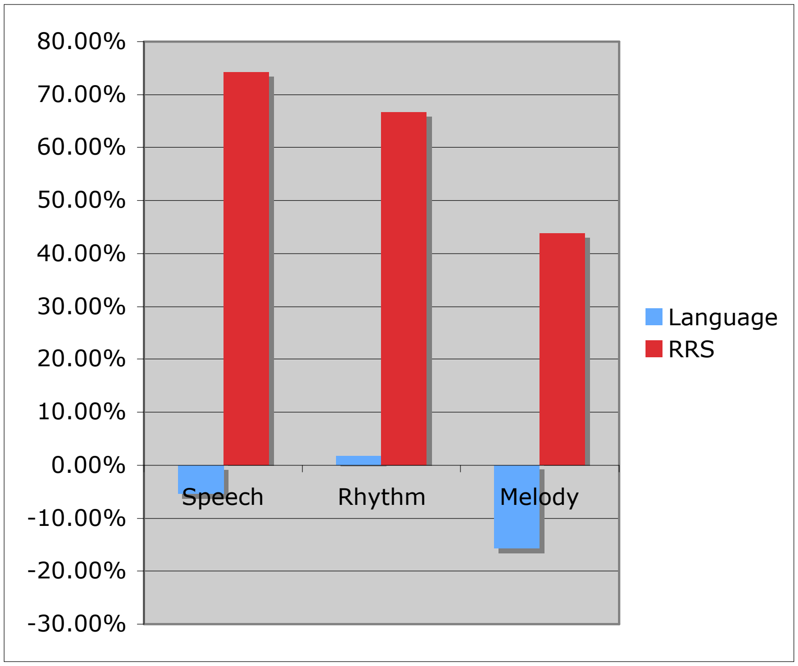


Figure 1. Percent of Change Means for Pre & Post Free Play. For rhythm or rhythm plus melody to be more effective than conversational speech alone, language scores would be shown to increase while RRS behaviors would be shown to decrease.

Language production frequency showed a slight positive increase from pre to post intervention free play in rhythmic speech condition. The frequency of language production decreased in the other conditions with a more marked decrease following the rhythmic speech plus melody conditions. RSS behaviors decreased the most in the melodic condition.

In addition, means of language output and RSS behaviors were calculated during intervention times across conditions. Behaviors during instruction were measured so findings might inform a classroom setting. The sum of language and RSS behaviors were calculated for each participant; Participant A was included in this calculation even though he not complete all three sessions in of the rhythmic speech plus melody condition due to illness. This calculation compared number of sessions completed opposed to means across all sessions, so Participant A was included despite not finishing the final session. The sum of the language scores of all participants was divided by the number of sessions completed by all participants in for each condition. The sums of the RSS scores of all participants were also divided by the number of sessions completed by all participants for each condition. The following formulas were used for the speech and rhythmic speech conditions ((total language scores/15 sessions) and (total RSS scores/15 sessions)) and the following formulas for melody conditions, to account for the final session not completed for Participant A in the melody condition ((total language scores/14 sessions) and (total RSS scores/14 sessions)). Table 5 shows the raw data for intervention sessions and the mean scores from the intervention.

Table 5

Mean Scores of Language and RSS Behaviors During Intervention

Participant	Speech - Language	Rhythm - Language	Melody - Language	Speech - RRS	Rhythm - RRS	Melody - RRS
A	57	41	35	12	7	8
B	36	69	51	16	8	4
C	56	46	47	1	2	0
D	55	40	40	0	1	0
E	59	84	65	57	53	68
Sum	263	280	238	86	71	80
Mean	17.53	18.67	17.00	5.73	4.73	5.71

Note. Language scores are the sum of all observed language behaviors (vocalizations, gestures, single word utterances and multiple word utterances) of the intervention in each condition. RRS behaviors scores are the sum of all observed RRS behaviors (unrelated vocal noises and inappropriate head, hand, and body movements) of the intervention in each condition. See Appendix F for raw data.

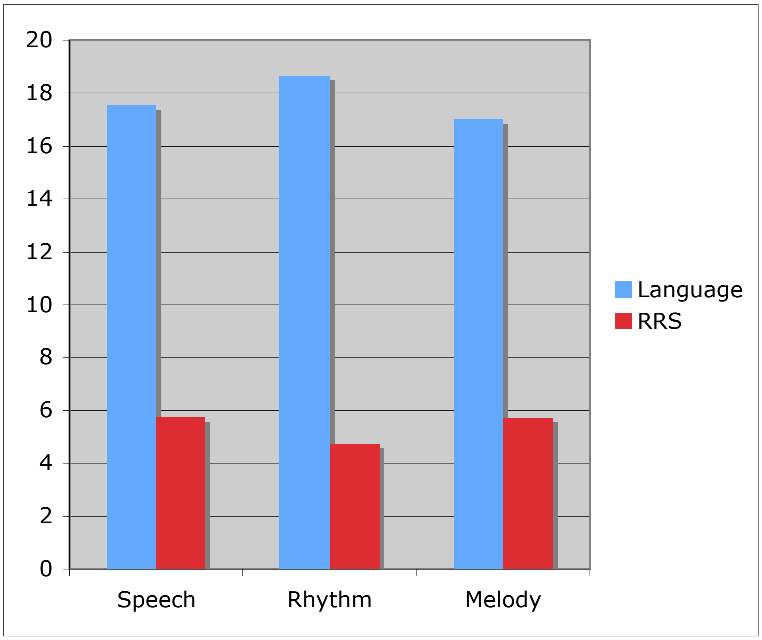


Figure 2. Mean scores of language and RSS behaviors during intervention. For rhythm or rhythm plus melody to be determined as more effective than conversational speech alone, language skills would increase while RRS behaviors would decrease.

While there was little difference between intervention score means across the three conditions, language scores for rhythmic speech were slightly higher during intervention than other conditions, and RSS behaviors were slightly lower in rhythmic speech compared to the other two conditions.

Observational Data

Since this was a small convenience sample, the researcher documented observational data of each participant and session to supplement the observational data taken during the session. The observational data is reported below.

Participant A (condition order: speech, rhythm, melody)

In the conversational speech condition, the student repeated both sentences during intervention and when prompted during free play in all three sessions.

In the rhythmic condition, the given sentences were repeated during intervention and when prompted in post-test free play, but he did not have the strong rhythmic emphasis in the first session. In the second condition, more rhythmic emphasis was used. In the third session, the rhythmic sentences were used and conversational sentences were also used in the pre-test and post-test free play.

In the first melodic condition, during the free play, the student made up songs for all the animals using the sentences from the previous conditions. When singing the hen sentence, the participant moved the hen back and forth in the rhythm of the song. In the second pre-test free play, the sentences were repeated in conversational speech for all animals. Following the intervention in the post-test free play, the participant again used his songs for each animal. The participant was unable to complete the third session due to absence.

Participant B (condition order: melody, speech, rhythm)

In the melodic speech intervention, the participant responded and repeated the sung sentences when prompted. In the second session post-test free play, the participant used the given sentence about the hen, but not the sheep.

In the first conversational speech condition, during the intervention, the researcher presented the spoken sentences through conversational speech. The participant repeated the sentences back using the melody of the sheep melodic sentence. During second conversational speech session, the participant again repeated the sentences back using a melody. In the post-test free play, the participant made up new melodic sentences for all animals, including animals that had not been presented in intervention previously.

In the rhythmic speech condition, the student was very verbal, but conversational speech was not related to the situation. In the post-test free play, the student made up his own stories about the animal and infrequently used the given sentences when prompted. In the third session, the student filled in the all the sentences from each condition. The sheep and pig sentences, which were in 6/8 time, were repeated more rhythmic accurate than the 3/4 time sentences.

Participant C (condition order: speech, melody, rhythm)

Participant C struggled to remember the words of the rhythmic intervention sentences. Conversational speech was better received and more easily remembered than the melodic or rhythmic sentences. No other significant observational data was collected.

Participant D (condition order: rhythm, speech, melody)

In all sessions, Participant D was very quiet. Prompting and questions from the researcher were required for the participant to speak. There was little spontaneous speech from the participant. At the end of all sessions, the participant could speak all the intervention sentences. No condition was more effective in producing speech than another.

Participant E (condition order: speech, melody, rhythm)

Participant E displayed more pronounced impairments in the categories of language development and sensory functioning. In the conversational speech condition, the participant displayed little response to the intervention. During the intervention and after the intervention in all speech sessions, no sentences were repeated.

In the first melodic condition, the participant oriented toward the researcher when she began to sing during the intervention session. However, the participant did not repeat any of the sentences. During the post-test period of the second melodic condition, the researcher prompted the sentence for the sheep by singing, “the sheep”, and the participant filled in the remainder of the sentence of “lives on the farm.” The participant did not respond to the prompts for the hen sentence. In the third melodic condition, when prompted with the sung words, “the sheep”, the participant again finished the sentence of “lives on the farm.” The participant also filled in the word “house” when prompted with the hen sentence.

In the rhythmic condition, the participant responded minimally to the intervention sentences. During the last rhythmic session, the participant would fill in the words “farm” and “mud” for the sentence for the pig.

CHAPTER 5

DISCUSSION

The following research questions were asked:

1. Does rhythm-based speech enhance sensory organization more effectively than conversational speech for children with autism spectrum disorders?
2. Does rhythm-based speech plus melody enhance sensory organization more effectively than conversational speech and rhythm alone?
3. Does rhythm-based speech enhance language production more effectively than conversational speech for children with autism spectrum disorders?
4. Does rhythm-based speech plus melody enhance language production more effectively than conversational speech and rhythm alone?

Results indicated that rhythmic-based speech and rhythm-based speech plus melody did not enhance sensory organization or language production more effectively than conversational speech and rhythm alone. While the statistical data showed no significance, the researcher's observational data recorded after each session with each student merits consideration as a guide for future research.

The melody condition sparked interesting behaviors from three of the participants. After receiving the melodic intervention, both Participants A and B used the melodic inflections of the sentences in the intervention to create melodic sentences about other animals. When Participant B was given the speech condition (after the receiving the melodic condition the week before), the researcher stated the sentence in a spoken voice and the participant echoed the sentence back, but with melodic inflection similar to the melody for the sheep (see Appendix E). Immediately following the speech intervention, he made up melodic sentences for all the other animals, even ones that had not been previously presented in an intervention. This occurred at the post-test period during the first two conversational speech sessions. (See Appendix E for condition specific sentences.) Participant A also created his own sentences after receiving the melodic condition, which was his final condition to receive. Following the rhythmic speech plus melody intervention, in the post intervention free-play the participant used the sentences that had been given in the previous conditions, but added a melody to every sentence. This happened in the two post-test melodic sessions the participant completed.

When these participants created original melodies, the melodies were sung in a 6/8 time signature, generally mimicking the melodic inflection of the sheep melody. When repeating rhythms and melodies, the melodies and rhythms in 6/8 time signature were repeated more accurately than those in 3/4 time signature. Many nursery rhymes for young children are in the time signature of 6/8; perhaps a 6/8 meter is more readily perceived for children with undeveloped language skills. Research is needed to explore this phenomenon further.

Repetition of the sentences was often better for the melodic sentences than either the speech or rhythmic sentences. Participant E, who had more severe language and sensory organization impairments than the other participants, showed a marked accuracy when repeating the melodic sentences than the other sentences. During spoken and rhythmic interventions, this participant would not repeat the sentences. However, during the melodic intervention, the participant would make eye contact with the researcher and would hold attention briefly. Participant E would never repeat any element of the spoken condition sentences, and one word, "mud," was repeated when prompted with parts of the rhythmic sentences. Yet when the melody and words, "the sheep" was prompted, the participant did complete the remainder of the sentence, "lives on the farm."

Interesting elements of prosody, or the emphasis, pitch accenting, rhythm and intonation of speech were also observed during the melodic repetitions of the sentences. Research suggests that perception and production of prosody is impaired in individuals with autism (McCann et al., 2007; Paul et al., 2005; Shriberg et al., 2001). After the melodic intervention, some participants worked hard to produce the inflection the melody gave, whether the participant was singing or speaking. Participant B would often lift his chin to emphasize the leap between the notes of E for "the" and the higher C for "sheep." Participant C would start the sentence for the sheep, yet when he did not produce the same inflection of the melody, he would stop and start again to produce something close to the large leap between "the" and "sheep."

Similarities and Differences Between Current Results and Extant Research

While there is little research in the field of autism and music to facilitate language development and sensory organization, some of the observations from the data collection sessions are supported by previous research. A growing body of research exists in the field of music therapy to support using music as a tool to address the functional needs of an individual with autism (Kaplan & Steele 2005; Wan, et al., 2010; Whipple, 2004). While the music-based conditions may not have been more effective than other conditions, the participants responded positively to the musical content. Only one participant initially expressed once that he would not like to go to the music room with the researcher, but agreed to go when prompted by the classroom teacher. The other participants always enthusiastically went along with the researcher to the music room.

Auditory perception is often a mystery in the brain of an individual with autism. Behaviors displayed by the participants may be supported by previous research studies. Boddaert et al. (2003) suggested that individuals with autism might passively listen to speech, perceiving it as strange noise rather than functional language. Whitehouse and Bishop (2008) also suggest that the process of encoding speech sounds may be impaired due to a possible aversion to speech sounds, and that novel tones generally caught the attention more effectively than speech sounds for children with autism. Dawson et al. (1998) also suggested that for a child with autism, orientation toward a sound stimulus such as a musical toy or rattle produced fewer orienting errors when compared to a speech stimulus.

In the current study, anecdotal evidence suggests the melodic speech may have more readily caught the attention and allowed participants to actively listen to language delivered through melody. This was demonstrated by a frequent and sharp change of focus when melodic intervention began. This was also evidenced by the ability of the participants, especially Participant E, to more readily repeat the melodic sentences correctly with fewer attempts than the other conditions. Perception of language is essential in the development of language skills. Future studies may attempt to measure perception of language through behaviors of eye contact, orientation, and reproduction of language. In the present study, however, these positive outcomes were not supported through behaviors that were statistically analyzed.

Interpretation of Results

While the results from the MANOVA did not show that rhythm or melody supported language production or sensory organization in children with autism, the way the melodic sentences were used by the participants and how the participants responded to the act of singing suggest that melody may capture the focus of attention, memory or engage auditory perception for children with autism.

Other approaches to the data were examined as well. The percent of change from pre-test free play to post-test free play was examined across the participants. While there were only slight differences in scores, RSS behaviors decreased slightly in the melodic condition compared to the speech and rhythmic condition. Language scores changed the most positively in rhythmic conditions with a slight increase of language production. However, when looking at the language scores of Participant E, the percent of change in language scores for this participant prompted further examination (Table 6).

Table 6

Raw Data and Language Percent of Change Scores of Participant E

	Speech Pre-Test	Speech Post-test	Rhythm Pre-Test	Rhythm Post-test	Melody Pre-test	Melody Post-test
	69	79	71	68	91	61
Percent of change	14.50%		-4.23%		-33%	

Participant E's percent of change scores decreased from the speech to rhythm to melodic conditions meaning he had fewer post-test vocalizations during the melodic condition. While this is contrary to the hypothesis, the quality of speech must be examined. Participant E had very low language skills and much of his language consisted of vocalizations that were not functional. The data collection tool in this study did not specify functional versus non-functional vocalizations, but merely documented vocalization events. Nevertheless, closer examination of the percent of change characteristics in vocalizations during the conditions is worth noting (Table 7).

Table 7

Raw Data and Percent of Change in Participant E's Vocalization Scores

	Speech Pre-Test	Speech Post-test	Rhythm Pre-Test	Rhythm Post-test	Melody Pre-test	Melody Post-test
	35	40	30	37	47	37
Percent of change	14.29%		23.33%		-21.80%	

Participant E had a steep drop in frequency of vocalizations after the melodic conditions. It may be that the melodic condition was able to organize his language better, displayed by a drop in inappropriate language. Subsequent studies must measure not only language production, but be sensitive to appropriate language production opposed to vocal noises or inappropriate language for the situation. Response definitions for data collection must reflect these sensitive differentiations in language production.

The means of the intervention scores were also calculated. There was little difference between intervention score means in the three conditions, but language scores for rhythmic speech were slightly higher during this intervention than the other conditions, and RSS behaviors were slightly lower in rhythmic speech compared to the other two conditions. This may indicate that when a researcher is presenting content, rhythmic speech is slightly more effective in producing language and calming the sensory system. While behavioral observations recorded a difference in perception and focus of attention, presenting speech rhythmically could have slightly more efficacy to calm the sensory system and produce slightly more language than other conditions.

This study had some limitations that are important to consider when discussing future studies of this nature. The sample size was small at only five participants, and only four were able to complete all nine sessions. When conducting the study, permission to video record sessions was denied. Participant E in particular had numerous and wide ranging language vocalizations and sensory behaviors, making it hard for data collectors to accurately record his fast paced vocalizations. This could have led to imprecision in recording. If video recording had been allowed, data could have been more sensitively measured with greater reliability.

A few limitations also existed in the data collection method. Language production measures should have taken into account how language was being used. Other elements to measure could have been how the language was being used (was it appropriate or inappropriate to the situation), whether the sentences were from the interventions being used in the free-play session, and how the language was produced (conversationally spoken, rhythmically spoken, sung). In addition,the data collection did not account for the different profiles of sensory dysfunction. Research suggests sensory dysfunction can be demonstrated through three profiles: under-stimulation to sensory input, over-stimulation to sensory input and sensory seeking behaviors (Ben-Sasson et al., 2009; Chen et al., 2009; Dunn, 2006) Therefore, sensory-seeking RSS behaviors such as such as inappropriate hand, head and body movements cannot solely demonstrate an individual's sensory dysfunction. Participants A and E demonstrated behaviors that could be characterized into the sensory-seeking profile of sensory dysfunction. In contrast, Participants C and D demonstrated an under-stimulated sensory profile. Unfortunately, data collection only recorded frequency of sensory-seeking behaviors. This would explain why Participants C and D displayed very few sensory behaviors across all sessions. More sensitive measurement tools would alleviate such discrepancies in future studies.

Other elements with timing of the sessions should be taken into consideration for future studies. The first consideration is the intervention time. It may be that two minutes is too short a time to organize sensory systems. It may be beneficial to consider other speech, rhythmic or melodic activities that could expand the intervention time to give the student more time to organize his or her systems. This could include playing the rhythms or melodies on an instrument, or expanding the sentences to include stories for the participant to listen to about the animals presented in a rhythmic or melodic manner. Also, imaginative play skills were very low for some of the participants. This caused the free-play time to be too long for participants C and D, as these participants did not always know how to play with the animals. New questions and prompts then needed to be composed on the spot for those children, which could have affected the language scores.

Generalizability of Findings

According to the statistical results of this study, there is no evidence to suggest that rhythmic speech or melody is more effective at producing language skills or organizing sensory systems for individuals with autism. However, none of these strategies were ineffective at producing language. It may be that the one to one ratio of teacher to student and intentionally addressing the language skills of the individual was effective, despite the medium.

An examination of behavioral data might give insight to music educators and the treatment of individuals with autism within the music classroom. Further research is needed, but if in fact melody does help with auditory perception of and orientation toward language, music educators should be made aware that the music classroom could be a place where an individual with autism perceives and focuses on the language that is sung. Music educators may have an opportunity to use high quality texts in classes of students with autism. The language need not be complicated, but use of cultural folk music, poetry set to music, and literature set to music could be used.

The Orff-Schulwerk approach of teaching music is highly based upon using rhythm and melody to incorporate language in the rhythmic playing of instruments, spoken ostinati, and singing (Frazee & Kreuter, 1987). This approach to music education is designed around the marriage of rhythm and language. The Orff-Schulwerk could be a readily available way for music educators to link rhythm and language for students with autism in order to facilitate auditory perception of language. It is also an approach to teaching music that is widely used in the music classroom that could facilitate the integration of music standards for typically developing children with the specialized needs of children with autism.

Discussion of Implications for Future Research

Many suggestions for future research have been discussed. Yet, the largest considerations emerging from this project for future research lie in the areas of auditory perception and prosody. Future projects that replicate elements of this study should focus on how auditory perception might be measured, whether that is in the areas of orienting or repetition of sentences. It may be that melody enhances auditory perception, which could improve language skills over time. The element of prosody could also be affected by melodic presentation of language. Multiple participants noticed and responded to the direction of the melodic line in the melodic presentations, and tried to replicate this contour. Participants B and C, who were observed to replicate the melodic line, generally demonstrate poor prosody in their conversational language skills. There is some evidence that perception of speech intonation and melodic contour may share cognitive resources (Patel et al., 1998). Using melodies that are developed from prosodic patterns in speech might in turn help develop prosody over time for individuals with autism.

While the statistical tests did not produce any significant results to answer the research questions, there is still a strong theoretical basis for continuing research in the area of sensory organization and language through rhythm and melody. The lack of statistical outcomes may have been due to the limitations of the data collection method. It still may be that rhythm and melody can be an avenue to facilitate sensory organization through the organization and temporal sense of music. There are still many findings in behavioral studies and in neurological research in the areas of language and music to suggest why music might be effective for addressing language development and sensory organization. It is important that music educators continue to seek out ways to not only teach all children music, but also to use music teaching as a way to enhance the learning across all domains for children, and if indeed it is effective in language and sensory development, especially for children with autism.

APPENDIX A

UMKC SSIRB APPROVAL LETTER

From: Barreth, Rebekah
Sent: Thursday, December 22, 2011 12:09 PM
To: Hanson-Abromeit, Deanna
Cc: Lillie, Sarah M. (UMKC-Student)
Subject: RE: Study SS11-171X: The Effect of Rhythm and Melody on Language Development and Sensory Organization in Children with Autism

Dear Investigators,

Please find attached the ICF for your use. Please be sure to use this document for consenting parents. You should know that even the chair commented on how well thought out and well written this application was. The responses were appropriately justified and clear and only minor edits were requested at the time of screening. Well done, and thank you for a nice application to review!

Regards,

Rebekah Barreth, CIP
Compliance Officer
Research Compliance Office
5319 Rockhill rd,
Kansas City, MO 64110
816-235-6150
barrethr@umkc.edu<mailto:barrethr@umkc.edu>

APPENDIX B

REQUEST FOR PARTICIPATION

IN A RESEARCH STUDY

Request for Participation in a Research Study

The Effect of Rhythm and Melody on Language Development and Sensory Organization in Children with Autism

Sarah Lillie
Sunny Pointe Elementary School and University of Missouri-Kansas City

Deanna Hanson-Abromeit
University of Missouri-Kansas City

Dear Parents,

My name is Sarah Lillie. I am the music teacher at Sunny Pointe Elementary and I am also a graduate student in the Division of Music Education and Music Therapy at the University of Missouri-Kansas City. I am inviting students from Sunny Pointe who are aged five to nine, receive special education services under the category of autism, and currently attend the autism music class with me to participate in this research study. I am hoping to recruit one to five children from our school to participate in this study to learn how rhythm and singing can help speech and sensory organization for a child with autism. This study is being supervised by Deanna Hanson-Abromeit, the principal investigator of this study and an associate professor of music therapy at UMKC.

I am hoping to observe a child's speech and sensory organization behaviors are effected by presenting sentences in one of three ways: spoken sentences, rhythm-based sentences and sung sentences. The child will spend time with me repeating sentences and free playing with plastic toy farm animals.

Participation in this study is voluntary. If you agree for your child to be part of this study, your child and I will meet in the music classroom at Sunny Point Elementary during a sensory break 3 times a week for 3 weeks for a total of 9 sessions. Each one to one meeting will be during the school day at a regularly scheduled sensory break.

I would love to set up a time to meet with you to discuss this study further. I will be calling you in the next two days to find if you are interested and would like more information. If you have any questions about this study please contact:
Sarah Lillie, Music Teacher at Sunny Point Elementary and investigator
816-224-7800, email: sarah.lillie@mail.umkc.edu
or
Deanna Hanson-Abromeit, Associate Professor of Music Therapy, University of Missouri-Kansas City, faculty adviser and principal investigator
816-235-2906, email: hansonabromeitd@umkc.edu

Sincerely,
Sarah Lillie Deanna Hanson-Abromeit

APPENDIX C

CONSENT FOR PARTICIPATION

IN A RESEARCH STUDY

SS11-171X

Consent for Participation in a Research Study

The Effect of Rhythm and Melody on Language Development and Sensory Organization in Children with Autism

Sarah Lillie
Sunny Pointe Elementary School and University of Missouri-Kansas City

Deanna Hanson-Abromeit
University of Missouri-Kansas City

Dear Parents,

My name is Sarah Lillie. I am the music teacher at Sunny Pointe Elementary and I am also a graduate student in the Division of Music Education and Music Therapy at the University of Missouri-Kansas City. I am inviting students from Sunny Pointe who are aged five to nine, receive special education services under the category of autism, and currently attend the autism music class with me to participate in this research study. I am hoping to recruit one to five children from our school to participate in this study to learn how rhythm and singing can help speech and sensory organization for a child with autism. This study is being supervised by Deanna Hanson-Abromeit, the principal investigator of this study and an associate professor of music therapy at UMKC.

Participation in this study is voluntary. If you agree for your child to be part of this study, your child and I will meet in the music classroom at Sunny Point Elementary during a sensory break 3 times a week for 3 weeks for a total of 9 sessions. Each one to one meeting will be during the school day at a regularly scheduled sensory break.

Each session will last eight minutes, including time to travel to and from the classroom. Using plastic toy farm animals, I will allow your child to play with the farm for 2 minutes. Following this free play time, your child and I will play with the animal in one of three ways: spoken sentences, rhythm-based sentences and sung sentences. We will play with the toy in one way three times over the course of one week, followed by the other two ways in following weeks. Not every child will receive the sentences in the same order. After your child and I have played using the sentences for two minutes, your child with have an additional two minutes of free play using a Fisher-Price animal farm. During each session we will count your child's use of spoken language and sensory behaviors to see if there are changes when I use spoken sentences, rhythm-based sentences and sung sentences with your child. Travel time is given one minute both in traveling to and from the music classroom. The total amount of time your child will spend in the individual sessions with me across 3 weeks is 72 minutes.

All of the information I obtain from your child will be kept confidential. Your child's name will not be used on any of the forms for data collection, and no information about your child will ever leave school premises with a name attached. If the study were to be published, no identifying information to the school will be provided.

While every effort will be made to keep confidential all of the information you complete and share, it cannot be absolutely guaranteed. Individuals from the University of Missouri-Kansas City Institutional Review Board (a committee that reviews and approves research studies), Research Protections Program, and Federal regulatory agencies may look at records related to this study for quality improvement and regulatory functions.

Mr. Goos, Sunny Pointe Elementary Principal and Dr. Brouse, Blue Springs Director of Elementary Education, have approved this study. However, participation in this study is voluntary at all times. You may choose to not participate or to withdraw your participation at any time. Deciding not to participate or choosing to leave the study will not result in any penalty or loss of benefits to which you are entitled. Your decision to not participate will not affect your relationship with UMKC, Blue Springs School District, or the researcher now or in the future. If you decide to leave the study the information you have already provided will be shredded.

There is no cost to you for allowing your child to participate in this study. You will not receive any compensation for participating in this study.

While there are no direct benefits to you or your child for participating in this study, your child will receive more individual language instruction across the three weeks. The information from this study may help us learn more about what helps language development and sensory organization for children with autism. The only known risk associated with the study is a small change in routine by adding three weekly music sensory breaks to their weekly schedule. The time the child leaves the classroom has been coordinated with your child's teacher so that it will take place during a sensory break your child currently receives during the instructional day. Careful consideration will be given to the change of schedule, and behaviors will be watched that might indicate the child is upset by the change in schedule. During the music sessions, the researcher will be watching for any behaviors that could indicate that your child no longer wishes to participate (leaves the music room, verbally or non-verbally indicated they no longer wish to participate, screaming, physical resistance, etc.). If any of these behaviors are exhibited, the current activity will be stopped, the child will be supported to a calm state and the activity will be resumed. If the child continues to be upset, the child will be given an opportunity to continue at a later date.

SS11-171X

The University of Missouri-Kansas City appreciates the participation of people who help it carry out its function of developing knowledge through research. If you have any questions about the study that your child is participating in you are encouraged to call Sarah Lillie**,** the investigator, at 816-224-7800 or Deanna Hanson-Abromeit, the faculty adviser, at 816-235-2906.

Although it is not the University's policy to compensate or provide medical treatment for persons who participate in studies, if you think you have been injured as a result of participating in this study, please call the IRB Administrator of UMKC's Social Sciences Institutional Review Board at 816-235-1764.

If you have any questions about this study please contact:
Sarah Lillie, Music Teacher at Sunny Point Elementary and investigator
816-224-7800, email: sarah.lillie@mail.umkc.edu

or
Deanna Hanson-Abromeit, Associate Professor of Music Therapy, University of Missouri-Kansas City, faculty adviser and principal investigator
816-235-2906, email: hansonabromeitd@umkc.edu

If you agree that your child may take part in the research please return a signed copy of this form to me in the enclosed envelope. You may keep the other copy for future reference.

You have read this permission form and agree to have your child take part in the research.

____
Name of Student

____
Printed Name of Parent

____ _________________
Signature of Parent Date

____ _________________
Signature of Investigator Date

____ _________________
Signature of Faculty Adviser/Principal Investigator Date

Version dated: 11/17/11

UMKC SSIRB
Approved
12/22/2011

APPENDIX D

DATA COLLECTION TOOL

Data Collection Tool

Intervention content: Conversational Speech
Rhythmic Speech
Rhythm + Melody

Pre-test

Free Play Session (2 minute free play)

Gestures	Vocalizations	Single Word Utterance	Multiple Word Utterance

Intervention

Intervention (1 minute on each sentence, 2 sentences presented)

Gestures	Vocalizations	Single Word Utterance	Multiple Word Utterance

Post-test

Free Play Session (2 minute free play)

Gestures	Vocalizations	Single Word Utterance	Multiple Word Utterance

Data Collection Tool

Intervention content: Conversational Speech
Rhythmic Speech
Rhythm + Melody

Pre-test

Free Play Session (2 minute free play)

Hand	Head	Body	Unrelated Vocal

Intervention

Intervention (1 minute on each sentence, 2 sentences presented)

Hand	Head	Body	Unrelated Vocal

Post-test

Free Play Session (2 minute free play)

Hand	Head	Body	Unrelated Vocal

APPENDIX E

MATCHED-SENTENCES AND

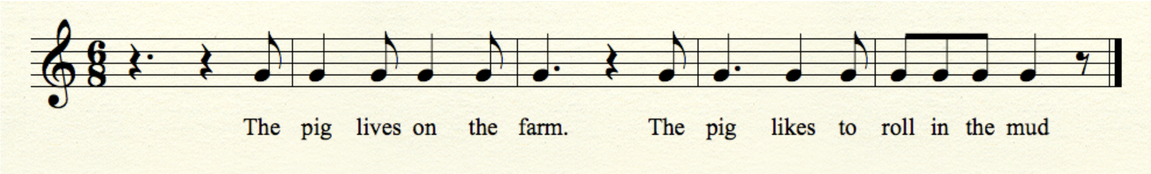
MUSICAL EXAMPLES

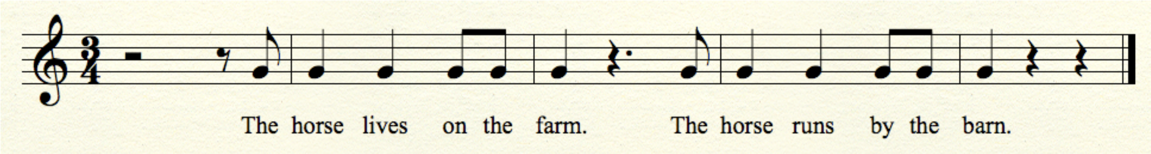
		Word Count	Words per sentence	Avg Letters / word	Reading Ease Score
	Conversational Speech				
Goat	The goat lives on the farm. The goat likes to jump and play! Maaa, maaa!	14	7	3.6	100
Cow	The cow lives on the farm. The cow eats all the grass. Moo, Moo!	13	6.5	3.4	100
	Rhythmic Speech				
Pig	The pig lives on the farm. The pig likes to roll in the mud! Oink, Oink!	15	7.5	3.2	100
Horse	The horse lives on the farm. The horse runs fast by the barn. Neigh! Neigh!	14	7	3.7	100
	Melody + Rhythm				
Sheep	The sheep lives on the farm. The sheep likes to cut her wool. Baa Baa Baa!	13	6.5	3.6	100
Hen	The hen lives on the farm. The hen lays eggs in her house. Cluck, cluck, cluck!	13	6.5	3.4	100

1. The goat lives on the farm. The goat likes to jump and play!
2. The cow lives on the farm. The cow eats all the grass.
3. The pig lives on the farm. The pig likes to roll in the mud!
4. The horse lives on the farm. The horse runs fast by the barn.
5. The sheep lives on the farm. The sheep likes to cut her wool.
6. The hen lives on the farm. The hen lays eggs in her house.

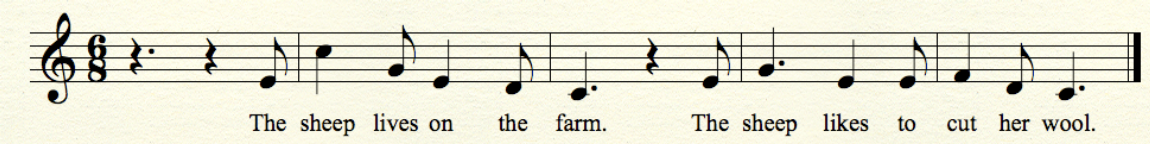
Nouns
Articles (the, a, an)
Prepositions
Present-tense verbs (runs, eats, lives...verb + /s/)
Infinitive verb ("to" plus verb...to cut, to roll)
Possessive pronouns (her, his, their)
Adverb
Conjunction (and)
Transitive verb (likes)
Adjectives (all)

Rhythmic speech sentences:





Rhythm and melody sentences:



APPENDIX F

RAW DATA

Part. & Session	Gestures	Vocal	SWU	MWU	TOTAL LANG	Hand	Head	Body	URV	TOTAL RRS
SpeechPreA1	3	0	4	11		0	0	1	0	
SpeechPreA2	0	3	4	15		0	0	0	2	
SpeechPreA3	0	1	1	18		0	0	0	0	
SpeechPreA	3	4	9	44	60	0	0	1	2	3
SpechIntA1	0	1	6	19		0	0	2	1	
SpechIntA2	0	1	4	13		0	0	2	0	
SpechIntA3	0	0	1	12		0	0	6	1	
SpeechIntA	0	2	11	44	57	0	0	10	2	12
SpeechPostA1	2	1	2	22		0	1	3	1	
SpeechPostA2	1	0	4	11		0	0	0	0	
SpeechPostA3	0	2	8	11		0	0	1	1	
SpeechPostA	3	3	14	44	64	0	1	4	2	7
RhythmPreA4	0	1	6	17		0	0	0	4	
RhythmPreA5	0	2	4	23		0	0	2	0	
RhythmPreA6	0	1	0	9		0	0	1	5	
RhythmPreA	0	4	10	49	63	0	0	3	9	12
RhythmIntA4	0	1	3	18		0	1	3	0	
RhythmIntA5	0	0	0	14		0	0	1	0	
RhythmIntA6	0	0	0	5		0	0	1	1	
RhythmIntA	0	1	3	37	41	0	1	5	1	7
RhythmPostA4	0	2	1	12		0	0	3	2	
RhythmPostA5	0	0	6	17		0	0	2	1	
RhythmPostA6	0	0	0	10		0	0	5	2	
RhythmPostA	0	2	7	39	48	0	0	10	5	15
MelodyPreA7	0	0	1	20		1	0	0	1	
MelodyPreA8	0	0	3	16		0	0	1	0	
MelodyPreA9										
MelodyPreA	0	0	4	36	40	1	0	1	1	3
MelodyIntA7	0	0	1	15		0	0	0	0	0
MelodyIntA8	0	1	2	16		0	0	0	0	0
MelodyIntA9										
MelodyIntA	0	1	3	31	35	0	0	0	0	0
MelodyPostA7	0	0	1	22		0	0	2	0	0
MelodyPostA8	0	0	3	20		0	0	0	0	0
MelodyPostA9										
MelodyPostA	0	0	4	42	46	0	0	2	0	0

Part. & Session	Gestures	Vocal	SWU	MWU	TOTAL LANG	Hand	Head	Body	URV	TOTAL RRS
SpeechPreB1	0	0	0	25		0	0	1	5	
SpeechPreB2	0	0	0	29		0	0	3	2	
SpeechPreB3	0	2	0	12		0	0	0	9	
SpeechPreB	0	2	0	66	68	0	0	4	16	20
SpechIntB1	0	0	1	13		0	0	5	2	
SpechIntB2	0	0	0	17		0	2	1	0	
SpechIntB3	0	0	0	5		0	0	4	2	
SpeechIntB	0	0	1	35	36	0	2	10	4	16
SpeechPostB1	0	0	0	21		0	0	0	4	
SpeechPostB2	0	1	5	18		0	0	0	13	
SpeechPostB3	0	2	3	8		1	0	3	10	
SpeechPostB	0	3	8	47	58	1	0	3	27	31
RhythmPreB4	0	0	2	21		0	0	0	4	
RhythmPreB5	0	0	3	20		0	0	0	7	
RhythmPreB6	0	0	1	24		0	0	0	13	
RhythmPreB	0	0	6	65	71	0	0	0	24	24
RhythmIntB4	0	0	1	18		0	0	0	1	
RhythmIntB5	0	1	0	27		0	0	1	1	
RhythmIntB6	0	0	1	21		0	0	4	1	
RhythmIntB	0	1	2	66	69	0	0	5	3	8
RhythmPostB4	0	1	2	29		0	0	0	5	
RhythmPostB5	0	1	1	21		0	0	0	10	
RhythmPostB6	0	0	2	25		0	0	2	9	
RhythmPostB	0	2	5	75	82	0	0	2	24	26
MelodyPreB7	0	0	6	15		0	0	0	0	
MelodyPreB8	0	0	6	15		0	0	0	0	
MelodyPreB9	0	0	1	23		0	0	0	0	
MelodyPreB	0	0	13	53	66	0	0	0	0	0
MelodyIntB7	0	1	0	13		0	0	0	0	
MelodyIntB8	0	0	2	15		0	0	1	0	
MelodyIntB9	0	0	0	20		0	0	1	2	
MelodyIntB	0	1	2	48	51	0	0	2	2	4
MelodyPostB7	0	0	2	18		0	0	0	0	
MelodyPostB8	0	1	2	18		0	0	1	2	
MelodyPostB9	0	0	1	20		0	0	0	1	
MelodyPostB	0	1	5	56	62	0	0	1	3	4

Part. & Session	Gestures	Vocal	SWU	MWU	TOTAL SPEECH	Hand	Head	Body	URV	TOTAL RRS
SpeechPreC1	0	1	5	16		0	0	0	3	
SpeechPreC2	0	1	8	21		0	0	0	0	
SpeechPreC3	0	0	7	15		0	0	0	0	
SpeechPreC	0	2	20	52	74	0	0	0	3	3
SpechIntC1	0	1	4	10		0	0	0	0	
SpechIntC2	0	0	3	16		0	0	1	0	
SpechIntC3	0	0	8	14		0	0	0	0	
SpeechIntC	0	1	15	40	56	0	0	1	0	1
SpeechPostC1	0	0	4	15		0	0	0	0	
SpeechPostC2	0	0	15	12		0	0	0	1	
SpeechPostC3	0	2	8	10		0	0	0	0	
SpeechPostC	0	2	27	37	66	0	0	0	1	1
RhythmPreC4	0	0	1	18		0	0	0	1	
RhythmPreC5	0	0	1	14		0	0	0	0	
RhythmPreC6	4	0	2	18		0	0	0	0	
RhythmPreC	4	0	4	50	58	0	0	0	1	1
RhythmIntC4	0	0	1	13		0	0	0	0	
RhythmIntC5	0	0	1	11		1	0	0	0	
RhythmIntC6	0	0	4	16		0	0	1	0	
RhythmIntC	0	0	6	40	46	1	0	1	0	2
RhythmPostC4	0	0	3	10		0	0	0	0	
RhythmPostC5	0	0	2	13		0	0	0	0	
RhythmPostC6	0	0	2	17		0	0	3	1	
RhythmPostC	0	0	7	40	47	0	0	3	1	4
MelodyPreC7	0	0	6	18		0	0	0	0	
MelodyPreC8	0	0	4	18		0	0	0	0	
MelodyPreC9	0	0	2	14		0	0	0	0	
MelodyPreC	0	0	12	50	62	0	0	0	0	0
MelodyIntC7	0	0	2	13		0	0	0	0	
MelodyIntC8	0	0	1	13		0	0	0	0	
MelodyIntC9	0	0	6	12		0	0	0	0	
MelodyIntC	0	0	9	38	47	0	0	0	0	0
MelodyPostC7	0	0	2	12		0	0	0	0	
MelodyPostC8	0	0	6	14		0	0	0	1	
MelodyPostC9	0	0	6	17		0	0	0	3	
MelodyPostC	0	0	14	43	57	0	0	0	4	4

Part. & Session	Gestures	Vocal	SWU	MWU	TOTAL SPEECH	Hand	Head	Body	URV	TOTAL RRS
SpeechPreD1	0	0	12	5		0	0	0	0	
SpeechPreD2	0	0	24	6		0	0	0	0	
SpeechPreD3	0	0	15	9		0	0	0	0	
SpeechPreD	0	0	51	20	71	0	0	0	0	0
SpechIntD1	0	0	2	17		0	0	0	0	
SpechIntD2	0	0	1	14		0	0	0	0	
SpechIntD3	3	0	6	12		0	0	0	0	
SpeechIntD	3	0	9	43	55	0	0	0	0	0
SpeechPostD1	0	0	8	7		0	0	0	1	
SpeechPostD2	0	0	16	10		0	0	0	1	
SpeechPostD3	1	0	14	8		0	0	0	0	
SpeechPostD	1	0	38	25	64	0	0	0	2	2
RhythmPreD4	0	0	6	8		0	0	0	0	
RhythmPreD5	0	0	5	2		0	0	0	0	
RhythmPreD6	1	0	4	6		0	0	0	0	
RhythmPreD	1	0	15	16	32	0	0	0	0	0
RhythmIntD4	0	0	0	12		0	0	0	1	
RhythmIntD5	0	0	2	13		0	0	0	0	
RhythmIntD6	0	0	1	12		0	0	0	0	
RhythmIntD	0	0	3	37	40	0	0	0	1	1
RhythmPostD4	0	0	2	10		0	0	0	1	
RhythmPostD5	1	0	4	7		0	0	0	0	
RhythmPostD6	0	0	3	12		0	0	0	0	
RhythmPostD	1	0	9	29	39	0	0	0	1	1
MelodyPreD7	0	0	15	12		0	0	0	0	
MelodyPreD8	0	0	9	8		0	0	0	0	
MelodyPreD9	0	0	16	13		0	0	0	0	
MelodyPreD	0	0	40	33	73	0	0	0	0	0
MelodyIntD7	0	0	2	14		0	0	0	0	
MelodyIntD8	0	0	0	12		0	0	0	0	
MelodyIntD9	0	0	0	12		0	0	0	0	
MelodyIntD	0	0	2	38	40	0	0	0	0	0
MelodyPostD7	0	0	7	8		0	0	0	0	
MelodyPostD8	0	0	13	12		0	0	0	0	
MelodyPostD9	0	0	9	17		0	0	0	0	
MelodyPostD	0	0	29	37	66	0	0	0	0	0

Part. & Session	Gestures	Vocal	SWU	MWU	TOTAL SPEECH	Hand	Head	Body	URV	TOTAL RRS
SpeechPreE1	0	10	6	1		0	0	0	8	
SpeechPreE2	2	9	10	1		0	0	0	15	
SpeechPreE3	3	16	10	1		0	0	3	17	
SpeechPreE	5	35	26	3	69	0	0	3	40	43
SpechIntE1	2	9	2	4		0	0	2	7	
SpechIntE2	0	7	5	1		3	0	3	22	
SpechIntE3	4	13	9	3		2	0	5	13	
SpeechIntE	6	29	16	8	59	5	0	10	42	57
SpeechPostE1	0	8	7	2		0	1	0	17	
SpeechPostE2	8	11	12	0		3	1	5	16	
SpeechPostE3	0	21	10	0		0	0	2	36	
SpeechPostE	8	40	29	2	79	3	2	7	69	81
RhythmPreE4	1	10	11	1		0	0	0	18	
RhythmPreE5	0	13	9	2		0	0	3	15	
RhythmPreE6	0	7	8	9		0	0	2	15	
RhythmPreE	1	30	28	12	71	0	0	5	48	53
RhythmIntE4	5	7	12	4		3	2	6	6	
RhythmIntE5	3	3	14	10		5	0	0	9	
RhythmIntE6	3	7	7	9		1	4	5	12	
RhythmIntE	11	17	33	23	84	9	6	11	27	53
RhythmPostE4	1	11	4	3		0	0	1	34	
RhythmPostE5	0	10	9	5		0	0	0	18	
RhythmPostE6	1	16	5	3		2	0	1	43	
RhythmPostE	2	37	18	11	68	2	0	2	95	99
MelodyPreE7	0	19	12	3		0	0	1	20	
MelodyPreE8	3	17	12	2		2	0	2	20	
MelodyPreE9	0	11	8	4		0	0	0	21	
MelodyPreE	3	47	32	9	91	2	0	3	61	66
MelodyIntE7	2	11	7	0		3	0	5	15	
MelodyIntE8	1	9	1	6		8	1	3	15	
MelodyIntE9	2	10	10	6		1	0	4	13	
MelodyIntE	5	30	18	12	65	12	1	12	43	68
MelodyPostE7	0	11	6	0		0	0	1	23	
MelodyPostE8	3	14	5	3		4	2	4	31	
MelodyPostE9	0	12	5	2		1	0	4	22	
MelodyPostE	3	37	16	5	61	5	2	9	76	92

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