Using music to motivate movement in children aged 4-6 years with Autism Spectrum Disorder

By

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Using music to motivate movement in children aged 4-6 with Autism Spectrum Disorder

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Abstract

Autism spectrum disorder (ASD) is an umbrella term used to describe a group of disorders of brain development usually diagnosed in early childhood. Children with ASD experience difficulties in social skills, communication and repetitive or restricted behaviors. Additionally, they often have delays and difficulties with movement skills. Improving movement skills in early childhood may have an impact on the core characteristic of ASD. The aim of this study was to investigate the effects of a 6-week music and movement intervention on the movement, social and adaptive skills of children aged 4-6 with ASD. Nine children aged 4-6 with ASD participated in the study, they were randomly divided into either a music and movement intervention (n=6) or movement intervention without music (n=3), the children participated in the interventions for 2, 45 minute sessions per week. The music group experienced significant improvements in BOT-2 body coordination (p=0.01), BOT-2 total raw scores (p=0.04) and a significant reduction in maladaptive behaviors (p=0.04) (Vineland Adaptive Behavior Scales). The movement group demonstrated significant improvements in social skills (p=0.02) and daily living skills (0.03). The results support the use of music during movement interventions to increase body coordination and reduce maladaptive behaviors.

Keywords: Autism spectrum disorder, early intervention, childhood, movement skills, music

Statement of Originality

I, Keri-Ellen Walcer, hereby declare that this thesis is, to the best of my knowledge, original, except as acknowledged in the text. I further declare that the material contained in this thesis has not been previously submitted, either in whole or in part, for a degree at this or any other university.

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Finally, I would like to thank my family members who have supported me and encouraged me each step of the way. Especially my dear husband Alex, my eternal companion. I would like to dedicate this work to my children, Ella, Tommy, Jason and Jane, you inspire me every day.

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List of Abbreviations

ABA	Applied behavioral analysis therapy
ADOS	Autism Diagnosis Observation Schedule
ANOVA	Analysis of Variance
ASD	Autism spectrum disorder
ATEC	Autism Treatment Evaluation Checklist
BOT-2	Bruinincks Oseretsky Test of Motor Proficiency 2nd edition
DS	Down Syndrome
DSM-5	Diagnostic and Statistical Manual of Mental Disorders 5th edition
DST	Dynamic Systems Theory
EMG	Electromyography
GCC	Grandview Children's Centre
IQ	Intelligence Quotient
MABC-2	Movement Assessment Battery for Children 2nd edition
MSEL	Mullen Scales of Early Learning
PDMS-2	Peabody Developmental Motor Scales
PT	Physiotherapy
SRS	Social Responsiveness Scales
SSIS	Social Skills Improvement System
TGMD	Test of Gross Motor Development
VABS-2	Vineland Adaptive Behavior Scales 2nd edition

Overview

This thesis is divided into six sections:

1. Introduction
2. Literature Review
3. Manuscript 1
4. Manuscript 2
5. Thesis Conclusions
6. Appendices which includes; ethics approval, letter of invitation, consent forms, enjoyment scales

Chapter 1: Introduction

Children with autism spectrum disorder (ASD) often have difficulty connecting socially, behaviorally and verbally with the people in their environment (American Psychiatric Association, 2013). ASD affects approximately 1 in 45 children in North America and the incidence has steadily increased over the past decade (Zablotsky, Black, Maenner, Schieve, & Blumberg, 2015). There is no known cure or cause for ASD, there are, however, a number of treatment options that provide varying degrees of positive behavioral outcomes (Seida et al., 2009). Most behavioral therapies are administered by specialized therapists on an individual basis. These therapies are often inaccessible to many families due to high cost, long wait times and high demand (Seida et al., 2009). Typically young children develop social and communication skills through active play with peers, and fundamental movement skills play a pivotal role during these interactions (Piek, Hands, & Licari, 2012). Children with ASD consistently demonstrate poor fundamental movement skills, which could be a limiting factor in their social and verbal development (MacDonald, Lord, & Ulrich, 2014). A multisystem intervention approach such as a music and movement intervention may lead to improved movement skills and enhance social outcomes for children with ASD (Srinivasan & Bhat, 2013). The inaccessibility, due to high costs and long waits, for current specialized therapies creates a need for community-centered, evidence based early interventions to improve developmental outcomes for children with ASD.

Autism Spectrum Disorder

ASD is an umbrella term used to describe a group of disorders of brain development that are often diagnosed in early childhood (Srinivasan & Bhat, 2013). ASD is a complex developmental disorder that is characterized by impairments in social

interaction and the presence of stereotyped and repetitive behaviors or interests, with the lack of or delay in language acquisition commonly co-occurring (American Psychiatric Association, 2013). In addition to the core deficits of ASD there exists associated motor skill difficulties that are apparent in the achievement of motor milestones such as, gait, postural control and motor planning which are present and pervasive across age (Lloyd, 2013; MacDonald et al., 2014). Research has established that children with ASD may experience both gross and fine motor skill delays, and atypical motor patterns (Jasmin et al., 2009; Lloyd, 2013; Provost, Heimerl, & Lopez, 2007). While therapeutic approaches to ASD have traditionally focused on core social, communication and behavioral characteristics, it is possible that improving movement skills may be an indirect means of affecting change in the core characteristics of ASD (MacDonald et al., 2014).

Motor Performance Delays of Children with ASD

When children are limited in their movement abilities it can lead to decreased participation in active play situations with peers (Bremer, Balogh, & Lloyd, 2015; Lloyd, 2013). Decreased social engagement may limit movement exploration and motor development, thus creating a negative downward spiral of cause and effect (Lloyd et al., 2013). Since the coordination of sensory and movement information is required for; social interaction, verbal communication, and participation in the environment, research focused on movement skills could impact many behavioral characteristics of ASD (Donnellan, Hill, & Leary, 2012). The evidence suggests that better movement skills early in life could provide children with the foundation that they need to achieve greater success in social and cognitive domains (MacDonald et al., 2014; Sutera et al., 2007).

Therefore, rehabilitation programs for children with ASD that are focused on improving movement skills in the early years is an area that warrants further investigation.

Musical Skills and ASD

Despite the impairments in socialization, speech and behavior typical of ASD, the preservation of musical skills is frequently observed (Lai, Pantazatos, Schneider, & Hirsch, 2012). Musical experiences can impact many forms of development including social, verbal and movement skills in early childhood (Srinivasan & Bhat, 2013). Studies suggest that children with ASD have enhanced pitch perception when compared to their peers with typical development (Bonnel et al., 2003; Heaton, 2003). Furthermore, there is evidence that children with ASD may recognize emotions conveyed through music better than those conveyed through speech (Heaton, Hermelin, & Pring, 1999). Early studies of the effects of music on movement have demonstrated that synchronization of movement with music can improve motor performance in children with typical development (Beisman, 1967; Brown, Sherrill, & Gench, 1981; Karageorghis & Terry, 1997). A recent study revealed that active music therapies led to significant improvements in verbal communication skills and non-verbal gestural communication in children with ASD (Gold, Wigram, & Elefant, 2006).

Movement patterns combined with musical rhythms may enhance the atmosphere for the learners, resulting in greater improvement in movement qualities through increased engagement and practice (Derri, Tsapakidou, Zachopoulou, & Kioumourtzoglou, 2001). However, there are no known published studies exploring the effectiveness of music on the movement skills of children with ASD (Srinivasan & Bhat, 2013).

Research Questions

1) Will the use of age appropriate music with rhythmic and verbal cueing during movement intervention improve movement proficiency outcomes of children with ASD?
2) Will a group music and movement intervention improve social and adaptive skills of young children with ASD?
3) Will the use of age appropriate music with rhythmic and verbal cueing during movement intervention improve children's enjoyment of movement activities?

Hypothesis

1) Both movement interventions will result in an improvement in movement skills of the participants. It is expected that the music and movement intervention will yield greater gains in movement skills than the traditional movement intervention.
2) The participants in the music and movement intervention group will exhibit gains in social and adaptive behavior.
3) The children who participate in the music and movement program will experience greater enjoyment and engagement in movement activities.

Purpose and Contribution

A review of current research shows promise for the use of music to improve social skills in people with ASD, however, there have been virtually no studies measuring the effectiveness of music on the movement skills of these individuals. Specialized recorded music with embedded rhythmic and verbal cueing will be used to accompany a gross motor movement intervention during this study. The outcomes of participation in the music and movement intervention will be compared to the outcomes of participation

in a movement intervention without music. If the outcomes of this study support the use of recorded musical accompaniment to improve the movement and social skills of children with ASD, this teaching technique could be easily implemented in many community settings.

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Chapter 2: Literature Review

History of ASD

Dr. Leo Kanner is credited with the earliest descriptions of what is now known as ASD (American Psychiatric Association, 2013; Kanner, 1943). In his seminal paper, Autistic Disturbances of the Affective Contact, Kanner describes eleven children who, while individually unique, had several peculiar behaviors in common (Kanner, 1943). One of the most pervasive characteristics described was the children's inability to relate themselves to their environment (Kanner, 1943). This inability to connect to others was manifest in their apparent lack of affect towards people, rigid adherence to routines, and repetitive behaviors. The majority of the children also experienced a delay in their verbal development (Kanner, 1943). Several of the children were reportedly clumsy in their gait and gross motor performances (Kanner, 1943). Of the eleven children described, eight had noteworthy preferences for music; some of the children preferred communicating through singing or humming rather than speaking while others were described as speaking in sing-song manner, and singing their actions (Kanner, 1943). A few of these original cases even demonstrated affinities for recognizing concertos, singing in perfect tune and distinguishing symphonies at very early ages (Kanner, 1943). It seems that from the earliest recognitions of children with ASD, music has emerged as an important means of communication and connection with the world.

Today the DSM-5 uses ASD as an umbrella term to identify a neurodevelopmental disorder characterized by restrictive and repetitive behaviors or interests and social-communicative difficulties (American Psychiatric Association, 2013). Social communication qualities that are characteristic of ASD include limited social-emotional reciprocity expressed in behaviours such as, poor joint attention,

conversational challenges, and reduced sharing of interests and emotions (Dawson et al., 2004). Other social behaviors include poor nonverbal communication such as atypical eye contact, challenges interpreting non-verbal cues, and difficulties in forming and maintaining relationships with peers (Srinivasan & Bhat, 2013). Restricted or repetitive patterns of behavior indicative of ASD may include stereotyped motor habits such as; simple motor stereotypies, repetitive play, echolalia, and formal or idiosyncratic speech (Volkmar & McPartland, 2014). It may also refer to rigid adherence to routines, or patterns of behavior, intense fixation on specific interests and sensory sensitivities or interests such as hyper reactivity to pain and sensory input, sensitivity to noise and visual captivation with objects or movement (Volkmar & McPartland, 2014). Therefore interventions must be designed with flexibility to adapt stimuli to the unique sensitivities of the individuals involved.

Interventions for ASD

The overarching goal of current treatments for ASD is to help individuals improve functional skills and independence (Myers & Johnson, 2007). A range of treatment types are available to families, including behavioral, psychosocial, educational, medical, and complementary approaches (Seida et al., 2009). These approaches often aim to improve social communication skills, social interactions and reduce the impact of restricted behaviors (Myers & Johnson, 2007). The most popular treatment approaches to ASD are behavioural therapies. Applied behavioral analysis therapy (ABA) began to be recognized in 1987 for its impact on improving cognitive abilities and advancing educational placement for a subgroup of children with ASD (Lovaas, 1987). The research that followed focused on social skills, communication, and behavior impairments using

both highly structured approaches and natural developmental approaches delivering interventions within everyday contexts (Myers & Johnson, 2007).

Although the methods vary, the focus of many early interventions is on teaching social communicative skills, often through the use of active play (MacDonald et al., 2014). Effective interventions commonly include features such as; high number of treatment hours per week, direct instruction, emphasis on attending to others, imitation skills, high structure, consistency and functional language development (Sutera et al., 2007).

Motor Performance Delays in Children with ASD

Sensory and motor differences are commonly observed in children with ASD during their early development (Baranek, 2002). Historically, these characteristics have been dismissed as having no apparent impact on the core features of ASD (Leary & Hill, 1996). However, it is widely accepted that the development of fundamental movement skills is a pivotal part of early childhood (Piek et al., 2012; Williams et al., 2008). In studies of children with typical development it has been observed that fundamental movement skills form the basis for engagement in physical activity and once learned, are generally retained through to adulthood (Graham, 2010). In preschool children with typical development, movement skills are positively associated with enhanced cognition, language skills, self-concept and social development (Piek et al., 2012). Recently some research focus has been placed on the relationship between the symptoms of movement impairment and the core characteristics of ASD (Bremer, Balogh, & Lloyd, 2015; MacDonald, Lord, & Ulrich, 2014; Sutera et al., 2007).

Provost, Lopez and Heimerl (2007) assessed motor delays in young children with ASD. Motor score comparisons were made between children with ASD, children with developmental delay and children with developmental concerns without motor delay. The purpose of this study was to determine if young children with ASD experience delays in their movement skills and whether or not these skills were different from those of young children with developmental delay (Provost et al.). Fifty-six children between the ages of 21-41 months participated in this study. These children were divided into three groups based on their diagnosis. There were 19 children in both the ASD and developmental delay groups and 18 children in the group with developmental concerns without motor delays. Researchers used Bayley Scales of Infant Development 2nd Edition (Bayley, 1993) and the Peabody Developmental Motor Scales Second Edition (PDMS-2) (Folio & Fewell, 2000) to measure motor skills as these are the most commonly used standardized tests for assessing motor skills of young children (Provost et al.). When measures were compared, all of the children with ASD were found to have some degree of motor delay in one or more areas of motor development (Provost et al.). Based on the standard score classifications, no child with ASD who participated was classified as having motor skills in the normal or average range. The motor scores of the children with ASD were very similar to the young children with developmental delay, and were lower than the children without motor delays (Provost et al.). The findings of this study indicate that significant motor skill delays, of either gross motor skills, fine motor skills, or both, can be detected in very young children with ASD and that these motor skill delays are similar to the ones observed in children with developmental delay (Provost et al.).

Jasmin and colleagues (2009) confirmed the presence of motor skill delays in young children with ASD using the PDMS-2 and suggested that motor difficulties can impact a child's performance of daily living skills (Jasmin et al., 2009). The term daily living skills includes performing self-care skills such as bathing, dressing, eating and toileting. Proficiency in these skills is essential for a child's integration into daycare and schools (Jasmin et al., 2009). Researchers observed 35 children with ASD between the ages of three and four years to assess the impact of sensory responses and motor skills on daily living skills proficiency for children with ASD (Jasmin et al., 2009). Motor skills were assessed using the PDMS-2. The Vineland Adaptive Behavior Scales second edition (VABS-2) and Functional Independence Measure for children were used to determine daily living skills (Jasmin et al., 2009). Mean scores of the children with ASD showed substantial gross motor delays and poor fine motor skills (Jasmin et al., 2009). In particular the lowest motor performance scores were found in locomotion, object manipulation and grasping (Jasmin et al., 2009). The correlation between total motor composite on the PDMS-2and the motor skill domain including gross and fine motor skills of the VABS-2 was significant. The results of this study revealed that children with ASD have difficulties with daily living skills as well as gross and fine motor skills. The researchers suggest that low functional independence in daily living skills is related to and caused in part by their motor difficulties (Jasmin et al., 2009). While the cause of motor delays in children with ASD is unclear, the association between low functional independence and poor motor skills is evident. One of the main concerns for caregivers of children with ASD is to increase their child's level of independence (Jasmin et al.,

2009). This study demonstrates that improving motor skills appears to be an important step towards achieving functional independence for children with ASD.

Lloyd, MacDonald and Lord (2013) examined the gross and fine motor skills of 162 children with ASD between the ages of 12 and 36 months. They also followed a subset of 58 of these children longitudinally. The researchers utilized the Mullen Scales of Early Learning (MSEL) a developmental test designed for young children from birth to 68 months which includes gross and fine motor subsets to assess motor skills (Lloyd et al., 2013). A motor difference variable for both gross motor and fine motor skills was calculated based on their age equivalent motor score and their respective chronological age. The children were separated into three groups based on chronological age. Gross motor skills of the children in the 12-24 month age group were an average of 3.5 months behind what would be expected of children with typical development (Lloyd et al., 2013). The 25-30 month age group were 5.13 months behind and those in the 31-36 month group were 9.18 months behind what is observed in children with typical development (Lloyd et al., 2013). A subset of 58 of these children were reassessed two times, 12 months apart. The second assessment revealed a significant difference in the gross motor difference between the two time points. These findings highlight the fact that the gross motor skills of children with ASD are behind for chronological age early in life and the gap widens over time (Lloyd et al., 2013).

Sutera and colleagues (2007) studied a group of 13 children who were diagnosed with ASD at age two but no longer met the diagnostic criteria at age four. These children were originally part of a larger group of 90 children with early ASD diagnoses (Sutera et al., 2007). Researchers were interested in determining the differences at baseline

between the children who moved off the spectrum by age four and those who did not. When comparisons were made it was observed that there were no significant differences found in symptom severity, socialization or communication skills between the two sets of children at age two. The clearest distinguishing factor between the children who retained the diagnosis of ASD and the children who did not was motor skill proficiency at baseline (Sutera et al., 2007). The results of this study are not sufficient to make definitive claims regarding the optimal outcomes of all children with ASD, however they do raise further questions regarding the association between movement skills and ASD severity.

MacDonald, Lord and Ulrich (2014) investigated the relationship between motor skill deficit and social communicative skills of children with ASD. One hundred and fifty-nine young children between the ages of 14 and 33 months participated in this descriptive study. All of the participants had a confirmed ASD diagnosis. The MSEL was used to assess motor skills as well as cognitive development of the participants. The Autism Diagnosis Observation Schedule (ADOS) was used to assess ASD severity including social interaction, communication, play and imaginative use of materials (MacDonald et al., 2014). The results of this study indicated that there was an inverse relationship between gross motor skills and ASD severity. Children with lower gross motor skills had a higher ASD severity score (MacDonald et al., 2014); implying that the improvement of movement skills in the early years may lead to improved ASD symptomology.

In a recent wait list control experiment, Bremer, Balogh and Lloyd (2015) investigated the effectiveness of a fundamental movement skill intervention at improving

the fundamental movement skills, adaptive behavior and social skills of four-year old children with ASD. Nine children with a confirmed diagnosis of ASD were recruited for the study. The participants were randomly assigned to either the intervention group or wait listed control group. The wait listed group received the same intervention for the same number of sessions and hours following group one (Bremer et al., 2015). Assessments were taken prior to the intervention, post intervention and six weeks following the intervention. Researchers utilized PDMS-2 to measure movement skills, VABS-2 to assess adaptive skills, and the Social Skill Improvement System (SSIS) measured social skill adaptations (Bremer et al., 2015). The experimental group experienced improvements in motor skills between time one and time two as measured by the PDMS-2 (Bremer et al., 2015). Improvements were seen on all PDMS-2 variables which included locomotor skills, object control, visual-motor integration as well as fine motor and gross motor quotient. All areas of improvement were either maintained or continued to improve from the conclusion of the intervention to 6 weeks post intervention; demonstrating that a motor skill intervention may contribute to the improvement of fundamental movement skills of children with ASD. The gain in movement skills experienced through this intervention may provide a foundation for future engagement in active play experiences and warrants further research (Bremer et al., 2015).

Movement skill delays are among the initial developmental concerns of parents; making them an important consideration in the planning of early detection and intervention strategies (Teitelbaum, Teitelbaum, Nye, Fryman, & Maurer, 1998). Movement skills are an important part of active play in childhood. Engaging in active

play facilitates physical development, cognitive function and social skills in early childhood (Pellegrini & Smith, 1998). When children are limited in their movement experiences it can lead to decreased engagement in social situations including active play opportunities (Williams et al., 2008). Furthermore, decreased engagement in active play with peers may limit movement exploration and motor development (Lloyd et al., 2013). There is a need to study interventions that target fundamental movement skills and their impact on other areas of a child's life.

Music Affinity in Children with ASD

While children with ASD tend to lag behind their peers with typical development in the social, motor and language domains, many children with ASD demonstrate musical abilities that are fully intact and in some cases enhanced (Heaton, Hermelin, & Pring, 1999; Kanner, 1943; Lai, Pantazatos, Schneider, & Hirsch, 2012). Heaton et al. (1999) explored accuracy in perceiving emotion communicated through music in a group of children with ASD. Given the well documented limitations in empathy and social communication which accompany ASD (American Psychiatric Association, 2013; Dawson et al., 2004), it seemed unlikely that these children would decipher emotion communicated through music.

Fourteen children with an ASD diagnosis were age and intelligence matched with children with typical development in the control group. The participants in this study ranged from seven to 15 years old. The children were tested for their ability to identify the affective connotations of musical melodies in major and minor keys (Heaton et al., 1999). Musical samples were played to the participants who were then required to match the melody to a schematic of either a happy or sad face. The results of this experiment did

not show a difference between participants with ASD and those with typical development (Heaton et al., 1999). These findings indicate that although children with ASD have difficulty interpreting emotion through language, their ability to detect emotion in music may be unimpeded. In earlier studies, Heaton and colleagues found musical affinities in people with ASD including, enhanced pitch memory, interval discrimination, and chord disembedding (Heaton, 2003; Heaton et al., 1999). These enhanced sensitivities to music combined with other sensory difficulties of some children with ASD may lead to hyper responsiveness to musical stimuli if the volume is too loud (Srinivasan & Bhat, 2013). For this reason it is important that practitioners be sensitive to the child's individual needs when incorporating sensory stimuli.

In adults with typical development, neural systems which engage during music and language functions tend to be interconnected; therefore, the disparity between language and music function in ASD is somewhat of a paradox (Lai et al., 2012). Lai, et al. (2012) explored this paradox using functional magnetic resonance imaging (FMRI) and diffusion tensor imaging. Thirty-six patients ranging in age from 5.41-22.47 years with ASD participated in the experimental group for this study. Twenty-one participants with typical development between the ages of 3.57-17.78 were assigned to a control group. Comparisons between the experimental and control groups were based on age matched subjects. Researchers observed that stimulation of the brain area, that is important for speech and language comprehension, showed greater activation in people with ASD during song stimulation. The control group demonstrated greater brain activation during speech stimulation (Lai et al., 2012). Additionally, there was more connectivity between brain regions during song stimulation in participants with ASD than

during the speech stimulation (Lai et al., 2012). These results demonstrate that, for participants with ASD in this study, functional systems of the brain that process speech and song were more effectively engaged during song than speech (Lai et al., 2012). Song appears to be more effective than speech when communicating with some people with ASD, therefore, children with ASD may be more likely to follow musical directions than verbal instruction.

Music and Movement Improve Motor Proficiency in Early Childhood

Fundamental movement skills do not develop through maturation alone. In order for children to progress beyond the elementary stage of movement they require practice, encouragement and instructions (Gallahue & Ozmun, 1998; Logan, Robinson, Wilson, & Lucas, 2012). It has been observed that programs of instruction can be more effective than free play experiences in helping children to improve fundamental movement skills (Logan et al., 2012). Many physical activity programs utilize music to enhance the participant experience. Studies have demonstrated that the synchronization of movement with music can improve motor performance in children with typical development (Karageorghis & Terry, 1997).

Vassiliki, Derri et al. (2001), investigated the effect of a music and movement program on the quality of locomotor skills in children aged four to six years old with typical development. Sixty-eight children were recruited to participate in this study, half of whom were assigned to the experimental group who participated in a music and movement program twice weekly for ten weeks, with each session lasting 30-40 minutes. The control group participated in a free play program (Derri et al., 2001). The Test of Gross Motor Development (TGMD) was used to assess locomotor skills. During the

movement to music program the children used percussion movements including clapping and patting knees, as well as simple percussion instruments such as tambourines and maracas to create music. The children used these instruments while simultaneously performing locomotor skills and spatial awareness exercises (Derri et al., 2001). The program facilitator provided additional rhythmic verbal cueing to direct movements. Pre-test and post-test measures revealed significant locomotor skill improvements in the experimental group. The children who participated in the music and movement program significantly improved in the categories of galloping, leaping, horizontal jumping and skipping (Derri et al., 2001). This study clearly demonstrates that the combination of music and movement is a viable method of instruction for improving the movement skills of young children. Still, this study did not compare the effectiveness of music and movement instruction to outcomes of traditional movement instruction.

One of the earliest investigations of the effect of music accompaniment on fundamental movement skill outcomes of young children was conducted by Gladys Lang Beisman (1967). Beisman conducted a study testing the effect of rhythmic accompaniment during instruction on the performance of selected fundamental movement skills in elementary school students from grade one to grade six (Beisman, 1967). Six hundred and seven children participated in this study. The movement skills measured were throwing, catching, climbing, balancing, jumping, leaping, dodging, bouncing and striking (Beisman, 1967). The children were separated into groups by age and were divided evenly into experimental and control groups. Both groups were given identical skills practice with an equal number of repetitions. All programs were held at the same time of day by the same instructor. The treatment period was 10 weeks in

length and classes were held twice per week for 10-20 minutes per session. Rhythmic accompaniment was the only design difference between the experiment and control groups (Beisman, 1967).

Rhythmic accompaniment was provided through the use of pre-recorded music, piano, dance-drum, clapping and singing (Beisman, 1967). Following the intervention period, the experimental and control groups were measured by researchers who were blind to group assignment. The experimental groups showed significant improvements in movement skills such as: jumping leaping, throwing, catching, climbing, balancing, bouncing and striking (Beisman, 1967). Teachers and class visitors also observed that the children utilizing rhythmic accompaniments appeared to enjoy the activities more than the children in the control groups did (Beisman, 1967). The evidence provided in this early study indicates that rhythmic accompaniment can result in better performance of some fundamental movement skills than similar exercises without rhythmic accompaniment (Beisman, 1967). It appears that the motivational qualities of music may play a significant role in movement education (Karageorghis & Terry, 1997).

Music and Dance Improve Motor Outcomes for People with Motor Difficulties

Researchers have studied the use of music to improve movement skills for a variety of populations with motor difficulties. Many of these studies have shown encouraging results for the use of music to motivate and improve movement skills. Biricocchi et. al. (2014) recently completed a case study describing the effects of a six-week tap dance program on static and dynamic balance for a six year old girl with congenital myotonic muscular dystrophy. The girl enrolled in this study participated with a small group of peers in a tap dance program, once per week for one hour sessions. In

her infancy, this child required surgical intervention to correct bilateral club feet. At the time of the study the child had difficulty keeping up with peers at play, she had an inability to run and had decreased balance skills. She also had difficulty with daily living skills (Biricocchi, Drake, & Svien, 2014). The Bruinincks-Oseretsky Test of Motor Proficiency second edition (BOT-2) was used to measure her balance before and after the intervention. The weekly dance class began with a warm up to music including stretching on the floor and exercises at the barre. Following the warm up, the students practiced tap dance steps in the center of the room (Biricocchi et al., 2014). The facilitator taught ten dance steps over the course of the six-week program. Following 20 minutes of instruction and practice, the children played music and movement games, then finished the class by reviewing the steps in combinations. Each week followed the same format (Biricocchi et al., 2014). The two greatest measured improvements were in; a) walking forward on a line and b) walking forward heel to toe on a line. She improved from a scaled score of two at the commencement of the first class to a scaled score of four by her sixth class, thus achieving clinically and statistically significant improvements in her motor control skills related to balance and postural control (Biricocchi et al., 2014). Additionally, there was an observable improvement in her social skills over the course of the six-week program. During the initial sessions she chose to position herself away from the other class participants but by the final sessions she was initiating interaction and conversation with her peers (Biricocchi et al., 2014). Although this study is clearly limited in scale and therefore cannot be generalized to the larger population, it provides encouragement for further examination of the therapeutic effects of music and dance on motor and social skills of children with motor difficulties.

Rhythmicity plays an essential role in learning, development and performance, as timing of movement is essential in many cognitive and motor control functions (Kugler & Turvey, 1987; Thaut, Kenyon, Schauer, & McIntosh, 1999). Some studies indicate that acoustic input can modify the timing and degree of motor activity in the spinal cord (Thaut, 1985; Thaut et al., 1999). Lower limb electromyography (EMG) displays synchronization of muscle movement to auditory rhythmic signals during repetitive motor tasks. This synchrony is called rhythmic motor entrainment (Thaut et al., 1999). Thaut et. al. (1997) studied the effect of rhythm on motor control with a group of eight stroke patients with hemiparetic gait patterns. A metronome in a simple instrumental composition was matched to the patient's step rate which became the rhythmic stimulant. The patients walked with and without rhythmic auditory stimulation. Each subject was tested three times over a five-week time period with two-week breaks in between sessions. In all cases rhythmic cuing produced significant improvements in stride uniformity, weight bearing balance on the paretic leg, knee angle and smoother forward trajectory of movement (Thaut, McIntosh, & Rice, 1997). It was discovered that rhythmic auditory cueing yielded these improvements immediately and across the duration of the movement. The effect of auditory rhythm on motor rhythm happens through entrainment mechanisms (Thaut, 1985). During auditory motor coupling the auditory external cue acts as a forcing function optimizing the efficiency of movement parameters. Observations in rhythmicity and brain research show that interaction between auditory rhythmic cues and motor response can be an effective tool for rehabilitation in movement disorders (Thaut et al., 1999).

Pacchetti et.al. (2000) compared the effectiveness of active music therapy to traditional physiotherapy (PT) on the motor and emotional responses of patients with Parkinson's disease. Thirty-two patients participated in this study which consisted of weekly sessions of either music therapy or PT for three months. Patients were randomly divided into two groups (n=16) one assigned to music therapy, the other to PT (Pacchetti et al., 2000). The music therapy group participated in choral singing, voice exercise, rhythmic and free body movement and active music making (Pacchetti et al., 2000). The PT group received passive stretching, specific motor tasks and strategies to improve gait and balance (Pacchetti et al., 2000). Pre and post-test measures were taken using the Unified Parkinson's Disease Rating Scale used as an indicator of bradykinesia, the Happiness Measure, an indication of emotional well-being and the Parkinson's Disease Quality of Life Questionnaire to determine quality of life (Pacchetti et al., 2000). The results indicated that music therapy had a significant effect on the improvement of movement rate or bradykinesia of patients with Parkinson's disease while the PT group showed no significant improvement in this domain. It was also demonstrated that music therapy contributed to greater daily performance of activities, happiness measures and quality of life (Pacchetti et al., 2000).

Music and Movement Improve Social Skills of Children with ASD

Interactive musical therapies have reportedly led to significant improvements in verbal communication skills and non-verbal gestural communication in children with ASD (Gold, Wigram, & Elefant, 2006). A review of novel treatments for ASD ranked music therapy among the highest in an evidence based grading system (Rossignol, 2009). Music therapy was the most effective of the non-biological treatments included in this

review with no adverse side effects reported (Rossignol, 2009). Studies using music therapy reported a range of benefits including improvement of ASD symptoms after 52 weeks of treatment, improved eye contact, joint attention, play and communicative skills (Gold et al., 2006; Kern & Aldridge, 2006).

In 2010, Finnigan and Starr set out to determine the effectiveness of music and non-music interventions on the social responsiveness of a preschool child with ASD. They conducted a single subject alternating treatment design whereby the child was administered two interventions with an identical approach except for the addition of music in the music condition. Data was collected over a 12-week treatment period. The MSEL and ADOS were used to measure social and communicative outcomes. Additionally the VABS-2 was used to measure adaptive behavior. The results indicated that the music intervention was more effective than the non-music intervention, social responsiveness was increased and avoidant behaviors were eliminated during the treatment sessions (Finnigan & Starr, 2010). While the study was limited due to the single subject design, the results led to further studies of the use of music during interventions for children with ASD.

LaGasse (2014) examined the effects of a group music therapy intervention on the social skills of children with ASD. Seventeen children six to nine years old with a confirmed diagnosis of ASD were included in this study. The children were split into two groups and randomly assigned to one of two intervention groups (LaGasse, 2014). Group one participated in a Music Therapy Group and group two participated in a typical Social Skills Group intervention without music. Both groups participated in the intervention for two 50-minute sessions per week for five weeks (LaGasse, 2014). The main items of

interest to the researchers were eye gaze, joint attention and initiation of, or response to, social communication in children with ASD (LaGasse, 2014). The Social Responsiveness Scales (SRS) was selected to measure the social skills of the participants. The SRS is an effective tool that can be used for children from age four to 18 years old, where low SRS is an indicator of high social skills (LaGasse, 2014). This questionnaire was completed by the parents of the participants once prior to the initial session of intervention then again within 3 weeks of the last session. The Autism Treatment Evaluation Checklist (ATEC) was used to measure treatment effectiveness over the duration of the study Finally, video coding was used to track progress, researchers watched for eye gaze, joint attention and communication happening during sessions three and ten (LaGasse, 2014). The children were organized into small intervention groups of three to four children per group. The music therapy group was led by a music therapist, the social skills group was led by an educator who specialized in working with children with ASD (LaGasse, 2014). During the music therapy group, music was used to provide anticipatory cues to help the children to follow through on tasks. Engagement in music making was a method of practicing social skills. Rhythmic verbal cues and music structure were used to help the children plan their response and to anticipate timing (LaGasse, 2014).

Parents reported significant improvements for SRS in the music therapy group. These results were very different from the social skills group. Although there were small improvements, ATEC scores did not reach significant improvement in either group (LaGasse, 2014). There were, however, more improvements of ATEC reported for music therapy participants. The music therapy group experienced improvements in peer interactions, joint attention and eye gaze during the intervention. Conversely the social

skills group participants showed a decrease in peer interactions. Neither of the two groups showed an increase in initiating or responding to communication and the social skill group participants had a slight decrease in communication by the final session. Results from this study provide support for the use of music to improve peer interactions including joint attention and eye gaze for children with ASD.

Koch, Mehl, Sobanski, Sieber, and Fuchs (2014), assembled a group of 31 young adults with ASD to determine if copying movement in dance therapy could improve the social skills of the participants. The aim of this study was to increase body awareness, social skills, self-other distinction, empathy and well-being (Koch, Mehl, Sobanski, Sieber, & Fuchs, 2014). The group was split into two subsets, one set included 16 subjects who received the dance therapy intervention and the other group included 15 subjects who received no intervention. The two groups were matched based on age and severity of symptoms. The experimental group attended one-hour sessions once per week for seven weeks (Koch et al., 2014). Data were collected using self-reported measures in the form of several questionnaires. Pre-test and post-test measures were taken prior to the first session and immediately following the last session. The adherence to the program in the treatment group was 90% (Koch et al., 2014). In the treatment group, all participants showed some improvement in all reported domains.

Summary

ASD is characterized by social and communication impairments, hence the primary focus of most interventions has been on improving social and language skills, while movement skills have frequently been overlooked (MacDonald et al., 2014). Further examination of movement patterns observed in early childhood indicates that

improving movement skills early in life may lead to optimal outcomes for children with ASD (Sutera et al., 2007). It is probable that practicing specific movement tasks and participation in active play opportunities would improve the movement skills of children with ASD (Bremer et al., 2015; Lloyd et al., 2013), however, they are unlikely to engage in such activities. Since many children with ASD demonstrate an affinity for song, and rhythm is positively associated with improving movement skills, then music could be a key motivator of participation in early movement interventions for children with ASD (Derri et al., 2001; Zachopoulou, Tsapakidou, & Derri, 2004).

Theoretical Framework

It is clear that children with ASD experience difficulties and delays in the acquisition of movement skills (Donnellan, Hill, & Leary, 2012; Lloyd et al., 2013; MacDonald et al., 2014). Movement skills are an important foundation for future learning and success in many domains including social, cognitive and communication (Pellegrini & Smith, 1998; Sutera et al., 2007). Children with ASD tend to be solitary, inflexible in their play, demonstrate difficulties in forming connections with others and do not readily participate in imitation or joint activities (Dawson et al., 2004; Hurwitz & Watson, 2015). These attributes make it challenging to instruct a child with ASD or to motivate the child to participate in movement activities, which contributes to the poor movement skills often observed in children with ASD (Bremer et al., 2015; Lloyd et al., 2013). Dynamic Systems Theory (DST) is a theoretical framework that can be applied to examine this behavior and lends insight into how it might be impacted.

DST has been used to explain a number of phenomena in the natural world, it is a flexible framework that can be applied to the analysis of nearly any developmental occurrence (Lewis, 2000). Here it will be applied to an intervention aimed at improving the movement skills of young children with ASD. The overarching premise of DST is self-organization; the spontaneous emergence of order out of apparent chaos (Lewis, 2000). Self-organization happens through dynamic interactions between control parameters out of which attractor states emerge.

Behavior is the product of interactions between many complex systems that work together to form a pattern under task, social and environmental constraints (Thelen, 2005). The preferred pattern of behavior is referred to as the attractor state. For

example, when a young child participates in active play with peers, it requires the coordination of many subsystems to produce this seemingly simple behavior. Cooperation between internal systems such as; neural pathways, musculo-skeletal abilities, and psychological conditions, and external systems such as; equipment, environment and sensory stimulation, will self-organize to create the observed behavior. There is no hierarchical order to the systems (Lewis, 2000), so changes in any one of these complex systems could result in a change in the emergent behavior, these systems are considered control parameters (Thelen, 1995, 2005). Control parameters can either hold a system back or contribute to shifting the system to a new behavior; DST suggests that there are multiple ways to affect change within a system.

In the case of young children with ASD, solitary, inflexible play and avoidance of imitation is the attractor state, nevertheless it could be impacted by a change of sensory stimuli in the environment. It has been observed that while children with ASD have difficulty understanding communication through speech and do not relate well to peers, many demonstrate an affinity for music (Geretsegger, Elefant, Mossler, & Gold, 2014; Kanner, 1943). Early work by Kugler and Turvey (1987) proposes that human movement is fundamentally rhythmic, and can be coordinated with information from the environment (Kugler & Turvey, 1987; Thelen, 1995). Several studies confirm that appropriately selected music can enhance adherence to physical activity and improve movement skills in many populations (Derri et al., 2001; Karageorghis & Terry, 1997; Zachopoulou et al., 2004). It is therefore possible that musical cueing could act as a control parameter and provide motivation for some children with ASD to participate in movement activities.

When a new behavior is practiced it gains stability over time and resists perturbations, this change represents a phase shift into a new attractor state (Thelen, 1995). Initially, young children with ASD may respond to musical motivation to persuade them to participate in movement activities. However, the goal of providing these musical cues is to help the child stabilize their new movement skills. If the new patterns of behavior are practiced long enough to produce a phase shift, the child may eventually find active play opportunities more attractive.

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Chapter 3: Manuscript 1 Investigating the Effects of a Music and Movement Intervention on the Movement Skills of Children Aged 4-6 years with Autism Spectrum Disorder

Abstract

In addition to social, behavioral and communication difficulties, children with autism spectrum disorder (ASD), often experience delays in movement skills. Few evidence based interventions exist to improve the movement skills of this population. The purpose of this study was to compare the effects of a group music and movement intervention to a movement-only intervention on the movement skills of children with ASD. Nine children, 4-6 years of age with ASD participated in the study. The music group (n=6) participated in a 6-week music and movement program for 2, 45 minute sessions per week, the movement group (n=3) participated in an identical intervention without music, the BOT-2 was used to measure movement skills. The music group experienced significant improvements in body coordination (p=0.01) and BOT-2 total raw scores (p=0.04) from pre-test to post-test. The results support the use of music during movement intervention to improve movement skills in young children with ASD.

Introduction

Autism Spectrum Disorder (ASD) is an umbrella term used to describe a group of disorders of brain development often diagnosed in early childhood (American Psychiatric Association, 2013). The core diagnostic criteria of ASD relate directly to social, behavioral and communication skills which include, lack of or delay in language acquisition, impaired communication, socialization skills and the presence of stereotyped or repetitive behaviors (APA, 2013). Additionally, though not part of the diagnostic criteria, children with ASD may exhibit difficulties and delays in movement skills (Lloyd, MacDonald, & Lord, 2013; MacDonald, Lord, & Ulrich, 2014; Staples & Reid, 2010). The incidence of ASD has increased dramatically over the past decade, recent reports suggest that 1 in 45 children are currently diagnosed with ASD (Zablotsky, Black, Maenner, Schieve, & Blumberg, 2015); and individuals with ASD fall within a wide range of symptom severity (Baranek, 2000). Due to the range of severity, and increased prevalence of ASD, there is a critical need to find evidenced based approaches to support and assist children with ASD to reach their full potential. The current landscape of therapeutic approaches is varied; finding the right support can be costly, and government sponsored programs often have long wait times (Seida et al., 2009; Levy, Mandell, 2003; Provincial Advocate for Children and Youth, 2016). Identifying evidence based interventions that could be implemented in community settings would improve the accessibility and efficiency of programming; thus improving the developmental trajectories of a greater number of children with ASD.

The focus of most therapeutic interventions for this population is directed at improving the core characteristics of ASD including: social interaction, delay or deficit in

language acquisition, social skills, behavioral challenges and sensory processing difficulties (Smith 2008, MacDonald, Lord & Ulrich 2014). Movement skill delays and difficulties often co-occur in children with ASD, however they are rarely the focus of therapeutic interventions (Baranek, 2002; MacDonald et al. 2014). This represents a significant oversight in early intervention strategies for children with ASD (Lloyd et al., 2013; MacDonald et al., 2014). It is widely accepted that the development of fundamental movement skills is an important part of early childhood (Piek et al., 2012; Williams et al., 2008). Young children commonly develop social and communication skills through active play with peers, and fundamental movement skills play a pivotal role during these interactions (Piek, Hands, & Licari, 2012). In preschool age children with typical development, movement skills are positively associated with enhanced cognition, language skills, self-concept and social development (Piek et al., 2012). Therefore, improving early movement skills may increase participation in physical activity and have a significant impact in other areas of development improving overall outcomes for children with ASD.

Movement Skills of Children with ASD

Differences in early movement skill development have been reported among the initial developmental concerns of parents (Teitelbaum, Teitelbaum, Fryman, & Maurer, 2002). Early reports on children with ASD describe clumsiness in movement quality and differences in gait (Kanner, 1943, Vilensky, Damasio & Maurer, 1981). Current research using standardized testing provides further insight into the movement delays and deficits found in young children with ASD. Provost, Lopez and Heimerl (2007) evaluated the motor skills of children with ASD between the ages of 21 and 41 months to determine

their level of movement skill and how they compared to children with a global developmental delay. The children were measured using both the Bayley Scales of Infant Development 2nd Edition and the Peabody Developmental Motor Scales 2nd Edition. All of the young children with ASD included in this study demonstrated gross motor and/or fine motor delays to some degree (Provost et al. 2007).

Lloyd, MacDonald and Lord (2013) examined the gross and fine motor skills of young children with ASD. Using the Mullen Scales of Early Learning, a motor difference variable for both gross and fine motor skills was calculated based on their age equivalent motor score and their respective chronological age. Gross motor skills of the children in the 12-24 month age group were an average of 3.5 months behind what would be expected of children with typical development (Lloyd et al., 2013). The 25-30 month age group were 5.13 months behind and those in the 31-36 month group were 9.18 months behind what is observed in children with typical development (Lloyd et al., 2013). The study confirmed that the gross motor skills of children with ASD were behind for chronological age early in life and the gap widened over time (Lloyd et al., 2013). There is a growing body of evidence demonstrating that significant motor skill delays and deficits exist in young children with ASD and early interventions may improve their development long term (MacDonald et al., 2014; Provost, Heimerl, & Lopez, 2007; Staples & Reid, 2010; Teitelbaum et al., 2002).

Movement skill differences in childhood have also been associated with calibrated autism severity scores (MacDonald, Lord, Ulrich, 2013; MacDonald et al., 2014). Empirical data confirms that a relationship exists between movement skills and the core characteristics of ASD (MacDonald et al. 2014). The National Research Council released

a report in 2011, recommending that early interventions for children with ASD include movement skill development (National Research Council, 2001). Since then, a number of researchers have focused on finding effective modalities of movement intervention for children with ASD (Baranek, 2002; Bremer, Balogh, & Lloyd, 2015; Hardy & LaGasse, 2013; Ketcheson, Hauck, & Ulrich, 2016; Pan et al., 2016).

Recent research suggests that children with ASD can experience improvements in their movement skills with intervention. Bremer, Balogh and Lloyd (2015) investigated the effectiveness of a movement skill intervention at improving the fundamental movement skills of four-year old children with ASD. Improvements in fine and gross motor skills were observed. Pan et al. (2016) examined the effect of a 12-week physical activity intervention involving table tennis, on the movement skills and executive functioning of 22 boys aged 9 and 10 with ASD. A significant increase in motor skill proficiency and executive functioning was measured following the intervention (Pan et al. 2016). These studies demonstrate that motor skill interventions can improve movement skills and may lead to other beneficial outcomes for children with ASD (Bremer et al., 2015; Bremer & Lloyd, 2016a; Ketcheson et al., 2016; Pan et al., 2016). However, due to the variability that exists within the autism spectrum (Baranek, 2002), there is not likely to be a single treatment that would benefit each child equally (Baranek, 2002, Pan et al. 2016). When evaluating a treatment approach, researchers should consider issues of feasibility, cost, and how the intervention fits within the child's broader educational context (Baranek, 2002). Therapies should also take into account individual preferences and maximize the child's strengths to avoid sensory difficulties and facilitate maximum participation (Baranek, 2002).

Musical Strengths in Children with ASD

Many children with ASD demonstrate unique musical strengths and preferences including enhanced pitch perception and superior reproduction of melodies (Kanner, 1943, Heaton 1999, Heaton 2008, Lai, Pantazatos, Schnieider & Hirsch 2012, Srinivasan, Bhat, 2013). Although atypical sensory responses such as hyper or hypo reaction to stimuli such as light, sound or touch are often observed in children with ASD, some people with ASD are drawn to music (Heaton, 2009; Jasmin et al., 2009). In one study investigating music perception, cognition and learning, musically untrained children with ASD demonstrated enhanced skills when compared to peers with typical development (Heaton, 2009). Skills such as superior reproduction of atonal melodies (Applebaum, 1979), enhanced pitch perception (Heaton et al. 1998, Bonnel et al. 2003, Heaton, 2003), and unimpeded ability to interpret affect in music (Lai et al. 2012) converge to provide evidence that music could be a key to making meaningful connections with children with ASD. Drawing on this strength may be pivotal in providing motivation for education and movement habilitation.

Using Music to Improve Movement Skills

Physical activity programs often utilize music to enhance the participant experience. Improved mood and movement synchronization to music are common effects of programs that include a musical component common examples include; group fitness classes and running while listening to music (Karageorghis & Terry, 1997). Studies have demonstrated that the synchronization of movement with music can improve motor performance in children with typical development (Beisman, 1967; Brown, 1981; Karageorghis & Terry, 1997; Derri, Tsapakidou, Zachapoulou, Kioumourtzoglou, 2001).

Derri et al. (2001), investigated the effect of a music and movement program on the quality of locomotor skills in children aged four to six years old with typical development. Pre-test and post-test measures using the Test of Gross Motor Development (TGMD) revealed significant locomotor skill improvements in the categories of galloping, leaping, horizontal jump and skipping for children in the experimental group (Derri et al., 2001). Another study examining the effect of rhythmic accompaniment during instruction on the performance of fundamental movement skills in children with typical development, included 607 children aged 6-12 years. A ten-week music and movement program was compared to a movement program without music (Beisman, 1967). Researchers found that the music and movement program yielded greater movement improvements than the traditional program in skills such as; throwing, catching, climbing, balancing, jumping, leaping, dodging, bouncing and striking (Beisman, 1967). This preliminary literature suggests that the motivational qualities of music may play a significant role in movement education (Karageorghis & Terry, 1997).

Music has also been effectively used as a motivator to improve movement proficiency in populations with impairments causing movement difficulties such as; congenital myotonic muscular dystrophy, stroke and Parkinson's disease (Thaut et al. 1996; Thaut et al. 1999; Abiru et al., 2008; Biricocchi, Drake, & Svien, 2014). Therapeutic interventions utilizing music have led to improvements in gait, timing, movement quality, and limb control in many populations with movement difficulty (Pacchetti et al., 2000; Thaut, McIntosh, & Rice, 1997). One study recently explored the effect of sung speech on the responsiveness of young children with ASD and showed promise for the use of sung directives to elicit performance on play activities, indicating

that children with ASD may respond positively to a movement intervention with music embedded (Paul et al., 2015).

There are no studies documenting the effect of music on the movement skills of children with ASD; this represents a significant gap in the literature. ASD is characterized by social, behavioral and communication impairments (American Psychiatric Association, 2013). The primary focus of interventions has traditionally been on improving these core characteristics, while movement skills have frequently been overlooked (MacDonald et al., 2014). Further examination of movement patterns observed in early childhood indicates that improving movement skills early in life may lead to optimal outcomes for children with ASD (Sutera et al., 2007). Practicing specific movement tasks, and increasing participation in active play opportunities, may improve the movement skills of children with ASD, thus providing opportunities for social interaction, active learning and the development of communication skills (Baranek, 2002; Bremer et al., 2015; Lloyd et al., 2013)

The purpose of this study was to examine the effects of a six-week, age appropriate music and movement intervention, on the movement skills of children aged 4-6 years with ASD. The outcomes of participation in the music and movement intervention were compared to the outcomes of participation in a movement intervention without music. We hypothesize that using age appropriate music with rhythmic verbal cueing during a movement intervention could provide motivation for young children with ASD to participate in group movement activity practice; thereby leading to improved movement skills. Since many children with ASD demonstrate an affinity for song, and rhythm is positively related to improving movement skills, then music could be a key

motivator of participation in early movement interventions for children with ASD (Derri et al., 2001; Zachopoulou, Tsapakidou, & Derri, 2004).

Methods

Study Design

Ethics approval was obtained from the UOIT Research Ethics Board (Appendix A) and the research committee at Grandview Children's Centre. Parents gave written informed consent (Appendix B) for their children to participate in the study; additionally child assent was verbally obtained from participants who were able to do so. This study followed a randomized control design whereby the participants were assigned by random draw to participate in either a music and movement program, or a movement program without music, twice weekly for six weeks. Both programs followed essentially the same activities and format targeted at improving movement skills. The independent variable between the groups was the use of age appropriate music with rhythmic verbal movement cueing. In addition to the 12 intervention sessions over six weeks, all participants, regardless of group assignment, attended pre-test, post-test and four-week follow up assessments where movement skills were measured.

Procedures

Individual pre-test assessments took place one week prior to the commencement of the intervention at the UOIT Motor Behavior and Physical Activity Laboratory. Parents and caregivers were asked to complete the Vineland Adaptive Behavior Scales 2nd Edition (VABS-2), Social Skills Improvement System (SSIS) and a supplemental information package (Appendix I) while their child completed the Movement Assessment

Battery for Children 2nd Edition (MABC-2) and the Bruincks Oseretsky Test of Motor Proficiency 2nd edition (BOT-2).

Post-test movement assessments were performed at the UOIT Motor Behavior and Physical Activity Laboratory within one week of the completion of the movement intervention using the BOT-2. Parents also completed the Vineland Adaptive Behavior Scale (VABS-2) at the post- test, a perceived enjoyment questionnaire and wrote their own observations or comments related to their child's behavior over the course of the intervention period. Please see Chapter 4 for the social and behavioral results.

Table 1. Study Timeline

Pre-test	6-week Intervention	Post-test	4-week Follow-up
M-ABC-2	Music Group 2x45min/week	BOT-2	BOT-2
VABS-2		VABS-2	VABS-2
SSIS		SSIS	SSIS
BOT-2			
		Parent Perspective	
	Movement Group 2x45 min/week	Enjoyment Scales	
Random Assignment	Child enjoyment scale		

Recruitment

A social media post (Appendix F) was published on a private parent's group board through Grandview Children's Centre. Children with an ASD diagnosis who range in age from 4 to 6 years were invited to participate in this study. Posters were also

displayed in several community recreation centers throughout the region inviting eligible volunteers to contact the principle researcher (Appendix E).

Due to the multisensory nature of the interventions and the wide range of sensory sensitivities that are present in children with ASD, respondents were asked to rate their child's receptivity to music on a scale from 0 to 10 defined as: 0 is adverse to music, 2 is agitated by music, 4, does not orient to music when playing, may as well be random noise; 6, will listen to and enjoy if playing but will not request it; and 10, will request it to be played frequently and listen attentively for long periods of time (Appendix D). Children satisfied the inclusion criteria by being rated either 5 or above. No respondents to the study were rated below 6 on the scale, therefore none were excluded from the study. A similar scale was successfully utilized by Lai, Pantazatos, Scheider and Hirsch in 2012.

Participants

Thirteen children were enrolled in the study following the screening protocols. Participants were then assigned by random draw to either the music or movement intervention group. The music group consisted of six children with ASD diagnosis and one child with both ASD and Down Syndrome (DS) diagnoses. The movement group consisted of six children with an ASD diagnosis. Two families consisting of 3 children who were selected to participate in the movement group withdrew from the study prior to the commencement of the intervention; leaving 7 participants in the music group and 3 participants in the movement group. Even though the child with both ASD and DS diagnoses fully completed the study, this participant's data is not included in the analyses due to the physical differences that affect motor development in DS.

Measures

Movement Assessment Battery for Children Second Edition

The MABC-2 is a widely accepted and frequently used movement skill assessment for children (Henderson, Sugden, & Barnett, 2007). It is useful in detecting movement delays and difficulties (Cools, De Martelaer, Samaey, & Andries, 2009). The MABC-2 is suited for children between age 4 and 12 years and is subdivided into 4 age bands. Each age band consists of 8 test items which measure manual dexterity, ball skills and balance skills (Cools et al., 2009). The overall score for this test was used to identify children who either have or are at risk of having motor impairments. This measurement was used as a baseline movement measure to detect the existence of movement delays.

Bruinincks Oseretsky Test of Motor Proficiency Second Edition

The BOT-2 is an individually administered measure of fine and gross motor skills useful for children and youth from age four through 21 years of age (Bruinincks, 2005). It is designed for practitioners and researchers to use as a measure of motor performance, specifically in the areas of fine motor control, manual coordination, body coordination, strength and agility. The BOT-2 includes a Complete Form and a Short Form (Deitz, Kartin, & Kopp, 2007) with a high correlation between both test versions. Since the children in this study were on the very young end of the suitable age range and had other difficulties related to their diagnosis of ASD the Short Form was best suited to appeal to their limited memory, attention capacity and vocabulary (Cools et al., 2009).

Vineland Adaptive Behavior Scales Second Edition

The VABS2 is a tool designed to assess adaptive functioning in communication, socialization, daily living and motor skill domains (Sparrow, Balla, & Cicchetti, 2005).

The overall purpose of VABS is to generally assess the social competence of individuals from birth to adulthood (Sparrow et al., 2005) it is widely accepted and useful with children including those with ASD. In this study the VABS motor skill domain scores were used to monitor progress of movement skills as well (Icabone, 1999) for full results see Chapter 4.

Social Skills Improvement System

The Social Skills Improvement System (SSIS) (Elliott & Gresham, 2007) is an assessment tool used to evaluate the social skills and problem behaviors of participating children; it is suitable for people aged three to 18. This rating scale was completed by parents or caregivers of the participants during the first assessment. The SSIS provided baseline descriptive characteristics of the participants, for full results see Chapter 4.

Enjoyment Scales

Participants rated their own enjoyment of the experience using a pictorial Likert scale at the end of each session (Appendix M). The Likert scale included 5 simple schematics representing satisfaction ranging from “really great” to “really bad”. A number value from 5 (really great) to 1 (really bad) was then assigned to each picture for ranked statistical analysis.

Parents were asked to complete a questionnaire rating their child’s enjoyment of the experience following the 6-week intervention period (Appendix L). Parents responded with answers ranging from strongly agree, to strongly disagree to seven statements regarding their child’s enjoyment in the program. A number value was then assigned to each answer ranging from 0-4 and a total score out of 28 was derived. Additionally the parents provided qualitative written feedback describing the changes

they had noticed in their child's behavior over the course of the intervention time period (Appendix N).

Movement Skill Intervention

The participants attended two 45-minute intervention sessions per week for six weeks. The sessions were led by the primary investigator with the assistance of two trained research associates. The primary investigator has fifteen years of experience facilitating music and movement programs for young children. The research associates were undergraduate students with experience facilitating programs for children with ASD. Each intervention session followed an identical format to create predictability, familiarity, and to reduce anxiety. The programs were designed utilizing best practice recommendations for embodied music interventions for this population proposed by Baranek (2002) and Srinivasan & Bhat (2013); these considerations include;

1. Follow a familiar activity schedule, and use a visual picture schedule
2. Avoid having other distractions in the room (eg: cover equipment until it is used)
3. Model desired behaviors and provide manual guidance for movements
4. Provide verbal and gestural reinforcement, for example saying "good job" and giving "high fives".
5. Instruction can be provided through songs (eg: tidy up songs)
6. Use props whenever necessary to clarify the goals of the activity

In this study, a visual schedule was used and provided structure and predictability for participants (Figure 1). Both groups followed the same sequence of activities which included; a warm up, fundamental movement skill instruction, practice, an obstacle course and cool down. The music group also utilized pre-recorded music embedded with rhythmic and verbal movement cueing. The physical environment was free from extraneous items that could distract from the focus activities. Sensory items such as;

small flashlights, light weight colored scarves, and other props were utilized in both programs to optimize participation and individual adaptations were made to accommodate participant preferences (Baranek, 2002; Srinivasan & Bhat, 2013). Both programs incorporated movement activities selected to improve the fundamental movement skills of the children. Details of program sessions are provided in Table 2.

Figure 1. Visual Schedule used during both intervention groups

Table 2. Program session plan

Activity	Song (music group only)	Skill	Time
Welcome	The More We Get Together	• Name recognition Underhand roll	10 min
Warm-up	Zoom, zoom, zoom	• Flex/extend knees • Jump	5 min
Stretch	Open Your Eyes	• Reach • Gallop	5 min
Stop and Go	The Ponies are Walking	• Walk • Trot • Gallop	5 min
Large muscle movement	You've Got the Groove	• Kick	5 min
Obstacle Course/ Circuit	If I Were a Frog	• Roll • Jump • Crawl	5 min
Cool Down	Fly My Kite	• Dynamic balance	5 min
Good Bye	Passing out the sticks	• Strike	5 min

Statistical Analysis

Descriptive characteristics were calculated on all variables at baseline. Attendance was taken during each session and a t-test was used to compare the group averages. Group MABC-2, BOT-2 and VABS-2 scores were compared using independent t-tests to detect the presence of any significant between group differences at baseline. Post intervention scores of the BOT-2, and VABS-2 were compared with baseline scores using paired t-tests to determine if significant changes in movement skills were made during the intervention within each group. The magnitude of change from pre-test to post-test was calculated on the BOT-2 raw and composite outcomes for both groups. The percent change for each group was also calculated.

A two way repeated measures ANOVA was used to examine the effect of the interventions at multiple time points. The two intervention groups were collapsed into one experimental group. A one way repeated measures ANOVA was run on the whole sample comparing the three time points (Table 6).

The child reported scores of enjoyment were collected. Each individual's session ratings were averaged resulting in a total score out of 5 for each participant. The Mann-Whitney U test was then used to compare the participant self-reported enjoyment scales between groups.

The sum of answers provided in the parent perceived enjoyment questionnaire resulted in individual parent reported score out of 28 possible points. A Mann-Whitney U test was then used to compare the parent perceived enjoyment scales.

Results

The descriptive characteristics of all participants which included eight males and one female (music n=6, 1 female), movement n=3), are found in Table 3. Even though the groups were randomly assigned, the children in the music group were considerably younger and had poorer movement, social and adaptive skills at baseline than the children in the movement group (Table 3). In addition to ASD diagnosis, some of the participants in the music group also had comorbid developmental difficulties (Table 3). Both groups had high average attendance rates; music group=82%, movement group = 89%, however 2 participants in the music group did fall below 80% attendance.

Table 3. Descriptive characteristics at baseline

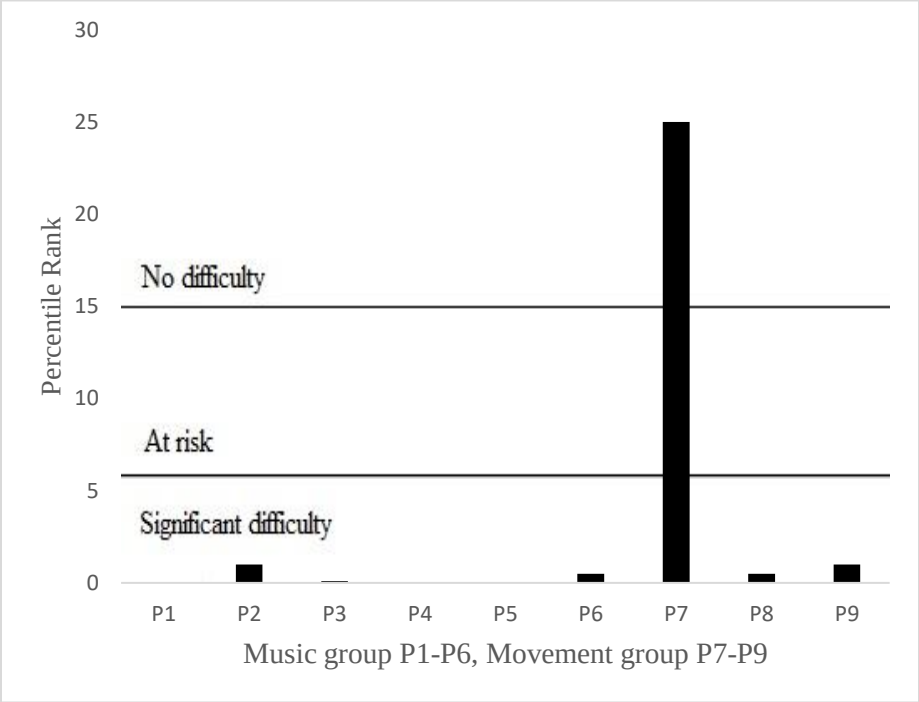
Variable	Music Group (mean, SD)	Movement Group (mean, SD)	p-value
Sex (male, female)	5 M, 1F	3M	
Age (months)	58.83 ±11.65	66.33 ±14.74	0.61
Age at diagnosis (months)	39.00 ±5.02	36.00 ±6.00	0.63
Ethnicity	1 A, 2C, 3O	3 C	
Multiple Diagnosis (Yes, No)	2Y, 4N	3N	
BOT-2 Total motor composite	25.17 ±7.39	38.00 ±4.58	0.01
MABC-2 Total Test Standard Score*	27.75 ±10.78*	54.00 ±25.45	0.24
VABS-2 Total Motor Score	52.33 ±15.60	59.67 ±5.13	0.33
SSIS Total Standard Score	77.67 ±18.28	85.67 ±2.89	0.34

*3 participants did not reach the criteria for completion of these test items

** A= Aboriginal C= Caucasian O= Other

MABC-2 scores were measured on all participants during the first assessment in order to establish existing movement difficulties. All participants, except one, scored below the 5th percentile confirming that eight of nine participants had significant movement difficulties at baseline (Figure 2). The MABC-2 total group means were compared using an independent t-test which showed no significant differences between group total movement scores at baseline. However, three of the six participants in the music group did not receive valid scores due to refusal to attempt some or all of the test components. Therefore, following the MABC-2 test protocol, rather than giving them a score of zero, no scores were included for them in the mean comparisons (Henderson, Sugden, & Barnett, 1992). Independent t-test comparisons of the BOT-2 group scores at baseline reveal significantly higher total motor composite scores for the movement group at baseline ($p=0.01$). Although the mean movement scores in the parent-reported VABS-2 total motor scores are lower in the music group at baseline; independent t-test comparisons did not reach a level of statistical significance ($p=0.33$).

Figure 2. MABC-2 total test scores at baseline by percentile rank



Post-test Movement Outcomes

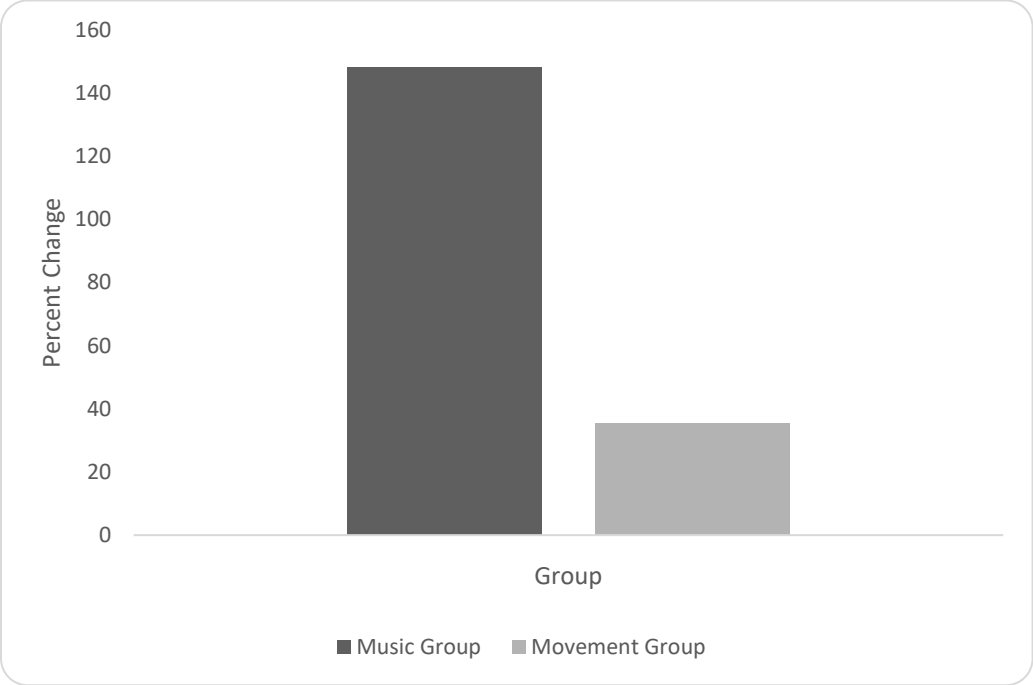
A paired t-test was used to compare pre- and post-test scores for each group on all BOT-2 short form raw subscale scores, total raw score and the total motor quotient (Table 4). Improvements were made on all variables, in both groups. The music group made improvements that reached a level of significance in body coordination from pre-test to post-test ($p=0.04$) (Table 4).

Table 4. Magnitude of change score from pre- to post-intervention on the BOT-2 in the music and movement group

BOT-2 Variable	Group	Pre-test (mean,±SD)	Post-test (mean,±SD)	Change (mean, ±SD)	% increase	p-value	Effect size (Cohen's d)
Fine Manual Control (raw)	Music	1.67 ±2.42	3.00 ±4.00	1.33 ±1.75	79.64	0.12	0.76
	Movement	10.67 ±3.21	13.33 ±3.78	2.67 ±6.50	25.02	0.55	0.41
Manual Coordination (raw)	Music	0.33 ±0.52	0.67 ±1.21	0.33 ±0.82	100.00	0.36	0.40
	Movement	2.67 ±3.05	2.67 ±0.58	0.00 ±2.64	0.00	1.00	0
Body Coordination (raw)	Music	1.50 ±2.51	4.50 ±5.20	3.00 ±2.97	200.00	0.04	1.01
	Movement	6.00 ±4.36	9.67 ±1.53	3.67 ±2.89	61.20	0.16	1.26
Strength and Agility (raw)	Music	0.33 ±0.82	1.33 ±1.97	1.00 ±1.26	303.00	0.11	0.79
	Movement	2.33 ±1.54	3.67 ±1.53	1.33 ±2.52	57.08	0.55	0.52
Motor Composite	Music	25.17 ±7.39	30.00 ±12.80	4.83 ±6.18	19.18	0.11	0.78
	Movement	38.00 ±4.58	41.33 ±7.02	3.33±6.66	8.70	0.48	0.50
Total Score (raw)	Music	3.83 ±6.11	9.50 ±12.11	5.67 ±6.28	148.04	0.08	0.90
	Movement	21.67 ±7.23	29.33 ±7.23	7.67±7.23	35.39	0.21	1.06

The music group experienced a greater average percent increase in all BOT-2 movement scores including the BOT-2 total raw score (148%) from pre-test to post-test when compared to the movement group (35%) (Figure 3).

Figure 3. Average group percent change from pre- to post-intervention on BOT-2 raw scores in music and movement groups



Movement Outcomes at 4-week Follow-up

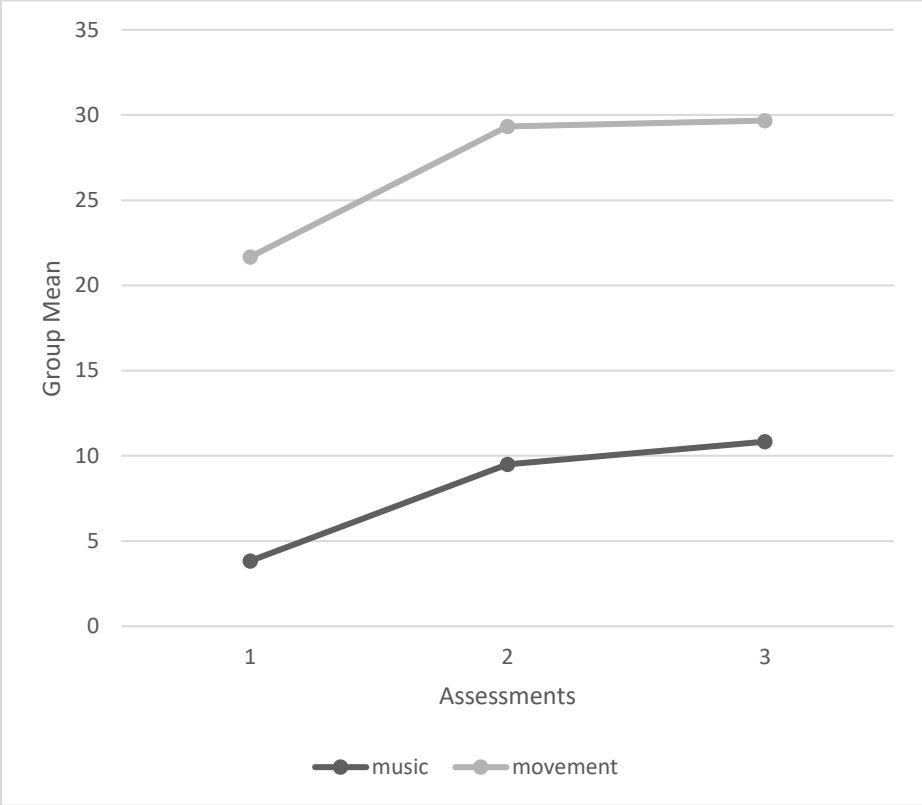
A two-way repeated measures ANOVA was run to determine the effect of each intervention over time on the BOT-2 movement scores and VABS-2 motor subtest score; the results are presented in Table 5. There were significant between group differences in fine manual coordination, manual coordination and BOT-2 total raw scores (Table 5). There was also a significant time interaction on body coordination, and BOT-2 total raw

scores indicating that significant changes were made over time from pre-test to follow-up (Table 5). Post-hoc analyses with Bonferroni corrections revealed that BOT-2 raw scores, fine manual coordination and manual coordination improvements reached a level of significance for the movement group ($p=<0.01$, $p=0.02$). The music group experienced significant improvements between pre- and 4-week follow up tests in body coordination and BOT-2 total raw scores ($p= 0.01$ and $p=0.04$ respectively). Even though skill levels were unevenly matched at baseline, both groups experienced a similar rate of improvement on BOT-2 total raw score (Figure 4), and experienced improvements in motor skills using parent reported VABS-2 scores. Both groups also experienced a similar rate of improvement in VABS-2 motor scores from pre-test to 4-week follow-up these improvements approached statistical significance over time ($p=0.05$).

Table 5. Pre-, post and 4 week follow-up BOT-2 and VABS-2 motor scores by group

BOT-2 Variable	Group	Pre-test (mean,±SD)	Post-test (mean,±SD)	4 Week Follow-up (mean,±SD)	Group	Time	Group X Time
Fine Manual (raw)	Music	1.67 ±2.42	3.00 ±4.00	3.17 ±4.35	F=16.82	F =1.80	F =0.54
	Movement	10.67 ±3.21	13.33 ±3.78	11.33 ±3.05	p <0.01	p =0.28	p =0.52
Manual Coordination (raw)	Music	0.33 ±0.52	0.67 ±1.21	1.17 ±1.70	F =8.61	F =2.54	F =0.48
	Movement	2.67 ±3.05	2.67 ±0.58	4.00 ±2.00	p =0.02	p =0.13	p =0.13
Body Coordination (raw)	Music	1.50 ±2.51	4.50 ±5.20	4.83 ±4.53	F =0.31	F =12.86	F =4.04
	Movement	6.00 ±4.36	9.67 ±1.53	10.67 ±1.50	p =0.65	p <0.01	p =0.08
Strength and Agility (raw)	Music	0.33 ±.82	1.33 ±1.97	1.67 ±1.97	F =5.10	F =3.4	F =0.06
	Movement	2.33 ±1.54	3.67 ±1.53	3.67 ±1.53	p =0.06	p =0.06	p =0.94
Motor Composite	Music	25.17 ±7.39	30.00 ±12.80	31.50 ±12.23	F =2.73	F =3.66	F =0.63
	Movement	38.00 ±4.58	41.33 ±7.02	40.33 ±5.69	p =0.14	p =0.08	p =0.47
Total Score (raw)	Music	3.83 ±6.11	9.50 ±12.11	10.83 ±11.48	F =8.75	F =9.43	F =0.14
	Movement	21.67 ±7.23	29.33 ±7.23	29.67 ±7.57	p =0.02	p =0.02	p =0.73
VABS-2 Motor	Music	52.33 ±15.60	56.00 ±14.53	55.83 ±16.56	F=0.61	F=3.64	F=0.22
	Movement	59.67 ±5.13	64.67 ±10.97	62.33 ±7.09	p=0.46	p=0.05	p=0.81

Figure 4. Pre-, post- and follow-up BOT-2 total raw score between group comparisons



Movement Intervention Outcomes on Whole Sample

Since both groups experienced a similar rate of improvement and the two interventions were essentially the same with the addition of music to one, the two intervention groups were also collapsed into one in order to analyze the effects of the movement intervention as a whole. A repeated measures ANOVA was run on the entire sample comparing the three time points (Table 6). Improvements in body coordination ($p=<0.01$), BOT2 overall standard score ($p=0.03$), BOT-2 overall raw score ($p=<0.01$) and VABS-2 motor score ($p=0.03$), reached a level of significance from pre-test to post-test. Indicating that the participants made significant movement gains over the course of the intervention.

Table 6. BOT-2 and VABS-2 Changes from pre-, post-intervention and 4-week follow-up for whole group

BOT-2 Variable	Pre-test (mean,±SD)	Post-test (mean,±SD)	4-week (mean, ±SD)	p-value	Effect size (Cohen's d)
Fine Manual (raw)	4.67 ±5.15	6.40±6.35	5.89±5.55	0.20	0.31
Manual Coordination (raw)	1.11±1.96	1.33±1.41	2.11±1.96	0.11	0.43
Body Coordination (raw)	3.00±3.71	6.22±4.92	6.78±4.68	p<0.01	0.99
Motor Composite	29.44±8.97	33.78±12.11	34.44±11.00	0.03	0.60
Total Score (raw)	9.78±10.77	16.11±14.25	17.11±13.61	p<0.01	0.85
VABS-2 Motor	54.78 ±13.12	58.89 ±13.45	58.00 ±13.95	0.03	1.00

Participant Enjoyment Scales

Parent-reported

A Mann-Whitney U test was run to determine if there were differences in parent reported enjoyment between the music and movement groups. The mean enjoyment scores as reported by parents were not significantly different between the music group (mean=22.00) and the movement group (mean=24.00). Distribution of enjoyment scores for the music group and movement group participants were similar, as assessed by visual inspection. Median enjoyment scores, on a 28-point scale, for parent reported enjoyment in the music group (22.00) and movement group (26.00) was not statistically significantly different, U=5.00, z=-1.07, p= 0.38.

Child-reported

A Mann-Whitney U test was also performed on the child reported enjoyment scales to determine if there were differences in enjoyment between the two groups. Median and mean enjoyment scores were equal. Self-reported enjoyment, on a five-point scale, was 4.50 for the music group, and 5.00 for the movement group, they were not statistically significantly different, U=3.00, z=-1.58, p=0.17.

Parent Written Feedback

Several parents provided written feedback in response to the following question: What behavioral changes (if any) have you noticed in your child since beginning their participation in this program?

Table 7. Written parent feedback

Child	Group	What behavioral changes (if any) have you noticed in your child since beginning their participation in this program? Verbatim Comment
P1	Music	More open to listening to music. Will spontaneously sing songs. Automatically sings a song and does exercises like standing on one leg, bending knees, jumping off ottoman. Seems to be less awkward when running.
P2	Music	Running is much smoother. Able to stand on one foot with help
P3	Music	Walking has improved. Gait has improved. Loves to dance and recognizes songs from the program.
P4	Music	More awareness and use of oral motor muscles. More knee bending.
P5	Music	Since the program started, his movement seems to be more purposeful. He's dancing and occasionally humming/singing while he moves.
P6	Music	Better language skills and better behaviour at school. Spends less time in "quiet room" more time in classroom. Great at kicking a ball, riding a tricycle. Uses pencils by himself, coloring more independently.
P7	Movement	No Feedback
P8	Movement	My son still falls when he is running, this is a behaviour we hoped would improve with his participation in this program. Was reluctant to attend on the last day but when another child from the class arrived my child laughed and played without any further displays of reluctance or displeasure. He does not talk about any of the other participants at home, but he has shown an interest in another person that we haven't seen before. Unfortunately, we have not seen any difference in his behavior since beginning the program. He has always been active ie: running, jumping and galloping at home several times a day. He is very quiet an uncommunicative so no mention of other participants in the program. Even when asked direct questions about what he did in class he simply doesn't answer.
P9	Movement	He improved his gross motor skills during the program. He had so much fun and loved going to his sessions. He talked about his teachers all the time and even made art for them spelling their

	names by himself. He has always been active, so I'm not sure that he was doing more of it since starting the program, but he does seem to have more confidence in his gross motor skills.

Discussion

The purpose of this study was to investigate the effects of a six-week music and movement intervention on the movement skills of children aged 4-6 years with ASD. Research on children with typical development suggests that music and movement programmes can lead to significant improvements in movement skills; and that music may improve the efficacy of a movement skill intervention (Beisman, 1967; Derri, Tsapakidou, Zachopoulou, & Kioumourtzoglou, 2001; Zachopoulou, Tsapakidou, & Derri, 2004). However, there are no published studies examining the effect of music and movement on the movement skills of children with ASD.

Groups at Baseline

All of the children included in this study presented moderate to strong preferences for music as indicated by their parents based on a music receptivity scale (Appendix D). This measure demonstrated that these children did not have aversions to music. Baseline motor skill assessments on the MABC-2 showed that all but one participant scored below the 5th percentile indicating the presence of significant movement difficulties in the majority of the participants. These scores confirmed a need for a movement skill intervention for these participants, which is consistent with other literature demonstrating that young children with ASD have significant delays in their motor skills (Donnellan, Hill, & Leary, 2012; Green et al., 2009; Lloyd et al., 2013; MacDonald et al., 2014).

Group comparisons at baseline revealed that the music group had significantly lower movement skills than the movement group as measured by BOT-2 total motor composite (Table 3). Although the MABC-2 scores and VABS-2 motor scores were also lower in the music group, this difference did not reach a level of statistical significance. The MABC-2 protocol requires the child to complete all tasks in order to receive a valid score (Henderson, Sugden, & Barnett, 2007). Only half of the children in the music group completed the required tasks while the other half fell below the lowest possible measure. All of the children in the movement group were able to complete the tasks required for the MABC-2, indicating that there was a bigger gap in actual ability level than what was measured by the MABC-2 because some of the music group participants' skills were too low to even register on the scale.

Although the children were divided by random assignment, the participants in the music group had lower movement skills, lower social skills scores, and were an average of 8 months younger than the participants in the movement group. Furthermore, two of the participants in the music group had co-occurring diagnoses, one with global developmental delay and another with attention deficit disorder with hyperactivity. These confounding variables made it difficult to make clear comparisons between the two groups. Many researchers have found that the high degree of variability in symptom severity and comorbidity that exists within this population makes it difficult to achieve large homogeneous samples (Wigram & Gold, 2006). These challenges highlight the diversity in abilities that exist in the ASD population, therefore it is important for researchers to include all ability levels in their research.

Movement Outcomes

The participants in this study experienced many improvements in movement proficiency from pre-test to post- test (Table 4). The sub tests of the BOT-2 short form are broken into 4 categories; fine manual, manual coordination, body coordination and strength and agility (Bruininks & Bruininks, 2005). The total motor composite score and total raw score are calculated based on these sub tests. The participants demonstrated unexpected changes in fine manual skills and manual coordination. These skills were not specifically targeted by the intervention, yet they are skill areas that are generally poor in children with ASD (Provost et al., 2007). During the interventions, the use of small hand held props and toys such as; rhythm sticks, scarves, balls and small flash lights may have contributed to these improvements. However, since both groups used the same equipment, the effects of their use are unknown and warrant further study.

The music group experienced significant improvements in body coordination immediately following the 6-week intervention ($p=0.04$). The movement group also made improvements in the desired direction. The body coordination domain refers to the individual's ability to control and coordinate large muscle movements while maintaining balance and posture (Bruininks & Bruininks, 2005). It is related to movement elements such as body and space awareness, movement effort and relationship concepts (Zachopoulou et al., 2004). Previous researchers have paired these movement elements with the rhythmic elements such as tempo, intensity and accent. The musical tempo can provide direction for the speed of movement, while intensity can guide the type and quality of movement (ie: lightness, heaviness or number of muscle groups engaged). Musical accents communicate the movement emphasis given to certain beats such as

clapping or marching on certain beats in the measure (Zachopoulou et al., 2004). Other programs based on elements of rhythm have led to improvements in rhythmic abilities for children with typical development (Derri et al., 2001; Weikart, Schweinhart, & Larner, 1987). Rhythmic ability is a coordinated ability that has been associated with the level of motor skill acquisition and body coordination in children with typical development (Brown, Sherrill, & Gench, 1981; Zachopoulou et al., 2004). The present study emphasized these rhythmical elements through the use of pre-recorded music which was paired with movement activities and saw improvements as measured by the BOT-2; however more research is needed to delineate the mechanisms of change.

Body coordination was targeted during both group interventions through the use of stretching with a parachute, obstacle course using play equipment, walking, kicking and jumping activities. During the music intervention however, music with simple melodies incorporating rhythmic movement cues were used in addition to the play equipment. The music provided rhythmic direction and motivation for the participants to move. Each movement activity was accompanied by a different song to emphasize the movement goals. For example when "Zoom, zoom, zoom, we're going to the moon" was played, the children bent and straightened their knees during the verse bouncing to the rhythm and cadence of the music, then cued by the words "blast off", jumped on the light spots projected by a flashlight. A song called "The ponies are walking" beckoned the children to walk, gallop and trot around the room in synchrony with the rhythmic accents, when the word "whoa!" was sung, the children would stop moving until the rhythm and lyrics directed them to move again. Sung directives have been effectively used by other researchers to engage children with ASD in movement activities as well (LaGasse, 2014;

Paul et al., 2015). Rhythmicity is an important part of the timing and total pattern of movement (Hardy & LaGasse, 2013; Thaut, Kenyon, Schauer, & McIntosh, 1999). It is hypothesized that pairing movement with musical cues contributed to the improvements in body coordination that were made by the music group. Future research may examine these effects using music with and without verbal cueing.

The music group also demonstrated improvements in total motor composite scores and total raw movement score with large effect sizes. Despite their low levels at baseline, the music group achieved a 148% improvement in their raw total motor scores while the movement group improved by 35%. These values demonstrate that the music group experienced a relatively greater change from baseline to post intervention than the movement group. Other studies examining the use of music to improve the movement skills of children with typical development have found that music can enhance the outcomes of movement interventions, in domains such as jumping, leaping and dynamic balance (Beisman, 1967; Brown et al., 1981; Zachopoulou et al., 2004). Therefore, the music is suspected to be a key contributor in these improvements. The results of this study are in harmony with the outcomes of other studies indicating that rhythmic accompaniment used as a teaching technique may augment movement performance in young children (Beisman, 1967; Brown et al., 1981; Derri et al., 2001; Zachopoulou et al., 2004).

Movement Outcomes at 4-Week Follow-up

A two-way repeated measures ANOVA was utilized to compare the effects of the music and movement interventions over time. The results of this analysis indicated that the improvements made during the intervention period were generally retained or, in

some cases, continued to improve by the 4-week follow-up. This is an important finding as it indicates that the skills practiced may have been successfully learned. Bremer et al. (2015) studied the effects of a movement intervention on the movement skills of children with ASD and found that improvements in movement skills that were made during a 6-week movement intervention were also retained at follow-up (Bremer et al., 2015). These results provide support for the use of movement skills interventions for young children with ASD.

Improvements on the motor sub-test domains continued up to 4-week follow-up and the music group achieved significant improvements from pre-test to 4-week follow-up on total raw score and body coordination. Some parents whose children participated in the music intervention indicated that their child began to sing or hum songs while practicing skills at home. The effects of this additional practice cannot be quantified in this study but may have contributed to the continued improvements. Previous literature indicates that children with ASD are capable of superior reproduction of melodies (Heaton, 2003, 2009). The music intervention attempted to harness this musical strength by linking memorable melodies to movement thus increasing movement practice beyond the intervention sessions. The results indicate that this technique may have been successful, however more research is needed on much larger sample sizes.

The movement group retained the improvements in total raw score, strength and agility, and they showed a small improvement in body coordination at the 4-week follow-up (Table 5). The movement group also demonstrated an unexpected jump in manual coordination from post-test to 4-week follow-up which was inconsistent with the trajectory of development from pre- to post-intervention. This was not a skill area that

was specifically targeted by the current intervention. The fact that this increase happened after the intervention period implies that the skill may have been developed in some other setting such as school, home or therapy. The average age of the movement group indicates that the participants were likely in a more advanced grade at school than the music group. Therefore some skills practiced at school such as hand writing, may have affected manual coordination and would differ with grade level (Koegel, Matos-Freden, Lang, & Koegel, 2012; Kushki, Chau, & Anagnostou, 2011). However, it is not possible to accurately account for variables such as this in the current study.

Both groups experienced similar rates of improvement in movement skills during this study. This is of interest considering the music group presented greater difficulties than the movement group at baseline. The difference in movement skill at baseline indicates that the children in the music group were significantly more delayed than the movement group prior to the commencement of the intervention. However, both groups experienced a similar rate of movement improvement when comparing pre-, post- and 4-week follow-up measures (Figure 4). Furthermore, the music group continued to make improvements post intervention while the movement group retained the gains made. This may be an indication that music based interventions are well suited for children with more severe ASD (Thompson, McFerran, & Gold, 2014). One study examined the impact of a family centered music therapy program on the social engagement of young children with severe ASD (Thompson et al., 2014). They compared the effects of the music based therapy to the effects of a non-music therapy and found that the children responded best to the music condition (Thompson et al., 2014). Due to the unequal division in our current sample it is unclear how children with higher skill levels at

baseline would respond to the music based intervention, however it warrants further study.

The BOT-2 short form was the primary movement assessment tool used for the participants in this study; however, it was found that the sub tests on this tool may have been too advanced for some of the participants in the music group. Half of the participants in the music group demonstrated skills at baseline that were below the lowest possible test score. For example, on one of the balance subtests, participants were required to take six consecutive steps on a line with hands on hips (Bruininks & Bruininks, 2005). During the initial assessment, some children were unable to independently step on the line. By the second assessment, they walked on the line but did not keep their hands on their hips. Although there were observable improvements in their movement skills from one assessment to the other, these changes were still not sufficient to register on the measurement tool. This test has been validated for individuals with developmental coordination disorder, mild to moderate intellectual disability and high functioning ASD (Bruininks & Bruininks, 2005; Cools et al., 2009), yet the participants in this study experienced a floor effect. This assessment was selected based on the chronological age group of the participants, however, selecting a test based on functional age may have provided a scale that would be more sensitive to capture the observable changes made by the participants.

Many children with ASD experience a comorbid intellectual disability diagnosis (Matson & Shoemaker, 2009). Some research indicates that intelligence quotient (IQ) can contribute to greater delays in movement, adaptive and social skills (Green et al., 2009). However, participant IQ measures were not available for the current study. Therefore, the

role that IQ may have played in this sample is uncertain. One study tested the BOT-2 reliability and responsiveness on children with cognitive impairments (Wuang & Su, 2009). Researchers indicated that the test was valid and reliable but that children with cognitive impairments may require longer periods of intervention in order to achieve substantial improvements on the test (Wuang & Su, 2009). The BOT-2 is designed for children as young as age four however it may not be as sensitive to change for very young children with severe delays; this too should be studied further.

Using Movement Interventions for Children with ASD

The focus on movement skill development in early interventions for children with ASD is an emerging area of research. Recent studies have found evidence to support the overall use of movement interventions to improve the movement skills of children with ASD (Bremer et al., 2015; Bremer & Lloyd, 2016b; Ketcheson et al., 2016; Pan et al., 2016) but there is still much to discover with regards to the ideal modalities, settings and dosage. Since the interventions used in this study were identical with the addition of music to one group, we combined the groups to assess the effects of a 6 week, community based, group movement intervention on the movement skills of children aged 4-6 with ASD. A repeated measures ANOVA was used to assess the effects of the intervention between pre-, post- and 4-week follow-up. Significant improvements were found in BOT-2 body coordination, total motor composite and total raw scores for the whole group combined. The motor improvement as reported in VABS-2 also reached a level of significance from baseline to 4-week follow-up confirming that the parents also noticed a significant increase in their children's movement skills over time. This indicates that this type of early movement intervention is a viable method of improving

the movement skills of young children with ASD. These findings are consistent with other recent literature exploring the effects of a movement intervention on young children with ASD (Bremer et al., 2015; Bremer & Lloyd, 2016b; Ketcheson et al., 2016). Because movement skills form the basis for active play, movement difficulties experienced by children with ASD may reduce their participation in this crucial component of early development (Bremer et al., 2015; Williams et al., 2008). Participation in active play with peers is associated with improved executive functioning, problem solving, social and language skills for children with typical development (Piek, Hands, & Licari, 2012). Children with ASD experience difficulty in these domains and are unlikely to choose to engage in active play opportunities. A focus on improving movement skills may lead to greater participation in active play. Poor movement skills have also been associated with increased autism severity (MacDonald et al., 2014). Therefore, including movement skill development in early interventions for this population could improve participation in active play and have a positive impact on the core characteristic of ASD leading to optimal outcomes for these children.

Participant Enjoyment Scales

The secondary outcome examined in this study was whether the addition of music to the movement intervention increased participant enjoyment. Many physical activity programs have successfully utilized music to increase engagement and enjoyment in movement activities for children with typical development (Derri et al., 2001; Zachopoulou et al., 2004). The results from the Mann-Whitney U test indicated that there was no significant differences in reported enjoyment of the program between the two groups. Both groups consistently rated their enjoyment very high. These findings were

based on participant self-reporting using a pictorial Likert scale following each session and parent report on a ranked enjoyment questionnaire at the conclusion of the intervention period (Appendix L). Some children in the current study demonstrated difficulty with comprehension of the symbols representing feelings on the pictorial Likert scale at the commencement of the intervention (Appendix M). For example, some of the children who were non-verbal appeared confused and hesitated prior to pointing at a picture. Their parents told the instructors that they did not think their child understood the significance of the pictures on the scale and that their children's facial expressions and observed behaviors during class would be a more accurate indication of their enjoyment. However, this enjoyment scale was presented to the children after every session in an effort to empower the children to communicate their own feelings and to provide a second perspective in addition to the parental reports. Heaton et.al. (1999) used similar schematics of happy and sad faces in a study involving children with ASD. The children in Heaton's study demonstrated an understanding of what the faces represented (Heaton, Hermelin, & Pring, 1999). In the current study however, more than two emotions were represented using pictures, so it is possible that presenting varying degrees of emotion between happy and sad may have been too complex for the children in our sample. Their understanding appeared to improve somewhat over the course of the intervention and many of the children showed an appreciation for the opportunity to indicate their feelings using the scale. Future studies should explore the reliability of pictorial Likert scales for children with ASD.

In addition to difficulties with comprehension, at times participants indicated feelings on the scale following the intervention that were inconsistent with observed

behaviors during the session. For example, participants who had tantrums during the session would often report the highest rank of enjoyment at the conclusion of the session. Since parents were not present in the intervention space to observe the sessions, some parents reported that it was difficult to accurately perceive their child's enjoyment as their children had difficulties with verbal communication and would not verbally report the events from the program to their parents. Nevertheless, both groups reported high participant enjoyment overall. They were often happy upon arrival and the high attendance rates are also reflective of their level of enjoyment and engagement in the programs.

The low instructor to child ratio (1:2) may have contributed to the participants' enjoyment level which allowed the children to receive personalized instruction and attention. The programs were play-based using age-appropriate toys and props to engage the children's interests. The instructors made adaptations based on individual preferences while abiding by the special considerations for music-based interventions for children with ASD recommendations, devised by Srinivasan et al (2013). The participants appeared to respond positively to the predictability that was created through the use of a familiar visual activity schedule (Carnahan, Musti-Rao, & Bailey, 2009; Srinivasan & Bhat, 2013). The children showed an interest in removing the picture cards at the conclusion of each activity. Age appropriate props were also used to clarify the goals of the activities (Srinivasan & Bhat, 2013). Some examples include, a large "stop" and "go" sign utilized during a walking activity to cue movement, a flash light shone on the floor symbolized the moon to promote jumping on the "moon" and a parachute was raised up to elicit group stretching and dynamic balance. Verbal and gestural reinforcements in the

form of “hi-fives” and clapping between playful activities kept participants interested and engaged in the activity sessions during both interventions (Srinivasan & Bhat, 2013). These techniques in conjunction with the group format created a fun and welcoming atmosphere that the children seemed to enjoy.

Early intervention strategies consistently yield the greatest long term outcomes for children with ASD and there are a variety of services that exist for this population (Baranek, 2002; Seida et al., 2009). However, the increase in demand and high cost of many therapeutic approaches, make specialized services difficult for some families to access during this sensitive window of early development (Couper & Sampson, 2003; Provincial Advocate for Children and Youth, 2016). Conversely, the movement skill interventions utilized in this study were implemented with low cost in a community setting. The techniques used during these interventions could also be adapted for recreation programs, classroom and home use. Music is a versatile modality that is commonly used in education settings to teach a variety of concepts and encourage skill practice for children in the general population (Carnahan et al., 2009; Zachopoulou et al., 2004). The outcomes of this study demonstrate that the addition of music to a movement intervention could be a viable option for children with ASD who enjoy music. This type of program is cost effective and could be more accessible than some of the specialized therapeutic approaches that are currently obstructed by long wait lists.

Strengths and Limitations

The present study used a variety of measurement tools to provide a robust assessment of the interventions including; standardized direct measures, standardized parent rating systems, parent perception enjoyment questionnaires, child- reported

enjoyment ratings and qualitative parent reports. Including multiple points of view was a strength of this study as it provided a detailed examination of the effects of the interventions. The participants' opinions were considered during this study. The children were given the opportunity to report their own enjoyment. Although the children had some difficulty with comprehension of the Likert scale, they appeared to appreciate the opportunity to communicate their own feelings. Researcher bias was limited by dividing the participants into groups by random assignment.

The researchers acknowledge that there are also limitations to these findings. The most prominent limitation is the small sample size, which led to a small degree of statistical power. The findings of this study are therefore less generalizable to the population of children aged 4-6 with ASD. Yet, the fact that significant results were found, shows promise for the use of music during movement interventions and warrants further investigation. There may have been some sample bias in the families who volunteered for the study. The families understood that music would be a prominent component of the study which may have attracted families whose children had particularly strong interests in music. This may have also been a reason for some families withdrawing from the study when they were not selected to participate in the music and movement group. Half of the participants in the movement group withdrew at the commencement of the intervention leaving one small and one very small group. Having small intervention groups of 3-6 children was however, advantageous for group dynamics. There were enough children to provide opportunities for social interaction but not so many that it deterred participant attention away from the movement instructions (Bremer et al., 2015). Additionally, there was no true control group incorporated into the

design of the study which made it impossible to compare the effects of the interventions to no intervention. Unfortunately recruiting more children for the study was not possible due to time and resource constraints.

The groups were also unequally balanced based on skill level. Even though we used random assignment, the movement group started with significantly higher movement scores and were generally older than the participants in the music group. The differences in ability levels made it difficult to accurately compare the intervention outcomes between the two groups. Additionally the groups did not have the same male to female participant ratio. There was only one female participant, and she was randomly assigned to the music group. Although the lack of uniform sample presented some challenges, this was a fairly good representation of the reality that researchers face when investigating this population. Given the heterogeneity of symptom severity found in children with ASD (Wigram & Gold, 2006), using a stratified sample with matched-group design based on age and movement skills may have provided more strength to the results.

Despite the limitations of the study, the interventions did lead to significant improvements in movement skills with moderate to large effect sizes. These findings are encouraging and add to the body of evidence supporting the effectiveness of movement skill interventions at improving the movement skills of children aged 4-6 with ASD. The results also warrant further research into the use of music to enhance early movement interventions for children with ASD.

Future Research

Future studies should continue to examine the efficacy of music on motivating movement for young children with ASD, in addition to other forms of play-based movement intervention. Investigating different types of music and including music with and without verbal cueing would also provide greater insight into the optimal use of music. Furthermore, researchers should investigate the impact of dosage on movement outcomes. Increasing the length of time that the intervention is offered may yield greater changes particularly in children with more severe delays (Wuang & Su, 2009). A longitudinal investigation may help to determine whether the improvement in movement skills leads to improvements in other domains, such as social, adaptive and communication skills.

It is important that future studies use larger sample sizes that are age and ability matched, and stratified to represent the full spectrum of children with ASD. It would also be of benefit to include cognitive measures in order to understand the impact of cognitive delays on treatment response. Intervention groups should be small with low instructor to child ratios to maintain an effective level of individual attention and specificity for each participant. Having small groups of 3-6 children per intervention group reduces the risk of over stimulation or distraction that may have occurred with more participants. It is therefore advisable to utilize a study design that would allow for multiple small groups to receive the movement interventions.

Conclusion

The purpose of this study was to compare the effects of a music and movement intervention to a movement intervention without music on the movement skills of

children aged 4-6 years with ASD. It was determined that the music and movement intervention effectively improved the movement skills of the participants. Furthermore, both groups experienced improvements in their movement skills from pre- to post-intervention and either retained the skills or continued to improve at four week follow-up. The results of this study support the use of music to enhance active play participation and improve the movement skills of children with ASD.

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Chapter 4: Manuscript 2
Investigating the Effects of a Music and Movement Intervention on the Adaptive Behaviors and Social Skills of Children Aged 4-6 years with Autism Spectrum Disorder

Abstract

Autism spectrum disorder is characterized by difficulties with social skills, communication, and the presence of stereotyped and repetitive behaviors. Additionally, children with ASD often experience delays in movement skills. The relationship between movement skills and the core characteristics of ASD is unclear. Some studies have associated higher levels of social and adaptive skills with increased movement skill. Other studies using music have led to improvements in these domains. The aim of this study was to investigate the effects of a six week music and movement intervention on the social and adaptive skills of children aged 4-6 with ASD. Nine children, 4-6 years of age with ASD participated in the study. The music group (n=6) participated in a 6-week music and movement program for 2, 45 minute sessions per week, the movement group (n=3) participated in an identical intervention without music. The music group experienced a significant reduction in maladaptive behaviors (p=0.04) measured by the Vineland Adaptive Behavior Scales (VABS-2). The movement group experience significant improvements in social skills (p=0.02) and daily living skills (p=0.03) as measured by the Social Skills Improvement System (SSIS). The results support the use of music during movement intervention to produce positive behavior in young children with ASD.

Introduction

Autism Spectrum Disorder (ASD) is a developmental disorder often diagnosed in early childhood (American Psychiatric Association, 2013). It is characterized by social skill deficiencies, lack of or delay in communication and repetitive or restricted behaviours (American Psychiatric Association, 2013). The incidence of ASD has increased dramatically over the past decade, with recent reports indicating that as many as 1 in 45 children are currently diagnosed (Zablotsky, 2015). The wide spectrum of severity and high prevalence of ASD, presents an urgent demand for evidenced based approaches aimed at supporting and assisting children with ASD to reach their full potential (Baranek, 2002). In addition to the core diagnostic characteristics, many children with ASD experience movement delays and difficulties (Lloyd, MacDonald, & Lord, 2013; MacDonald, Lord, & Ulrich, 2013; Staples & Reid, 2010). Motor skill delays and deficits are at times among the initial developmental concerns of parents; yet the relationship between movement skills and the social, language and behavior traits of ASD is unclear (MacDonald, Lord, & Ulrich, 2014; Teitelbaum, Teitelbaum, Fryman, & Maurer, 2002).

One of the ways that young children typically develop social and communication skills is through active play with peers; and movement skills play a pivotal role during these early interactions (Piek, Hands, & Licari, 2012). It is possible that poor movement skills, often demonstrated by children with ASD, could be a limiting factor in their social and verbal development as well (Baranek, 2002; Bremer, Balogh, & Lloyd, 2015). Combining music and movement skills with personal expression in a social environment

may lead to improved movement skills and enhance social outcomes for children with ASD (Srinivasan & Bhat, 2013).

There is no known cause or cure for ASD. There are, however, many treatment options that provide varying degrees of positive behavioral outcomes for this population (Couper & Sampson, 2003; Seida et al., 2009). The majority of therapeutic interventions for children with ASD focus directly on; social interaction, language acquisition, behavioral problems and sensory processing difficulties (Case-Smith & Arbesman, 2008; MacDonald et al., 2014). Even though movement skill delays and difficulties often co-occur in children with ASD, motor development is rarely the focus of therapeutic interventions (Baranek, 2002; MacDonald et al. 2014). Improved early movement skills are hypothesized to increase participation in active play and have a significant impact in other areas of development such as, social and adaptive skills, leading to better outcomes for children with ASD (Bremer et al., 2015; Lloyd et al., 2013; Sutera et al., 2007).

It is widely accepted that the development of fundamental movement skills is an important part of early childhood (Piek et al., 2012; Williams et al., 2008). In preschool aged children with typical development, movement proficiency is positively associated with improved cognition, language skills, self-concept and social development (Piek et al., 2012). Many researchers interested in ASD are now examining the relationship between movement skills and other behaviors observed in children with ASD (Leary & Hill, 1996; Provost, Lopez, Heimerl, 2007; Bremer et al., 2014; MacDonald et al., 2014; Sutera et al., 2007). The difference in movement skills experienced by children with ASD may be a limiting factor in achieving both social and communication skills (MacDonald et al., 2014). Some studies have found a positive relationship between motor skill

proficiency and improved long-term functional outcomes in other domains such as cognitive and adaptive functioning for children with ASD (Jasmin et al., 2009; Martos Perez & Fortea Sevilla, 1993; Sutera et al., 2007). Therefore, it is possible that improving movement skills may lead to improvements in cognitive and adaptive skills as well.

One of the common concerns for parents of children with ASD is to increase their child's level of independence (Jasmin et al., 2009). Jasmin and colleagues (2009) confirmed the presence of motor skill delays in young children with ASD and hypothesized that motor difficulties can impact a child's performance of daily living skills (Jasmin et al., 2009). Researchers assessed the impact of motor skill levels on daily living skills of young children with ASD and found that low functional independence in daily living skills is related to, and caused in part by, their motor difficulties (Jasmin et al., 2009). While the cause of motor delays in children with ASD is unclear, the association between low functional independence and poor motor skills is apparent suggesting that improving motor skills may be essential in achieving greater functional independence for children with ASD. There is a need to further examine the impact of improved movement skills on daily living skills.

MacDonald et al. (2014) investigated the relationship between motor skill deficit and social communicative skills of children with ASD. Researchers assessed participants' motor skills, cognitive development and ASD severity including social interaction, communication, play and imaginative use of materials (MacDonald et al., 2014). They observed that the children with lower gross motor skills had higher ASD severity scores (MacDonald et al., 2014). Therefore, in order to optimize a therapeutic approach, it is

important to address the role that movement skills can play in the overall growth and development of children with ASD.

Due to the variability that exists within the autism spectrum, no single treatment is likely to benefit each child equally (Baranek, 2002, Pan et al. 2016). There are some important characteristics that should be considered when evaluating any treatment for children with ASD these include; feasibility, cost, and how the intervention fits within the child's broader educational and family context (Baranek, 2002). Emphasizing the child's strengths and accommodating individual preferences to avoid sensory difficulties will lead to maximum participation and optimize outcomes (Baranek, 2002).

Musical Strengths in Children with ASD

Evidence indicates that some children with ASD demonstrate unique musical strengths and preferences (Kanner, 1943, Heaton 1999, Heaton 2008, Lai, Pantazatos, Schnieider & Hirsch 2012, Srinivasan, Bhat, 2013). Atypical sensory responses in the form of hyper- or hypo-reaction to stimulation are often observed in children with ASD, which could include but is not limited to; light, sound, touch, smell and taste stimulation (Jasmin et al., 2009). Yet, some experts describe people with ASD as being drawn to music, which may be due to its highly structured patterns (Huron, 2006; Mottron, 2009; Heaton, 2009). Two recent studies demonstrated that brain regions of people with ASD show greater activation during song stimulation when compared to speech stimulation (Lai, Pantazatos, Schneider, & Hirsch, 2012; Sharda, Midha, Malik, Mukerji, & Singh, 2015). In studies investigating music perception, cognition and learning, musically untrained children with ASD often demonstrate preserved and enhanced skills when compared to peers with typical development (Heaton, 2009). Skills such as; superior

reproduction of atonal melodies (Applebaum, Egel, Koegel, & Imhoff, 1979), enhanced pitch perception (Heaton et al. 1998, Bonnel et al. 2003, Heaton, 2003) and unimpeded ability to interpret affect in music (Lai et al. 2012) indicate that music based interventions may be particularly attractive for individuals with ASD (Srinivasan & Bhat, 2013). Engagement in musical games provides opportunities for social connections between individuals, shared affect and empathy (Molnar-Szakacs et al., 2009).

Using Music to Improve Social and Adaptive Skills

Many children with ASD experience problem behaviors that interfere with adaptive functioning, learning and socialization (Samson, Hardan, Lee, Phillips, & Gross, 2015; Sparrow, Cicchetti, & Balla, 1989). Maladaptive behaviors common amongst this population can include, but are not limited to; temper tantrums, aggression, sleeping problems and disobedience (Samson et al., 2015). These behaviors are challenging to educators, caregivers and the children, creating a barrier to learning (Carnahan, Musti-Rao, & Bailey, 2009). Music therapy has recently been classified as an emerging evidence based practice appropriate for children with ASD, which can be used to teach a variety of skills or goals through songs, rhythm and movement (Geretsegger, Elefant, Mossler, & Gold, 2014). The use of music during interventions has been found to be associated with a reduction in these challenging behaviors leading to outcomes such as enhanced social cooperation and engagement (Kim, Wigram, & Gold, 2009; LaGasse, 2014; Lanovaz, Fletcher, & Rapp, 2009; Paul et al., 2015; Rosenblatt et al., 2011). A music-based yoga and dance program designed to promote relaxation, found a strong reduction in problem behaviors amongst children aged 5-12 with ASD following an 8-week intervention (Rosenblatt et al., 2011). Teaching methods utilizing music have also

demonstrated a significant decrease in maladaptive behaviors such as, self-injury, aggression and stereotypical behaviors for children with ASD (Carnahan et al., 2009; Lanovaz et al., 2009; Whipple, 2004). Reducing these behaviors can lead to increased receptivity to learning which may be a precursor to improving adaptive behaviors and social skills.

In a pilot study investigating the effects of singing on eye contact and social responsiveness in young children with ASD, music was used to motivate positive social interactions rather than relying on extrinsic rewards (Paul et al., 2015). All participants showed an improvement in active performance, social gesture and eye contact during sung directives when compared to spoken directives (Paul et al., 2015). A music therapy group intervention was also effectively used to improve the social skills of children with ASD aged 6-9 years (LaGasse, 2014). The children were randomly assigned to either a music intervention or non-music social skills intervention. Participants in the music therapy group showed significantly greater improvements in eye gaze and joint attention with peers when compared to the participants in the non-music intervention (LaGasse, 2014). These studies suggest that a music based intervention may be more effective than non-music intervention in improving the social skills of children with ASD.

Another study including 23 young children with ASD, investigated the effects of a family-centered music therapy on social engagement (Thompson, McFerran, & Gold, 2014). The outcomes of a home based family centered music group were compared to outcomes of a non-music group after a 16-week period. The results indicated that the music group experienced a statistically significant improvement in social interactions at home and in the community (Thompson et al., 2014). There was also a significant

difference in levels of social engagement in favor of the family centered music group. The generalizability of the results of these individual studies are limited due to their small sample sizes, however taken together, the findings demonstrate support for the use of music to reduce maladaptive behaviors, engage participation and increase social interaction for children with ASD in a variety of settings.

The purpose of this study was to examine the effects of a six-week music and movement intervention on the social and adaptive skills of children aged 4-6 years with ASD compared to an identical movement intervention with no music. We hypothesize that using age appropriate music with rhythmic verbal cueing during a movement intervention could provide motivation for young children with ASD to participate in group movement activities and reduce problem behaviors leading to improved social and adaptive skills.

Methods

Study Design

Ethical approval was obtained from the UOIT Research Ethics Board (Appendix A) and the research committee at Grandview Children's Centre (GCC). Informed consent was obtained from parents for their children to participate in the study (Appendix B). Child assent was also obtained verbally from participants who were able to do so (Appendix H). This study followed a randomized control design whereby the participants were assigned, by random draw, to participate in either the music and movement program or the movement only program twice weekly for six weeks. Both programs followed the same design, however one group used pre-recorded music and the other did not. The independent variable between the groups was the use of age

appropriate music with rhythmic verbal movement cueing. In addition to the 12 intervention sessions over six weeks, all participants, regardless of group assignment, attended pre-test, post-test and four-week follow up assessments.

Table 8. Study Timeline

Pre-test	6-week Intervention	Post-test	4-week Follow-up
M-ABC-2 SSIS VABS-2 BOT-2 Random Assignment	Music Group 2 x 45min/week Movement Group 2 x 45 min/week Child enjoyment scales	BOT-2 SSIS VABS-2 Parent Perspective Enjoyment Scale	BOT-2 SSIS VABS-2

Recruitment

Children aged four to six years with ASD were invited to participate in this study. A social media post (Appendix F) was published on a private parent's group board through GCC. In addition to the social media, paper posters were displayed in several community recreation centers throughout the region inviting eligible volunteers to contact the principle researcher (Appendix E). Due to the multisensory nature of the interventions and the range of sensory sensitivities associated with ASD, which might include auditory stimulation, respondents were asked to rate their child's receptivity to music on a scale from 0 to 10. The scale was defined as: 0 is adverse to music, 2 is agitated by music, 4, does not orient to music when playing, may as well be random noise; 6, will listen to and enjoy if playing but will not request it; and 10, will request it to be played frequently and listen attentively for long periods of time (see Appendix D). In

order to satisfy the inclusion criteria for this study, the children must have been rated either 5 or above. None of the respondents rated their child below 6 on the scale, therefore, no respondents were excluded from the study. A similar scale was successfully utilized by Lai, Pantazatos, Scheider and Hirsch (2012).

Participants

Following the screening protocols, thirteen children were enrolled in the study. Participants were assigned by random draw to one of the two intervention groups. The music group consisted of six children with ASD diagnosis and one child with both ASD and Down Syndrome (DS) diagnoses. The movement group consisted of six children with an ASD diagnosis. Two families, consisting of 3 children, who were selected to participate in the movement group, withdrew from the study prior to the commencement of the intervention; leaving 7 participants in the music group and 3 participants in the movement group. While the child with ASD and DS fully completed the study, this participant's data is not included in the analysis due to the physiological differences that affect movement development in children with DS.

Procedures

Individual pre-test assessments took place one week prior to the commencement of the intervention at the UOIT Motor Behavior & Physical Activity Laboratory. Parents gave written consent and completed a supplemental participant information form at this time (Appendix I). Parents and caregivers then completed the Vineland Adaptive Behavior Scales 2nd Edition (VABS2) while their child completed the Movement Assessment Battery for Children 2nd Edition (MABC-2) and Bruincks Oseretsky Test of Motor Proficiency 2nd edition (BOT-2) movement assessments.

Parents also completed the VABS2 and SSIS at post-test and 4-week follow-up assessments. Within one week of completing the intervention, parents also completed the program enjoyment questionnaire (Appendix L) and wrote their observations or comments related to their child's behavior over the course of the intervention period (Appendix N).

Assessments

Social Skills Improvement System

The Social Skills Improvement System (SSIS) (Elliott & Gresham, 2007) was used to evaluate the social skills and problem behaviors of participating children. This scale is a valid and reliable measure of social skills for children; it is suitable for people aged 3 to 18 years old (Elliott & Gresham, 2007). This system has been used before to describe the social skills of children with ASD (Bremer et al., 2015). A standard social skills score and ASD severity rating are derived from subset scales of social skills that include; communication, cooperation, assertion, responsibility, empathy, engagement and self-control and problem behaviours such as; externalizing, bullying, hyperactivity and internalizing. This rating scale was completed by the parents and caregivers at all three assessments and differences were compared.

Vineland Adaptive Behavior Scales Second Edition

The VABS-2 is a parent reported assessment of adaptive functioning in communication, socialization, daily living and motor skill domains (Sparrow, Balla, & Cicchetti, 2005). The purpose of the VABS-2 is to assess the general social sufficiency of individuals from birth to adulthood (Sparrow, Balla, Cicchetti, Harrison, & Doll, 1984) it is widely accepted and useful with children including those with ASD. The VABS-2

can also be used to monitor progress of adaptive behaviors (Icabone, 1999), it was administered pre- and post-intervention and at follow-up.

Movement Assessment Battery for Children 2nd Edition

The MABC-2 is a widely accepted and frequently used general movement skill assessment for children age 4- 12; focused on detecting delay or deficiency in movement development (Cools, De Martelaer, Samaey, & Andries, 2009; Henderson, Sugden, & Barnett, 2007). The overall score for this test was used to identify children who either have or are at risk of having motor impairments (Henderson et al., 2007). This measurement was used as a baseline movement measure to detect the existence of movement delays.

Bruinincks Oseretsky Test of Motor Proficiency 2nd Edition

The BOT-2 is a measure of fine and gross motor skills useful for children and young adults from age 4 through 21 years (Bruinincks, 2005). Since the children in this study were on the very young end of the suitable age range and had other difficulties related to their diagnosis of ASD the Short Form was best suited to appeal to their limited memory, attention capacity and vocabulary (Cools et al., 2009). This test was administered at all three assessments to track changes in movement skills.

Parent Written Feedback

The parents were asked to provide a written response to the question: "What changes if any, did you notice in your child's behavior since beginning this program?" Please refer to Chapter 3 for their answers.

Movement Skill Intervention

The participants attended two 45-minute intervention sessions per week for six weeks (12 total sessions). The sessions were led by the primary investigator, and assisted by two trained research associates. The primary investigator has fifteen years of experience facilitating dance programs for young children. The research associates were undergraduate students with expertise in facilitating movement programs for children with ASD. In order to reduce anxiety and to create familiarity, each intervention session followed the same format. A visual schedule was used to provide further structure and predictability for participants (Figure 5). Both programs included; a warm up, fundamental movement skill instruction, practice, an obstacle course and cool down. The music group also used age appropriate pre-recorded music embedded with rhythmic and verbal cueing. The movement activities selected for the programs aimed to improve the fundamental movement skills of the children. Details of program sessions are provided in Table 9. The intervention sessions were followed by a post-test assessment within two weeks of the end of the program and one follow–up test session four weeks later.

Figure 5. Visual schedule used during both intervention groups

Table 9. Program session plan

Activity	Song (music only group)	Skill	Time
Welcome	The More We Get Together	• Name recognition Underhand roll	10 min
Warm-up	Zoom, zoom, zoom	• Flex/extend knees • Jump	5 min
Stretch	Open Your Eyes	• Reach • Gallop	5 min
Stop and Go	The Ponies are Walking	• Walk • Trot • Gallop	5 min
Large muscle movement	You've Got the Groove	• Kick	5 min
Obstacle Course/ Circuit	If I Were a Frog	• Roll • Jump • Crawl	5 min
Cool Down	Fly My Kite	• Dynamic balance	5 min
Good Bye	Passing out the sticks	• Strike	5 min

Statistical Analysis

Descriptive characteristics were calculated on all variables at baseline. Attendance was taken during each session and final averages were compared between both groups. Group VABS-2, SSIS, MABC-2, and BOT-2 scores were compared using independent t-tests to detect the presence of any significant between-group differences at baseline.

Post intervention scores of the SSIS and VABS-2 scores were compared with baseline scores using paired t-tests to determine if significant changes in social or adaptive skills were made over time within each group. The magnitude of change from pre-test to post-test was also calculated on the SSIS and VABS raw and composite outcomes for both groups. In order to detect any significant between-group differences, the average change for each group was compared using an independent t-test.

Participants were invited back for follow-up measures four weeks after the end of the intervention period SSIS and VABS were repeated at this time. A two-way repeated measures ANOVA was used to track whether or not the changes were retained over time.

Results

The descriptive characteristics of all participants which included 8 males and 1 female (music n=6, movement n=3), are found in Table 10. Both groups had high attendance rates; music group average = 82%, movement group average = 89%. The music group was an average of 8 months of age younger than the movement group but this difference did not reach a level of statistical significance.

Baseline measures

The individual SSIS and VABS-2 participant scores confirmed that all participants had very low social and adaptive skill levels at baseline. A between-group t-test of the SSIS scores revealed that although the music group had lower social skill scores, there were no significant between-group differences detected (p=0.34). Additionally, VABS-2 independent t-test comparisons revealed no significant between-group differences in adaptive behaviors. The MABC-2 baseline measures confirmed the presence of significant movement difficulties (< 5th percentile) in all participants except one (25th percentile), and BOT-2 total motor scores indicated that the movement group had significantly greater movement skills than the music group (Table 10).

Table 10. Descriptive characteristics at baseline

Variable	Music Group (mean, SD)	Movement Group (mean, SD)	p-value
Sex (male, female)	5 M, 1F	3M	
Age (months)	58.83 ±11.65	66.33 ±14.74	0.61
Age at diagnosis (months)	39.00 ±5.02	36.00 ±6.00	0.63
Ethnicity	1 A, 2C, 3O	3 C	
SSIS Total Standard Score	77.67 ±18.28	85.67 ±2.89	0.34
VABS-2 Total Score	63.00 ±18.45	75.67 ±15.31	0.34
BOT-2 Total motor composite	25.17 ±7.39	38.00 ±4.58	0.01
MABC-2 Total Test Standard Score*	27.75 ±10.78*	54.00 ±25.45	0.24

*3 participants did not reach the criteria for completion of these test items and were not included in the group mean
** A= Aboriginal C= Caucasian O= Other

Post-Intervention Outcomes

A paired t-test was run on the scores of the SSIS standard social skills, problem behaviors and ASD severity scores from time 1 to time 2 separately for the groups (Table 11). The music group showed a decrease in problem behaviors and ASD severity from pre-intervention to post-intervention, however these changes did not reach a level of significance (Table 5). The movement group experienced an increase in social skills and a decrease in problem behaviors and ASD severity; however, this change was not statistically significant. The music group experienced a greater reduction in problem behaviors (M= -7.00±12.93) than the movement group (M= -1.00±13.45), but this difference did not reach statistical significance either (p=0.54). The music group also experienced a greater reduction in ASD severity scores (M= -4.00±4.60) than the movement group (M=-1.67±1.15) however, a statistically significant difference was not achieved.

Table 11. Social Skills Improvement System pre-to post-test changes

SSIS Variable	Group	Pre-Test (mean, ±SD)	Post-Test (mean, ±SD)	Group Difference (mean, ±SD)	p-value	Effect Size (Cohen's d)
Social Skills Standard	Music	77.67±18.28	75.50±24.29	-2.17±14.77	0.73	0.15
	Movement	85.67±2.89	94.00±6.10	8.33±7.77	0.20	1.07
Problem Behaviors Standard	Music	115.50±12.37	108.50±8.92	-7.00±12.93	0.24	0.54
	Movement	115.67±14.57	114.67±26.39	-1.00±13.45	0.91	0.07
ASD Severity	Music	23.17±7.93	19.20±8.93	-4.00±4.60	0.09	0.87
	Movement	18.33±3.05	16.67±2.31	-1.67±1.15	0.13	1.45

A paired t-test was used to compare the pre- and post-intervention standard domain scores of the VABS-2 communication skills, daily living skills, social skills, motor skills, maladaptive behavior and adaptive behavior composite score (Table 12). The music group showed a significant decrease in maladaptive behavior from pre-intervention to post-intervention ($p=0.04$). The movement group experienced a significant increase in social skills ($p=0.02$). The music group also experienced an improvement in social skills, however, these changes did not reach a level of significance.

Table 12. Vineland Adaptive Behavior Scales 2nd edition standard score group changes

VABS-2 Variable	Group	Pre-Test (mean, ±SD)	Post-Test (mean, ±SD)	Difference	p-value	Effect Size (d)
Communication	Music	69.50±26.27	69.30±26.70	-0.17±1.60	0.81	0.11
	Movement	95.00±41.33	81.00±19.00	-14.00±38.22	0.59	0.37
Daily Living	Music	72.17±20.42	71.00±15.66	-1.17±7.65	0.72	0.15
	Movement	64.33±15.53	87.67±11.72	23.34±26.63	0.27	0.87
Social Skills	Music	68.17±17.43	71.67±19.29	3.00±9.44	0.47	0.32
	Movement	73.67±1.53	82.33±1.15	8.67±2.08	0.02	4.16
Motor Skills	Music	52.00±26.97	56.00±14.53	3.67±4.08	0.08	0.89
	Movement	59.67±5.13	64.67±10.97	5.00±7.00	0.34	0.71
Maladaptive Behaviors	Music	20.17±1.94	18.17±1.47	-2.00±1.79	0.04	1.12
	Movement	19.67±2.51	18.67±3.5	-1.00±0.58	0.22	1.72
VABS Total Composite	Music	63.00±18.45	64.33±17.65	1.33±1.97	0.16	0.67
	Movement	75.67±15.30	75.67±6.81	0.00±13.45	1.00	0

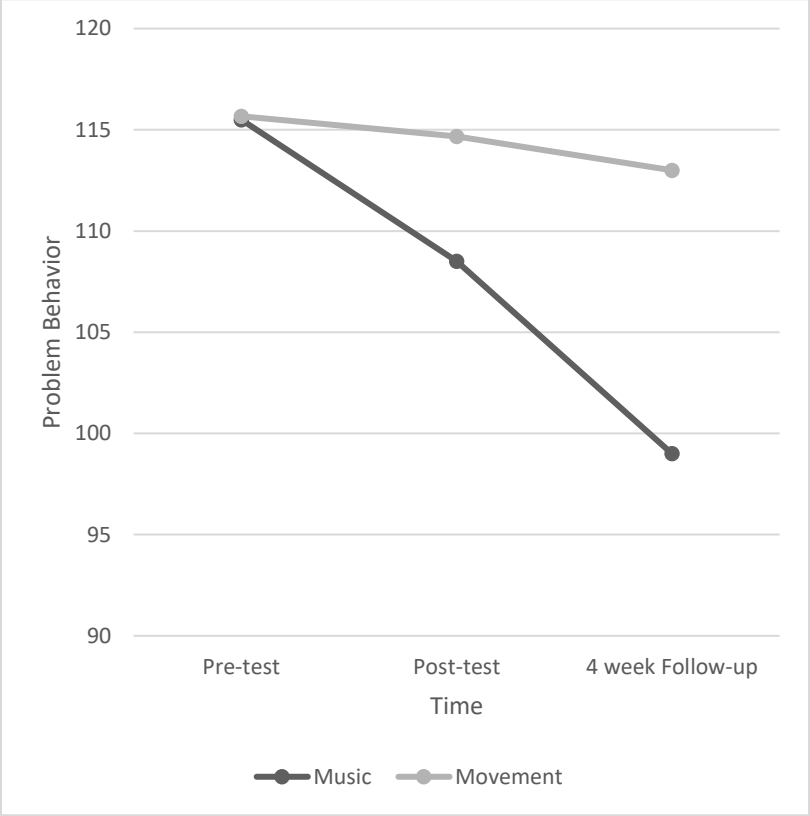
Outcome Measures 4-week Follow-up

A two-way repeated measures ANOVA was performed to determine the effect of the music and movement interventions over time on the SSIS standard social skills, problem behaviors and ASD severity scores; the results are presented in Table 13. The music group experienced an overall decrease in problem behaviors and ASD severity but these changes did not reach a level of significance. The decrease in problem behaviors experienced by the music group was greater than the reduction in problem behaviors experience by the movement group (Figure 6). The music group experienced measurable but not significant improvements in social skill scores. There were no significant group or group by time interactions on the SSIS test variables.

Table 13. Pre, post-, and 4-week follow up SSIS scores by group

SSIS Variable	Group	Pre-Test (mean, ±SD)	Post-Test (mean, ±SD)	4-week Follow-up	Group Interaction	Time	Group x Time
Social Skills Standard	Music	77.67±18.28	75.50±24.29	77.17±21.98	F=1.27	F=0.60	F=1.26
	Movement	85.67±2.89	94.00±6.10	93.00±7.55	p=0.30	p=0.56	p=0.31
Problem Behaviors Standard	Music	115.50±12.37	108.50±8.92	99.00±21.89	F=0.50	F=1.33	F=0.69
	Movement	115.67±14.57	114.67±26.39	113.00±15.10	p=0.50	p=0.30	p=0.52
ASD Severity Scores	Music	23.17±7.93	19.20±8.93	21.67±8.79	F=0.50	F=2.51	F=0.43
	Movement	18.33±3.05	16.67±2.31	17.67±4.93	p=0.50	p=0.12	p=0.66

Figure 6. SSIS Problem behaviors pre-, post-, 4-week follow-up group comparisons



A two-way repeated measures ANOVA was run to determine the effect of the music and movement interventions over time on the VABS-2 communication, daily living, social skills, motor skills, maladaptive behavior and adaptive behavior composite (Table 14). Significant time differences on the daily living ($p=0.03$), social skills ($p=0.02$) and maladaptive behavior ($p=0.02$) domains were demonstrated (Table 14). There was also a significant group by time interaction on daily living skills ($p=0.04$). Post-hoc analyses with Bonferroni corrections revealed that the decrease in maladaptive behaviors reached a level of significance between pre-test and follow-up for the music group but not for the movement group. The movement group achieved statistically significant improvements in social skills between time one and time two ($p=0.02$), these improvements were retained by time three. The movement group also achieved improvements in daily living that were significantly greater than the music group ($p=0.04$).

Table 14. Pre, post-, and 4-week follow-up VABS-2 scores by group

VABS-2 Variable	Group	Pre-Test (mean, ±SD)	Post-Test (mean, ±SD)	4 week Follow-up	Group	Time	Group X Time
Communication	Music	69.50±26.27	69.30±26.70	68.00±27.06	F=0.88	F=0.99	F=0.78
	Movement	95.00±41.33	81.00±19.00	81.33±18.50	p=0.38	p=0.36	p=0.41
Daily Living	Music	72.17±20.42	71.00±15.66	73.83±25.17	F=0.54	F=4.62	F=4.22
	Movement	64.33±15.53	87.67±11.72	91.67±12.22	p=0.49	p=0.03	p=0.04
Social Skills	Music	68.17±17.43	71.17±19.29	71.67±20.39	F=0.74	F=5.08	F=1.19
	Movement	73.67±1.53	82.33±1.15	83.67±2.30	p=0.42	p=0.02	p=0.33
Motor Skills	Music	52.00±26.97	56.00±14.53	55.83±16.56	F=0.61	F=3.64	F=0.22
	Movement	59.67±5.13	64.67±10.97	62.33±7.09	p=0.46	p=0.05	p=0.81
Maladaptive Behaviors	Music	20.17±1.94	18.17±1.47	18.33±1.75	F=0.02	F=5.56	F=0.86
	Movement	19.67±2.51	18.67±3.5	19.00±2.64	p=0.88	p=0.02	p=0.44
VABS Total Composite	Music	63.00±18.45	64.33±17.65	65.00±20.79	F=1.03	F=0.21	F=0.04
	Movement	75.67±15.30	75.67±6.81	76.67±5.77	p=0.34	p=0.82	p=0.34

Discussion

Many interventions involving music have led to improvements in behavior outcomes, and social skills for children with ASD (Carnahan et al., 2009; Kim et al., 2009; Rosenblatt et al., 2011; Whipple, 2004). Some studies also suggest that increased movement skills can be associated with improvements in adaptive and social behaviors in children with ASD (Bremer & Lloyd, 2016b; Jasmin et al., 2009), however, there are no studies examining the effects of a community based music and movement program on the social and adaptive skills of children with ASD. The purpose of this study was to investigate the effects of a six-week music and movement intervention on the social and adaptive skills of children aged 4-6 years with ASD. The results of the music and movement intervention were compared to the results of a movement intervention without music.

Participant Characteristics at Baseline

Baseline participant scores showed that all participants were in the moderately low to low range for adaptive behaviors; which is consistent in children with ASD and indicates a need for intervention. The participants also had below average social skills as measured by the SSIS. MABC-2 results indicated significant movement difficulties in all but one participant. These findings are consistent with other research indicating that children with ASD have movement difficulties and delays (Baranek, 2002; Staples & Reid, 2010). Furthermore, poor movement skills are often associated with poor adaptive skills in this population (Jasmin et al., 2009; MacDonald et al., 2013). Despite randomized group assignment, the music group had lower social skills, adaptive behavior and movement skills than the movement group. Additionally, the music group was an

average of 8 months younger than the movement group and had higher ASD severity scores than the movement group as indicated by the SSIS. Delayed development is often associated with intellectual disability, therefore, the lower skill levels experienced by the music group could be an indication of cognitive delay (Green et al., 2009). However, this study did not account for intelligence quotient (IQ) so it is impossible to determine the effect of IQ on our results (Baranek, 2002). The large range of ability levels identified in the current sample is common for this population (Wigram & Gold, 2006). Many researchers conducting studies involving this population have had difficulty finding large homogeneous samples (LaGasse, 2014; Whipple, 2004). This variability makes it difficult to directly compare the two groups or to generalize the results to the entire population, however, the population is heterogenous and therefore these findings are still relevant.

Post-Intervention Changes in Problem Behaviors and Adaptive Skills

The primary finding of this study was that a community based music and movement intervention was associated with a significant reduction in maladaptive behaviors as measured by the VABS-2. Reducing these behaviors may be a precursor to improvements in adaptive function (Sparrow et al., 2005). Maladaptive behavior is common in ASD and is often a key motivator for parents to seek treatment for their children (Samson et al., 2015). These behaviors can be a barrier to the development of functional adaptive skills, learning and socialization for children with ASD (Sparrow et al., 2005). Parents, teachers and therapists may have difficulty motivating children with ASD to fully engage in learning experiences due in part to distractions such as tantrums, irritability, inattention and repetitive behaviors (Samson et al., 2015). Therefore, reducing

these behaviors is hypothesized to be an important gateway to improving active engagement in learning and represents an important intervention goal of parents.

Carnahan et al. (2009) used music in conjunction with an interactive visual schedule to promote active engagement in small group academic learning experiences for children with ASD. Engagement was defined as body, face and eyes directed at learning materials without self-stimulatory behaviors, using learning materials appropriately and making verbal comments related to the learning materials (Carnahan et al., 2009). The children's behavior during the music condition was then compared to their behavior during instruction in the absence of music. A measured increase in engagement in learning was discovered when the teacher used music in conjunction with interactive visual materials. The present study created a similar learning environment combining music with a visual schedule to improve engagement in the movement intervention. The outcomes of this study demonstrated a significant reduction in maladaptive behaviors as reported by parents on the VABS-2 and parental written reports when music was combined with a movement intervention. One parent stated that their child had "better behavior at school" and "spends less time in quiet room and more time in the classroom" since beginning the music intervention (Table 7). These changes were measured post-intervention and the changes were maintained at 4-week follow-up. While the mechanism of behavior change is not known, our results are consistent with the outcomes of other studies indicating that musical experiences used in education may reduce challenging behaviors of children with ASD (Carnahan et al., 2009; Lanovaz et al., 2009). These findings indicate that the use of music for interventions with this population should be explored further.

The VABS-2 measures and written parent response confirmed the reduction in problem behaviors of children in the music group. Parental written reports and VABS-2 scoring provide insight into the improvements that were observed at home and school during the six-week intervention period. Parents reported improvements in mood and noticed their children sang more often at home while spontaneously practicing movement activities from class (Table 7). VABS-2 scores which are also based on parental reports, showed a significant reduction in maladaptive behaviors such as internalizing and externalizing. These findings are similar to other studies involving children with ASD that reported increased feelings of well-being and significant decreases in externalizing, internalizing and irritability in response to music based dance and yoga activities (Koch, Mehl, Sobanski, Sieber, & Fuchs, 2014; Rosenblatt et al., 2011).

The movement group experienced significant improvements in daily living skills from pre-test to 4-week follow up as measured by VABS-2 (Table 14). This progress was significantly better than the progress made by the music group in this domain. The improvements may be explained in part by their significantly higher movement skill levels at baseline as measured by the BOT-2. Previous literature documented an association between daily living skills and movement skills for children with ASD (Jasmin et al., 2009), the results of our study support the notion that improving movement skills may also lead to improvements in daily living skills. It is possible that the participants in the music group would have experienced similar improvements in daily living skills if their movement skills reached the same threshold as the movement group. The movement group also presented higher adaptive and social skills scores at baseline which may have also contributed to their receptivity to the intervention. Other

confounding variables that were not measured during this study may have also contributed to the differences in daily living skill outcomes. For example, cognitive function can contribute to skill development (Green et al., 2009; MacDonald et al., 2013). Cognitive measures such as IQ were not accounted for in this study, therefore, it is impossible to measure how it may have affected the group results. These findings warrant further investigation into the factors that contribute to improvements in daily living skills for children with ASD.

Post-Intervention Changes in Social Skills

The secondary outcome of this study was to compare the effects of a music and movement to a movement only intervention on the social skills of young children with ASD. Movement skills are fundamental for active play, but movement difficulties experienced by children with ASD may be a barrier to participation (Baranek, 2002; Bremer et al., 2015; Thompson et al., 2014). This study focused on improving movement skills with the expectation that it could lead to greater participation in active play. Participation in active play with peers is associated with improved social and language skills for children with typical development, and may lead to similar outcomes for children with ASD (Bremer et al., 2015; Piek, Hands, & Licari, 2012). Both groups experienced an increase in social skills measured by the SSIS. However, the movement group experienced a greater increase in social skills than the music group, which may be due in part to their higher level of movement proficiency (Bremer & Lloyd, 2016). Further investigation is needed to determine the association between movement and social skills in young children with ASD. Both interventions used a small group format, with activities that encouraged group interaction and social skills such as turn taking,

sharing play equipment, and cooperative games, it is hypothesized that this format contributed to the improvement in social skills that were measured. Individual movement interventions that do not use a group setting are needed to answer this question.

Previous studies involving musical group interventions for this population have demonstrated significant social skill gains (Koch et al., 2014; LaGasse, 2014; Thompson et al., 2014). One study compared the outcomes of a five-week music therapy group with the outcomes of a social skills group without music on children aged 6-9 with ASD. The music group demonstrated greater gains in social skills than the social skills group (LaGasse, 2014). Another study investigated the effects of a dance movement therapy on young adults with ASD (Koch et al., 2014). Thirty-one young adults with high functioning ASD were assigned to either a dance movement therapy group or a no-intervention control group. The dance movement therapy group experienced significant improvements in social skills following a 7-week intervention period. The participants in the present study were younger than the children included in previous studies, additionally, some children in the music group had comorbid diagnoses which may have affected their level of social skill improvements.

Music based therapy has also led to significant improvements in social engagement in children with ASD (LaGasse, 2014; Thompson et al., 2014). One study recently investigated the effects of a family-centered music therapy on social engagement of children aged 3-5 with severe ASD (Thompson et al., 2014). The outcomes of this 16-week home based family centered music group were compared to outcomes of a non-music group. The baseline characteristics between the two groups of children were very close and ASD severity scores were closely matched. The results indicated that the music

group experienced a statistically significant improvement in social interactions at home and in the community (Thompson et al., 2014). Furthermore, a significant difference was found in levels of social engagement in favor of the family centered music group (Thompson et al., 2014). It is possible that the six-week intervention period used in the present study was insufficient to achieve the same results as the family centered music program. Involving the family in the program may have also increased the time that was spent in practice beyond the intervention sessions. If the groups in the current study had been more closely matched at baseline, it may have impacted the results and provided a more accurate comparison. Further research into the effects of music based interventions on the social skills of children with severe ASD is recommended.

Poor movement skills have also been associated with increased autism severity (MacDonald et al., 2014). Both groups in this study experienced a measurable decrease in ASD severity measured by the SSIS. When the group outcomes were compared post-intervention, the music group experienced a larger decrease in ASD severity. The addition of music to the movement intervention may have enhanced the positive effects of the movement intervention yielding greater results. ASD severity is related to problem behaviors which also saw a greater reduction in the music group. The only domain that measured the same in both groups at baseline was problem behaviors as measured by the SSIS (Table 11). In this domain the music group experienced greater reductions than the movement group from baseline to 4-week follow-up (Figure 6). Some studies have suggested that although children with ASD have difficulty understanding emotion conveyed through speech, their ability to interpret affect in music is unimpeded (Heaton, Hermelin, & Pring, 1999; Molnar-Szakacs et al., 2009). There also appears to be an

association between problem behaviors and emotion regulation in children with ASD (Samson et al., 2015). It is possible that music may enhance the emotional experience for children with ASD and contribute to their ability to regulate emotions (Koelsch, 2014; Molnar-Szakacs et al., 2009). However, further research regarding the impact of music and movement on ASD severity and social response is required in order to clarify the reason for this interaction.

The goal of early interventions for children with ASD is to help them to reach their full potential. While there is a body of evidence suggesting that many children with ASD have musical preferences and affinities (Heaton et al., 1999; LaGasse, 2014; Lai et al., 2012; Paul et al., 2015; Srinivasan & Bhat, 2013), many children with ASD also have sensory processing sensitivities some of whom may have an aversion to music (Lai et al., 2012). It has been estimated that 40 percent of people with ASD show special interest in music (Heaton, 2003). The present study included participants who presented moderate to strong preferences for music, in other words they did not have an aversion to music. Results indicated that the addition of music to a movement intervention was associated with decreased maladaptive and problem behaviors. Parent comments indicated that music appeared to enhance the movement experiences of the participants in this study (see chapter 3). It is hypothesized that using music in combination with a movement intervention enhanced the efficacy of the movement intervention by reducing maladaptive behaviors and increasing participant engagement, however, these findings warrant further investigation. It is recommended that future research investigate the impact of music and movement interventions on children with ASD with larger sample sizes.

Strengths and Limitations

The participants in this study benefitted from a novel community based intervention, which was run twice weekly for a six-week period. This dosage is different from previous studies thus providing further insight into the optimal amount of intervention needed to produce change (Rosenblatt et al., 2011; Thompson et al., 2014). The intervention incorporated a number of unique instructional techniques and tools, such as; visual scheduling, music, movement and play equipment that was age appropriate and appealing to young children with ASD (Srinivasan & Bhat, 2013). Thereby utilizing a multisystem treatment approach to address the multisystem impairments of ASD (Srinivasan & Bhat, 2013).

This study also used a number of measurement tools which provided greater depth to the understanding of the interventions, including; standardized direct measures, standardized parent rating systems and qualitative parent reports. In an attempt to limit researcher bias, the children were randomly divided into one of the two intervention groups. Furthermore, parents were not aware of the exercises and activities being practiced during intervention sessions, which may have limited bias in the changes that they reported. Therefore, the responses that the parents provided may have been a truer reflection of actual changes rather than preconceived ideas of behaviors that they should be looking for.

Limitations to these findings are also noted by the researchers. For example, the findings of this study are less generalizable to the population of children aged 4-6 with ASD due to the small sample size. The size of the sample limited the power to detect change; yet, the fact that significant results were found on some variables, shows promise

for the use of music during movement interventions. Including several participants in each group provided opportunities for social interaction between the children Having a low leader to child ratio allowed the leaders to provide personal attention and accommodation to the individuals within the group. It is unclear whether social skill improvements would have been made if the same intervention were administered one on one between the leader and child. One limitation associated with the small sample size was that half of the participants in the control group withdrew at the commencement of the intervention leaving one small and one very small group for comparison. Time and resource constraints did not allow for recruiting more children.

The sample groups were imbalanced at baseline based on number of participants, skill level and age. The movement group started with higher scores on the majority of test variables including significantly higher movement skills, and were generally older than the participants in the music group. The group differences made it difficult to accurately compare the intervention outcomes between the two groups. Given the heterogeneity of symptom severity found in children with ASD (Wigram & Gold, 2006), using a stratified sample with matched-group design based on age and movement skills may have provided more strength to the comparisons.

The VABS-2 and SSIS were the main measurement tools used for the participants in this study, these tools are based on parent perception which could be somewhat subjective. While they are commonly used standardized assessments in this field, including more measures may have provided greater insights. The use of video footage of the intervention sessions coded for problem behaviors, on task behaviors and social interactions would have provided additional quantifiable data to report on behavioral

changes and participant engagement. The collection and coding of video data was not possible for the current study due to time and resource constraints.

Despite the limitations of the study, the interventions did lead to significant reductions in maladaptive behavior and improvements in social skills with moderate to large effect sizes. These findings are encouraging and add to the body of evidence supporting the effectiveness of movement skill interventions at reducing ASD severity and maladaptive behaviors and improving social skills of children aged 4-6 with ASD. The results also warrant further research into the use of music to enhance early movement interventions for children with ASD.

Future Research

It is important that future studies use larger sample sizes that are stratified to represent the full spectrum of functioning in this population. Intervention groups should be age and ability matched in order to provide stronger comparisons. They should also be small with low instructor to child ratios in order to maintain an effective level of individual attention and specificity for each participant. Having small groups of 3-6 children per intervention group reduces the risk of over stimulation or distraction that may have occurred with more participants. Therefore, it is advisable to employ a study design that would allow for multiple small groups to receive the movement interventions. Additionally, researchers may implement a similar intervention with individuals rather than a group format to determine the impact of group dynamics on behavioral outcomes.

In order to gain a greater perspective on the changes associated with this type of intervention, it would beneficial to incorporate measurement tools beyond those dependent on parent report. Including instructor observations and rating scales would

provide a second point of view. Creating coded video footage of the intervention sessions to account for on task, off task and other behaviors related to social and adaptive skills would allow researchers to quantify some of these observations and reduce bias. These additional measures could triangulate the results and highlight some of the more significant findings.

The present study utilized an embodied music intervention to address the multisystem impairments of young children with ASD (Srinivasan & Bhat, 2013). A variety of program components were used to provide multi-system results. The inclusion of visual scheduling, play equipment, group format, short bouts of physical activity and even music with verbal rhythmic cueing were included in the design of the programs based on existing literature suggesting their effectiveness for children with ASD (Carnahan et al., 2009; Rossignol, 2009; Srinivasan & Bhat, 2013). The results of the program were positive with strong effect sizes, however, it is unclear which element or combination of elements was responsible for the observed improvements. Future researchers may consider varying the combination of program elements in order to identify the most effective combinations. For example, examining a similar intervention on an individual basis rather than group, or comparing the effects of music with and without verbal cueing may provide greater insights. It may also be of interest to examine the impact of a similar intervention on older children with ASD.

Furthermore, researchers should investigate the impact of dosage on movement outcomes; greater changes may occur over a longer period of time (Bremer et al., 2015). A longitudinal investigation could help to determine whether the improvement in

movement skills leads to improvements in other domains, such as social, adaptive and communication skills.

The intervention setting is also an important consideration, these interventions were community based and held in a lab space that was similar in size and appearance to a typical kindergarten classroom. The program was facilitated outside of regular school hours. It may be difficult for some families to fit additional programming into their schedules due to time and travel constraints. In order to improve accessibility for young children future studies may explore the integration of a similar intervention in settings such as daycares, elementary schools, or home based programs (Bremer & Lloyd, 2016b; Thompson et al., 2014).

Conclusion

The purpose of this study was to compare the effects of a music and movement intervention to a movement intervention without music on the adaptive behaviors and social skills of children aged 4-6 years with ASD. It was determined that the addition of music to a movement intervention effectively reduced maladaptive behaviors of the participants. Furthermore, both groups experienced improvements in their ASD severity scores, maladaptive behaviors and movement skills from pre- to post- intervention and either retained the skills or continued to improve at four-week follow-up. The results of this study support the use of music to enhance participation in active play with peers and reduce maladaptive behaviors of children with ASD.

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Chapter 5: Thesis Conclusions

Summary

ASD is characterized by difficulty with social skills, lack of or delay in communication and repetitive or restricted behaviours; movement difficulties are also frequently observed (American Psychiatric Association, 2013). The primary focus of interventions have traditionally been on improving social, behavioral and language skills, there are very few studies examining the effects of movement on these core characteristics (MacDonald, Lord, & Ulrich, 2014). The study of movement development reveals that improving movement skills early in life may lead to optimal outcomes in social and adaptive behaviors for children with ASD (Bremer & Lloyd, 2016; Sutera et al., 2007). Music has been effectively used to motivate engagement and social communication for young children with ASD (LaGasse, 2014; Paul et al., 2015). Therefore, we used music to motivate children with ASD to participate in group movement activities in order to improve movement skills, social skills, and adaptive behavior. (Bremer, Balogh, & Lloyd, 2015; Lloyd, MacDonald, & Lord, 2013).

The effects of the music and movement group intervention on the movement, social and adaptive skills of children aged 4-6 years with ASD were examined. The outcomes of participation in the music and movement group were compared to the outcomes of participation in an identical movement intervention without music. We hypothesized that the participants in both movement interventions would experience an improvement in movement skills. However, we expected that the music and movement intervention would yield greater gains in movement skills than the traditional movement intervention. Both groups did experience improvements in overall movement skills between pre-test and follow-up testing. When compared to the movement only group, the music group experienced larger improvements in body coordination.

Movement skills are fundamental for active play, but movement difficulties experienced by children with ASD may be a barrier to participation (Bremer et al., 2015). This study focused on improving movement skills with the expectation that it could lead to greater participation in active play with peers. The music group experienced significant movement skill improvements during the intervention period which were generally retained or in some cases continued to improve by 4-week follow-up. Some parents whose children participated in the music intervention reported that their child sang or hummed songs while practicing skills at home. Many children with ASD are capable of superior reproduction of melodies (Heaton, 2003, 2009), it is possible the music intervention harnessed this documented musical strength by linking memorable melodies to movement thus increasing movement practice beyond the intervention sessions.

It was expected that the participants in the music intervention group would also exhibit gains in social and adaptive behavior. Maladaptive behaviors inhibit the development of functional adaptive skills, learning and socialization for children with ASD (Sparrow, Balla, & Cicchetti, 2005). Behaviors such as tantrums, irritability and inattention can be barriers to participation in group activities for some children with ASD (Samson, Hardan, Lee, Phillips, & Gross, 2015). We found that the music group experienced a greater decrease in maladaptive behaviors and ASD severity than the movement group. Other studies have also indicated that musical experiences used in a group setting can lead to a reduction in challenging behaviors of children with ASD (Carnahan, Musti-Rao, & Bailey, 2009; Lanovaz, Fletcher, & Rapp, 2009).

The movement group experienced significant improvements in daily living skills from pre-test to 4-week follow up as measured by the VABS-2 which were greater than those experienced by the music group (Table 8). Previous literature has documented a positive

correlation between movement and adaptive skills (Jasmin et al., 2009; MacDonald, Lord, & Ulrich, 2013). Therefore, these improvements may be explained, in part, by the movement group's significantly higher movement skill levels at baseline. It is possible that the participants in the music group would have experienced similar improvements in daily living skills if their movement skills reached a similar level. While both groups experienced improvements in social skills, the movement group experienced greater gains in social skills than the music group. This may have been due in part to their higher level of movement, adaptive and social skills at baseline. Further research is needed to determine the reason for these improvements. Our findings indicate that the movement skills of children with ASD can be improved through involvement in movement experiences and that these improvements may have a measurable impact on the core characteristics of ASD.

We expected that the children who participated in the music program would experience greater enjoyment and engagement in the intervention than the movement group. The parent reported and self-reported enjoyment scales showed similar high levels of program enjoyment between the two intervention groups. However, it is unclear whether the participants understood the meaning of the symbols used on the pictorial Likert scale since the participants' observed behaviors during the intervention sessions did not always correspond to the enjoyment levels indicated on the scale. The instructors generally observed greater compliance and engagement during the music intervention sessions.

Music, Movement and Dynamic Systems Theory

Movement skills are an important foundation for learning and development in many domains including social, cognitive and communication (Pellegrini & Smith, 1998; Sutera et al., 2007). Children with ASD tend to be solitary, sedentary and inflexible in their play and

demonstrate difficulties in forming connections with others; they do not readily participate in imitation or joint activities (Dawson et al., 2004; Hurwitz & Watson, 2015). They also have challenges and delays in their movement skills (Green et al., 2009; Lloyd et al., 2013). These characteristics make it challenging to instruct a child with ASD or to persuade the child to participate in movement activities, which may contribute to the poor movement skills often observed in children with ASD (Bremer et al., 2015; Lloyd et al., 2013). Dynamic Systems Theory (DST) is a theoretical framework that was applied as we examined this behavior and how it might be impacted.

Behavior is the product of interactions between many complex systems that cooperate to form a pattern under task, social and environmental constraints (Thelen, 2005). For example, when a young child participates in active play with peers, it requires the coordination of many subsystems to produce this behavior. Collaboration between internal systems such as; neural pathways, musculo-skeletal abilities, and psychological conditions, and external systems such as; equipment, environment and sensory stimulation, will create the observed behavior. DST postulates that there is no hierarchical order to the systems (Lewis, 2000), so changes in any one of these complex systems could impact the emergent behavior, these internal and external systems are considered control parameters (Thelen, 1995, 2005). Control parameters can either hold a system back or contribute to shifting the system to a new behavior; DST suggests that there are multiple ways to affect change within a system.

In the case of young children with ASD, solitary, sedentary, inflexible play and avoidance of imitation is often their attractor state, we attempted to impact this condition by introducing musical stimulus to the environment. Although some children with ASD have difficulty understanding communication through speech, and do not relate well to peers, there are

studies that indicate that many demonstrate unique musical preferences (Geretsegger, Elefant, Mossler, & Gold, 2014; Kanner, 1943). Several studies support the use of age appropriate music to enhance adherence to physical activity and improve movement skills in many populations (Derri, Tsapakidou, Zachopoulou, & Kioumourtzoglou, 2001; Karageorghis & Terry, 1997; Zachopoulou, Tsapakidou, & Derri, 2004). We used musical cueing as a control parameter in an effort to provide motivation for children with ASD to participate in group movement activities. In other words, music was added to the environment to motivate movement.

It was observed that the participants had a greater tendency to stay in the intervention space during the music condition when compared to the movement condition. The instructors reported increased compliance, and fewer off-task behaviors during the music group intervention when compared to the movement intervention. The music also provided smoother transitions between activities. Since the songs followed a predictable and consistent pattern from beginning to end the children were able to pace themselves accordingly and anticipated the endings of each activity. There was very little resistance when putting one prop away and introducing another during the music group sessions. During the movement intervention, transitioning between activities was difficult; the children often contested the end one activity or resisted the beginning of a new activity. The children in the movement group frequently opposed practicing the movement activities and required additional coaching in order to comply with instructions. The instructors generally observed an increase in attention, compliance and social skills during the music intervention which is consistent with results obtained in previous research using sung directives to engage children with ASD in interactive play activities (Paul et al., 2015).

When a new behavior is practiced it gains stability and resiliency over time, this change represents a phase shift into a new attractor state (Thelen, 1995). The young children in our

movement group responded positively to musical motivation during the intervention. The goal of providing the music and movement intervention was to motivate the children to practice the movement activities and improve movement skills. These new patterns of behavior were practiced twice weekly for 45 minutes per session over 6 weeks. Post- test and follow-up assessments which were performed without music indicated that this dosage may have been sufficient to produce small changes in movement, social and adaptive behaviors. The improvements that were made between pre- and post-intervention were retained, and in many cases improved by the 4-week follow-up. Many parents whose children participated in the music intervention reported that their children were spontaneously singing and moving more at home and participating more often in group activities at school. Study participants also reported a significant reduction in maladaptive behaviors.

Some individuals within both groups made friendships during the interventions. Parents have reported that they have kept in touch with each other and arranged "play dates" beyond the the intervention demonstrating that participation in these movement interventions led to meaningful changes for the participants in the current study. Some parents indicated that they were happy that their child had the opportunity to form friendships with other children with ASD because they felt that their children were able to relate to each other without fear of judgement or criticism. Therefore, providing opportunities for social group interaction and play with other children with similar challenges can be an important source of support and friendship for children with ASD.

Recommendations

There is an urgent need to develop evidence based early interventions that can be widely accessible for children with ASD. Combining music and movement is a multisystem

intervention approach that may address the multidimensional impairments of ASD (Srinivasan & Bhat, 2013). There is evidence to suggest that music and movement interventions may have positive impacts on social-emotional, behavioral and movement skills of children with ASD (Baranek, 2002; Geretsegger et al., 2014; Srinivasan & Bhat, 2013). Therefore, further examination of the optimal use of music and movement is warranted.

When measuring the movement skills of young children with ASD, researchers should carefully consider the type of assessments used. We recommend that researchers use multiple assessment tools to triangulate results, these may include standardized tools such as the BOT-2, Peabody Developmental Motor Scales Second Edition (PDMS-2), and Mullen Scales of Early Learning (MSEL). Selecting a test based on the functional age of the child rather than the chronological age may provide a more sensitive measure of change. In addition to standardized testing, researchers should use video coding to measure movement and social behaviors during the intervention sessions. Movement behaviors such as accuracy of imitation and amount of time spent on task and in synchrony could be coded. Social communication such as social gaze, joint attention and use of gestures and emotional changes including positive, neutral and negative emotions could also be accounted for this way.

Given the diversity of impairment that exists in the ASD population, it is important for researchers to stratify their samples. These samples should account for differences in ASD severity, comorbidities, basic IQ measure and gender. Stratified samples will improve the strength of the results and provide a more accurate representation of the ASD population. The small group based activities employed by the current study provided opportunities for the children to socialize with their peers. This appeared to create a welcoming and trusting atmosphere which resulted in friendships continuing beyond the intervention period. Other

benefits of group intervention strategies are, cost reduction and increased accessibility to a greater number of participants simultaneously. It is unclear how this group dynamic impacted the movement and social outcomes of the participants. Future research should explore the use of music and movement in dyadic and large group interventions. This would help to determine the best group size for optimal outcomes.

Active music interventions, that emphasize participation through synchronized rhythmic movements, are more likely to lead to improvements in movement, social and adaptive skills than passive listening (Srinivasan & Bhat, 2013). We recommend the use of pre-recorded music with rhythmic and verbal cueing with simple melodies that invite group singing and repetition. These resources are easy to use, reproduce and to share. However, practitioners should be mindful of the sensory sensitivities that exist within the ASD population and modulate volume and musical pitch based on participant preferences. This type of resource could be offered in a variety of settings such as home, school and community. Future studies should investigate the ease of implementation and effectiveness of a music and movement intervention offered in these settings.

We have compiled a list of recommendations for early childhood educators, teachers, community programmers and parents who are interested in implementing music and movement programming for young children with ASD.

1. Use pre-recorded music with simple melodies, rhythmic and verbal cueing to reinforce the movement goals.
2. Be mindful of sensory sensitivities; adjust volume, speed and pitch of the music to accommodate participant preferences.
3. Use age appropriate toys and play equipment that emphasize the movement goals of the activity. Equipment should be out of sight when not in use, and cleaned between uses.

4. Use simple, age appropriate play-based activities. Be prepared to adjust activities based on individual preferences.
5. Give the children an opportunity to make choices and take turns directing some of the activities.
6. A variety of movement activities should be practiced in short bouts (eg. 2-3 minutes per activity).
7. Activities should follow a consistent schedule during each session (eg. visual schedule).
8. Group programs should have low child to leader ratio of 3:1.

Conclusion

The results of this study provide preliminary evidence to indicate that a six-week music and movement intervention might effectively improve movement skills, and reduce maladaptive behaviors of children aged 4-6 with ASD. These improvements may lead to increased participation in active play with peers and improvements in adaptive behaviors and social skills. To the best of our knowledge this is the first study to investigate the effects of a music and movement program on the movement, social and adaptive skills of young children with ASD. Therefore, this study fills a significant gap in the early intervention literature. We recommend that music and movement opportunities be incorporated into early interventions for children with ASD which may improve engagement in active play and lead to greater behavioral outcomes long term.

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Chapter 6: Appendices

Appendix A: Ethics Approval Letter

Date:	*February 04, 2016*
To:	*Keri-Ellen Walcer*
From:	*Shirley Van Nuland, REB Chair*
REB # & Title:	*(15-084) Using Music to Motivate Movement in Children Aged 4 to 6 Years with Autism Spectrum Disorder*
Decision:	*APPROVED (January 29th, 2016)*
Current Expiry:	***February 01, 2017***

Notwithstanding this approval, you are required to obtain/submit, to UOIT's Research Ethics Board, any relevant approvals/permissions required, prior to commencement of this project.

The University of Ontario, Institute of Technology Research Ethics Board (REB) has reviewed and approved the research proposal cited above. This application has been reviewed to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2 (2014)) and the UOIT Research Ethics Policy and Procedures. You are required to adhere to the protocol as last reviewed and approved by the REB.

Continuing Review Requirements (forms can be found at: http://research.uoit.ca/faculty/policies-procedures-forms.php)**:**

- **Renewal Request Form**: All approved projects are subject to an annual renewal process. Projects must be renewed or closed by the expiry date indicated above ("Current Expiry"). Projects not renewed within 30 days of the expiry date will be automatically suspended by the REB; projects not renewed within 60 days of the expiry date will be automatically closed by the REB. Once your file has been formally closed, a new submission will be required to open a new file.
- **Change Request Form**: Any changes or modifications (e.g. adding a Co-PI or a change in methodology) must be approved by the REB through the completion of a change request form before implemented.
- **Adverse or Unexpected Events Form**: Events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form**: This form must be completed when the research study is concluded.

Always quote your REB file number (15-084) on future correspondence. We wish you success with your study.

REB Chair
Dr. Shirley Van Nuland
shirley.vannuland@uoit.ca

Ethics and Compliance Officer
compliance@uoit.ca

Appendix B

Informed consent:

Using music to motivate movement in children aged 4-6 years with Autism Spectrum Disorder

Date: TBD

Investigators:

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Dear Parents,

You and your child are invited to participate in a voluntary research study. The purpose of this study is to investigate the effectiveness of a music and movement intervention compared to a traditional movement intervention for children ages 4-6 with Autism Spectrum Disorder (ASD). The children will be randomly assigned into either a music and movement or movement group. Both groups will meet twice a week, for six weeks. Each session will take 45 minutes.

Why is this work important?

Children with ASD often experience differences and delays in their movement skills, which could impact other areas of development, such as social and physical. Participation in movement skill interventions at an early age may lead to improved outcomes for children with ASD.

Music can act as a motivator for movement. Studies show that music can be an effective way to promote physical activity and improve movement skills in young children. Some research studies suggest that many children with ASD have strong musical abilities and preferences. For these reasons we believe that music could be a useful component in a

movement program for children with ASD. Studies have also demonstrated that interventions that use music can lead to improved social skills of the participants.

A recent pilot study confirmed that traditional movement instruction and practice can help to improve movement skills for children aged 4-6 years with ASD. Therefore we expect that the children who participate in the movement skill group without music will experience improvements in movement skills as well. The children who participate in this group will practice the same skills and activities that the music group will experience without the musical component.

The purpose of this study is to see whether there is any benefit to using music with rhythmic cueing during a movement intervention for children ages 4-6 with ASD. We will be looking at movement skills, social skills and adaptive skills. We are also interested in comparing the enjoyment levels of the children in each intervention.

Study Procedure

This study includes assessment of movement skills, social skills and adaptive skills. Prior to the intervention, we will ask you to complete a few questionnaires in order to provide demographic and background information about your child. It will take approximately 60 minutes to complete the questionnaires. They will be provided to you on-site at the pre-test. When you arrive at the pre-test, we will measure your child's movement skills and will ask you and your child a series of questions. Your child will be randomly assigned to either a music and movement group or a movement group. More details about each portion of the study are included below:

Assessments

There will be four pre-tests prior to the intervention and three post-tests after the children have participated in the interventions, these three tests will be repeated four weeks after the end of the six week program. The children will also be asked to rate their enjoyment of the program at the end of each session. The participants may be video recorded during the pre and post-test assessments to insure accuracy of data collection and scoring. The video recordings will not be used for any other purposes other than scoring the assessments. All recordings will be kept confidential

The Movement Assessment Battery for Children Second Edition (MABC2) will be used at pretest to measure your child's movement skills. Your child will be asked to perform a number of movement activities (i.e. jumping, walking, balancing, throwing and catching) and scores will be used assess your child's movement skills before participating in the intervention. This test will assess the following skill areas:

- Manual Dexterity- 3 items (i.e.: threading beads, drawing)
- Aiming and Catching- 2 items (i.e.: bean bag toss)
- Balance- 3 items (i.e.: balance on one leg, jumping, walking)

A standard assessment tool called the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) Short Form will be used to measure gross and fine motor skills at pre-test and post-tests. This test has 8 subtests:

- Fine Motor Precision—2 items (e.g., drawing lines and folding paper)
- Fine Motor Integration—2 items (e.g., copying a star, copying a square)
- Manual Dexterity—1 items (e.g., transferring pennies)
- Bilateral Coordination—2 items (e.g., tapping foot and finger, jumping)
- Balance— 2 items (e.g., walking forward on a line, standing on one leg on a balance beam)
- Running Speed and Agility—1 item (e.g., shuttle run, one-legged hop)
- Upper-Limb Coordination—2 items (e.g., dropping and catching a ball, dribbling a ball)
- Strength—2 items (e.g., knee push ups, sit-ups)

Social and Adaptive Skills

The social skills of the participants will be measured before and after the intervention using the Social Skill Improvement System (SSIS). This is a standardized social skill rating system and is administered by using a form completed by the parent or guardian of the child.

The adaptive skills of the participants will be measured using the Vineland Adaptive Behavior Scales Second Edition (VABS2). This is a standardized survey that will be used to assess your child's communication, daily living skills, socialization and motor skills. This is a survey that will be completed by the parent or caregiver before and after the six week intervention.

Enjoyment Scales

For the purposes of this study, the researchers have created a simple picture scale that your child will be asked to use to communicate their enjoyment of the class at the end of each class session.

At the conclusion of the six week intervention you will also be asked to rate your child's enjoyment of the program by filling in a brief questionnaire. You will also have the opportunity to write any changes that you have noticed in your child since the commencement of the intervention.

Risks and benefits:

Your child's participation in this study does not pose any risk that differs from what they would normally experience in daily life. All physical activities are similar to regular gym class, and sport/recreation camp activities. As with any physical activity, there is a risk of falling; however safety is our first priority. All researchers participating in this study are trained in First Aid and CPR. In the event of an injury, the facility's standard emergency

procedures will be followed. These procedures involve administering first aid on site and notifying the UOIT Emergency Management Response Team to carry out any other emergency procedures that may be required. By participating in this study, you do not waive your legal rights.

Your child may benefit from this study as they will receive valuable movement skill instruction by highly experienced personnel and will be tested by the research team, which may create more awareness of their movement, social and adaptive skills. The research findings will also help to shape future programs and have the potential to improve the outcomes for other children with ASD. We will also provide you with a report on your child's personal results.

Are there any consequences for not participating?

No, participation in this research study is completely voluntary. You may withdraw your child from the study at any time by notifying the researchers, and you are not required to provide a reason for withdrawing. Not participating in this study, or withdrawing your child partway from the study, will not prevent your child's participation in the program or any future programs. If you withdraw from the study prior to its conclusion, you and your child may not receive your child's completed results from the study. However you will be eligible to receive a summary of the research results at your request. These results will be available by October 2016.

Missing a session does not disqualify your child from participation in the study. If you are going to miss a session, please notify us as soon as possible. In order for results to be included in the study, your child must attend a minimum of 10 out of 12 group sessions.

Confidentiality

The data collected in this study will be used for current and potentially future research, it will be secured safely. All information that you and your child provide will be numbered and will not contain names. Overall group results may be published for scientific purposes, but participant identities will remain confidential. Limits of this confidentiality include situations of suspected child abuse, concerns of harm to self or others, or any request for information by court order.

Right to withdraw:

You are free to withdraw your child at any time without penalty. If you choose to withdraw and would NOT like us to use your child's data, please inform us within 1 week of withdrawing. At your request, any data that has been collected from your child will be destroyed and will not be used in any analyses, publications or future research.

Dissemination:

At your request, you may receive a copy of the results for this study following its completion. You will also receive a summary of your child's personal results once they have completed their final assessment session.

Questions About the Study:

If you have any questions about this study, please contact Keri-Ellen Walcer at 905-721-8668-5988 or keri-ellen.walcer@durhamcollege.ca or Dr. Meghann Lloyd at 905- 721-8668 ext. 5308 or meghann.lloyd@uoit.ca. This study has been reviewed and is approved on [date] by the University of Ontario Institute of Technology Research Ethics Board (REB #15-084), which is a committee of the university whose goal is to ensure the protection of the rights and welfare of people participating in research. The Board's work is not intended to replace a parent/guardian or child's judgment about what decisions and choices are best for you. Any questions regarding your rights as a participant, complaints or adverse events may be addressed to The University of Ontario Institute of Technology Research Ethics Board at 2000 Simcoe St. N., Oshawa ON, L1H 7K4 through the Ethics and Compliance Officer - compliance@uoit.ca or 905.721.8668 x. 3693.

Informed Consent to Participate: Using music to motivate movement in children aged 4-6 years with Autism Spectrum Disorder

I, _____,

(Your Name)

the parent/guardian of _____,

(Your Child's Name)

- ☐ Give consent to my child's participation in the above study.
- ☐ Give consent for my child to be video recorded during assessments.
- ☐ Give consent for using data collected from my child if my child withdraws.
- ☐ Give consent to be contacted for future studies regarding individuals with Autism Spectrum Disorder.

I have read and understood the attached information sheet or had the attached information sheet verbally explained to me, and have received a copy of this consent form. I have been fully informed of the details of the study and have had the opportunity to discuss my concerns. I understand that I am free to withdraw my child at any time or not answer questions.

_____

Name of Child

_____

_____

Name of Parent/Guardian Contact Phone Number

_____

_____

Signature of Parent/Guardian Date

Appendix C

Letter of Invitation:

Using music to motivate movement in children aged 4-6 years with Autism Spectrum Disorder

January 06, 2016

Dear Parents and Caregivers,

My name is Keri-Ellen Walcer; I am a graduate student pursuing a Master's degree in the Faculty of Health Sciences at the University of Ontario Institute of Technology (UOIT). My thesis supervisor Dr. Meghann Lloyd is an Assistant Professor at UOIT and Research Associate at Grandview Children's Centre.

We would like to invite you and your child to participate in a research project through UOIT called: Using music to motivate movement in children aged 4-6 with Autism Spectrum Disorder. Movement skills play a very important role in early childhood development. We have created two fun and active interventions that are designed to improve movement skills for young children with Autism Spectrum Disorder (ASD).

Children who volunteer to participate in this study will be randomly assigned to one of two small groups: a) music and movement activity group or b) movement activity group. Both groups will meet two times per week for 6 weeks at a UOIT movement lab in Oshawa. The groups will be led by a children's fitness expert with over fifteen years of experience teaching children's movement programs assisted by a small team of kinesiology students. Each participant will have their movement skills, social skills and adaptive skills assessed through non-invasive measures before and after the 6 week program. We will also keep track of their self-reported enjoyment of the activities.

Our goal is to help children with ASD improve their movement skills through safe, fun and effective physical activity programming. We believe that children who participate in these programs will improve their movement skills and enjoy benefits to their overall health and development.

Recruitment for this study will take place during the month of (*month*), there is no cost to participate in the program and parking is free, but space is limited. If you are interested in enrolling your child, or have any other questions or concerns regarding this study please contact myself or Dr. Lloyd at your earliest convenience using the contact information below. We look forward to hearing from you.

Best Regards,

Keri-Ellen Walcer
Graduate Student
University of Ontario Institute of Technology
200 Simcoe St. N
Oshawa, Ontario
L1H 7K4
905-721-8668, ext.5988
keri-ellen.walcer@durhamcollege.ca

Dr. Meghann Lloyd
Assistant Professor
University of Ontario Institute of Technology
200 Simcoe St. N
Oshawa, Ontario
L1H 7K4
905-721-8668, ext.5308
meghann.lloyd@uoit.ca

Appendix D

Music Receptivity Scale (screening)

Name	
Age	
Gender	

Please indicate with a check mark (√) on the line below how receptive your child is to music on a scale of 0 to 10.

0 = is adverse to music

2 = is agitated by music

4 = does not orient to music when playing, may as well be random noise;

6 = moderately, will listen to and enjoy if playing but will not request it

10= extremely, will request it to be played frequently and listen attentively for long periods of time

0	1	2	3	4	5	6	7	8	9	10

Scale adapted from (Lai et al., 2012)

Lai, G., Pantazatos, S. P., Schneider, H., & Hirsch, J. (2012). Neural systems for speech and song in autism. *Brain, 135*(3), 961-975.

Appendix E

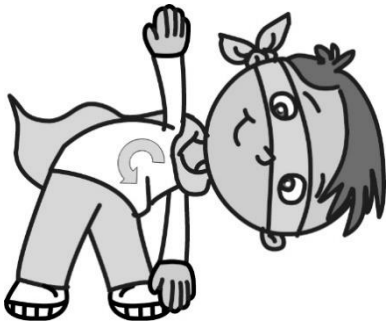
Free!

Fun Active Movement Program for Kids

We are looking for 4-6 year old children

With Autism Spectrum Disorder (ASD)

to participate in a 6 week group activity program led by a children's dance and fitness expert and UOIT graduate student.



There is no cost to participate in this research project taking place winter 2016

For more information please contact Keri-Ellen Walcer or Dr. Meghann Lloyd:

905-721-8668, ext. 5988

keri-ellen.walcer@durhamcollege.ca

meghann.lloyd@uoit.ca

UOIT Research Ethics Board approval 15-084

If you have any concerns regarding your child's rights as a research participant, please contact UOIT Ethics Board at compliance@uoit.ca

Appendix F

Social Media Post Script

Facebook Post:

An exciting study led by a UOIT Kinesiology student aims to improve movement and social skills of young children with Autism. The children who participate in the study will be assigned to a music and movement play group OR a movement play group without music. This is a great opportunity for children with Autism to improve their skills and make new friends. If you are the parent or legal guardian of a child between the ages of 4 and 6 years who might like to participate in this FREE 6 week program please contact Keri-Ellen via: keri-ellen.walcer@durhamcollege.ca. The study will take place winter 2016 in Oshawa Ontario. Please like or repost this message, to benefit as many children as possible.

Appendix G

Verbal Script for Screening Questions

Thank you very much for contacting me regarding my research project. My name is Keri-Ellen Walcer I am a master's student at UOIT and am the lead researcher on the project called: Using music to motivate movement in children aged 4-6 years with Autism Spectrum Disorder. I would like to ask you a few questions about your child to ensure that he or she meets the eligibility criteria for our study.

1. Does your child have a diagnosis of Autism Spectrum Disorder (ASD)?

2. Is your child between the ages of 4 and 6 years old?

3. Can your child see, hear and walk independently?

4. Does your child have a tendency towards self-injurious behavior or react violently towards others?

5. On a scale of 0 to 10, how receptive is your child to music?

0 = is adverse to music

2 = is agitated by music

4 = does not orient to music when playing, may as well be random noise;

6 = moderately, will listen to and enjoy if playing but will not request it

10= extremely, will request it to be played frequently and listen attentively for long periods of time

If YES to 1-3, NO to 4 and greater than 4 to music receptivity scale then child is eligible for the study.

Your child meets the eligibility criteria for the study; do you have any further questions for me about participation in the study? If you are interested in enrolling your child in this study, I would like to schedule an appointment for you and your child to come to our lab so that I can explain the study in more detail and begin your child's assessments.

If NO to any one of 1-, YES to 4 or less than 5 on music receptivity scale then child is not eligible for the study.

I am sorry but your child does not meet the eligibility criteria for the current study (reason). Thank you so much for taking the time to contact me. Would you like me to keep your contact information on file so that you could be contacted regarding any other studies that your child may be eligible for

Appendix H

Child Assent

Hi, (child's name), your (mom, dad or legal caregiver's name) has said it is okay for you to be part of my research play group, is that okay with you?

The reason we are doing this project is to help us to understand how moving to music and playing can help kids. We want to know what kinds of activities are the most fun and helpful for you.

If you choose to be part of my project, I will ask you to come here to our play room 2 days per week for about two months. When you come here, you might be part of a group that does activities to music or you might be in an activity group without music. Both groups will practice fun activities like jumping, galloping, walking and playing together. You will also get to meet other boys and girls your age during our group activities.

You do not have to be part of my play group if you don't want to.

If you do choose to come to the group the things you do and tell us here will not be shared with anyone else except you and your parents. If you want to stop coming to the group at any time, then you can.

Do you have any questions?

Do you want to participate in my research play group? YES / NO

Appendix I

Supplemental Information Form

This form includes questions about your child that will help to describe the information we learn through this study and identify factors that may relate to children's rate of progress and development. Please feel free to ask questions if you would like further clarification.

1. Child's name: _____

2. Birth date: _____ (day, month, and year)

3. What is your child's diagnosis?

   _____

4. At what age did your child receive their diagnosis? _____

5. Please indicate the number of siblings your child has and her birth order:
   # siblings: _____ birth order: _____

6. Has a doctor/physician or other health care provider told you that there are specific types of physical activity your child should not participate in? If yes, please specify.

   _____

7. Has your child also been diagnosed with any of the following?

- ☐ Anxiety
- ☐ Attention Deficit Disorder
- ☐ Attention Deficit Hyperactivity Disorder
- ☐ Development Delay
- ☐ Epilepsy
- ☐ Intellectual Disability
- ☐ Learning Disability
- ☐ Operational Defiant Disorder
- ☐ Seizures
- ☐ Sensory Integration Disorder
- ☐ Visual Problems
- ☐ Other:_____

8. Has your child ever received any motor interventions (i.e. physical therapy, occupational therapy)? If yes, please specify from what age and the duration.

_____

_____

9. Is your child currently receiving any other form of therapy (i.e. speech-language, Applied Behaviour Analysis (ABA)-based services, etc.)? If yes, please specify the type and duration.

_____

_____

_____

10. Please list any medications your child is currently taking:

_____

_____

11. Please self-declare your child's ethnicity using the options below:
(Consistent with Statistics Canada, 2011)

- ☐ Aboriginal
- ☐ Arab/West Asian
- ☐ Black
- ☐ Chinese
- ☐ Filipino
- ☐ Japanese
- ☐ Korean
- ☐ Latin American
- ☐ South Asian
- ☐ Southeast Asian
- ☐ White
- ☐ Undeclared
- ☐ Other:

Appendix J

Music and Movement Program Session Plan

Activity	Song	Skill	Time
Welcome	The More we Get Together	• Name recognition Underhand roll	10min
Warm-up	Zoom, zoom, zoom	• Flex/extend knees • Jump	5min
Stretch	Open Your Eyes	• Reach • Gallop	5min
Stop and Go	The Ponies are Walking	• Walk • Trot • Gallop	5min
Large muscle movement	You've Got the Groove	• Kick	5 min
Obstacle Course/ Circuit	Black Dog In the River	• Throw • Leap • Crawl	5min
Cool Down	Fly My Kite	• Dynamic balance	5min
Good Bye	Passing out the sticks	• Strike	5min

Appendix K

Movement Program Session Plan

Activity	Skill	Time
Welcome	• Name recognition Underhand roll	10min
Warm-up	• Flex/extend knees • Jump	5min
Stretch	• Reach • Gallop	5min
Stop and Go	• Walk • Trot • Gallop	5min
Large muscle movement	• Kick	5 min
Obstacle Course/ Circuit	• Throw • Leap • Crawl	5min
Cool Down	• Dynamic balance	5min
Good Bye	• Strike	5min

Appendix L

Program Enjoyment Questionnaire

We are interested in how your child responded to participating in this program. Please indicate your level of agreement below.

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
My child was happy to participate in the program.					
My child practiced some of the activities from the program at home.					
My child made friends at the program.					
My child tried new activities during the program.					
My child improved and/or gained new movement skills (*i.e.: jumping, running, reaching, balancing*) during the program.					
My child is interested in participating in programs like this in the future.					
I would like my child to continue to participate in programs like this in the future.					

Comments:

Appendix M

How did you like the program?

Please circle the picture that shows how you feel during the program.

Really Great! Really Bad.

Appendix N

Discussion Question for Parents

What behavioral changes, (if any) have you noticed in your child since beginning their participation in this program? (i.e.: singing or humming songs, practicing galloping, jumping or other activities between sessions, talking about people or objects from movement sessions)

Appendix O

Participation Feedback Letter: Using music to motivate movement in children aged 4-6 with Autism Spectrum Disorder

Dear (Parent or Caregiver Name),

I would like to take this opportunity to sincerely thank you and (child's name) for participating in our research study investigating the effects of music on movement, social and adaptive skills of children with Autism Spectrum Disorder (ASD). Your child's participation has contributed to making scientific advancements in novel therapies for children with ASD and other developmental disabilities. We hope that this study will help your family and many more families now and for generations to come.

The data collected during this study involved the use of; the Movement Assessment Battery for Children Second Edition MABC2, The Bruinincks Oseretsky Test of Motor Proficiency Second Edition (BOT2), Vineland Adaptive Behaviour Scales Second Edition (VABS2), Social Skills Improvement System (SSIS), and Enjoyment Questionnaires. Enclosed is a summary of your child's scores on these assessments. Any publications or reports relying on this data will be completely anonymous and will contain no personal information that can identify you or your child.

Thank you once again for participating in this research study. If you have any questions about this report or study, please contact me at any time at keri-ellen.walcer@durhamcollege.ca or 905-721-8668, ext.5988.

Best Regards,

Keri-Ellen Walcer

Appendix P

Study Timeline

Event	Place	Tasks	Date
Ethics approval	UOIT	Submit to REB	December, 2016
Recruitment	UOIT Grandview Children's Center, Abilities Center, Legends Center	Posters, mail letters, social media posts, phone calls, email, screening participants	February, 2016
Parent and child telephone and email screening for interested individuals that meet inclusion criteria	UOIT Movement Lab	Inform parents and children of the purpose and methods of study. Provide consent forms, make individual pre-test appointments.	March, 2016
Pre-test sessions with individuals	UOIT Movement Lab	M-BAC, BOT-2, VABS, SSIS	March 14-19, 2016
Intervention	UOIT Movement Lab	Music group M-W Movement group T-TH	March 21-April 30, 2016
Post- test sessions with individuals	UOIT Movement Lab	BOT-2, VABS, SSIS, Enjoyment Scale	May 2-7, 2016

Follow up sessions with individual participants	UOIT Movement Lab	BOT-2, VABS, SSIS	June, 2016
Data Analysis	UOIT	Data Analysis and Thesis writing	May- July, 2016
Prepare Thesis	UOIT	Write paper for publication, Submit Thesis	August, 2016
Thesis Defense	UOIT		September, 2016

Appendix Q

RESEARCH ETHICS BOARD

Title: Using music to motivate movement in children aged 4-6 years with Autism Spectrum Disorder

Research Assistant Statement of Confidentiality

I (please print name)_____am assisting Keri-Ellen Walcer in her study "Using music to motivate movement in children aged 4-6 years with Autism Spectrum Disorder" _____with collecting data _____.

As a Research Assistant, I am acknowledging that:

- I will maintain the confidentiality of this research data and will maintain the anonymity of the participants involved.
- I understand that the content of the data is to be held in strictest confidence and is not to be discussed outside of the research group.
- I understand that security of the data files must be maintained at all times and is to be stored appropriately as stated in the protocol.

.

In signing my name below, I agree to the above statements.

Research Assistant Signature: _____, Date: _____,

I have fully explained the issues of confidentiality, integrity of data and security issues to the above Research Assistant.

Principle Investigator Signature: _____, Date: _____,