The Impact of Rhythmic Music on Walking Gait for Individuals with Cerebral Palsy

by

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ABSTRACT

Cerebral palsy (CP) is a non-progressive neurologic disorder characterized by motor pathway damage prior to functional development. Damage to the central nervous system impairs motor functioning, including control of motor movement, loss of coordination, and loss of purposeful posture in individuals with cerebral palsy. This creates abnormal walking gait, impaired balance, and loss of muscle control. Current research shows positive results in studying the use of rhythmic music and walking gait for individuals with neurologic disorders. However, most research focuses on neurologic disorders acquired later in life, such as post-stroke patients and individuals with Parkinson's disease and traumatic brain injuries. The current study addresses the impact of rhythmic music on walking gait for an individual with cerebral palsy. Research addresses whether the use of rhythmic music impacts: (a) endurance (laps, distance traversed, and steps taken) (b) cadence (steps per minute), (c) velocity (distance over time), (d) emotional responsiveness (positive or negative affect), and (e) motivation. The current study is a single subject, mixed method design under randomized treatment conditions. The subject is a 25-year-old female diagnosed with spastic diplegic cerebral palsy. The subject participated in a five-week study, three times a week for one hour each session. Assessment was conducted during the first session. The following 14 sessions included gait training either under treatment (the use of recorded rhythmic music accompanied by audible drum beat) or control (no music) randomly assigned prior to the beginning of the study. Data were collected through video recordings, subject and researcher journals, and emotional

responsiveness surveys. Data were analyzed for treatment versus control conditions. Analysis of both quantitative and qualitative data indicated that rhythmic music does impact walking gait for individuals with cerebral palsy. When compared to control conditions, the treatment conditions showed an increase in endurance, cadence, and velocity, and improvement in affect and motivation.

DEDICATION

To my Father and Mother

With their endless loving support I have had the ability to pursue my dreams.

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CHAPTER I: INTRODUCTION

Overview

The use of rhythm in a therapeutic setting was a reoccurring theme throughout history. Dating back to shamanic healers, rhythm played a large role in healing ceremonies (Gioia, 2006). As the field of medicine and research advanced, the reasoning behind the therapeutic power of rhythm was explored. Current research links rhythm with biological factors. In beginning to understand how our bodies have their own internal rhythm, the use of outside auditory and sensory rhythmic elements is an area of interest. The field of music therapy explored and continues to expand the possible effects of rhythmic music used in treatment, and promising results are found in studies of the use of rhythm with neurologic disorders (Thaut, 2010).

Cerebral Palsy

Cerebral palsy (CP) is a non-progressive neurologic disorder characterized by motor pathway damage prior to functional development, including impairment in walking gait. It is the most common congenital disorder caused by lack of oxygen to the brain during birth but also may be acquired later in life from head injuries and infection. Due to damage in the brain areas, control of motor movement is impaired, creating loss of coordination and controllable and purposeful posture. Damage to the central nervous system creates inability to integrate movement patterns and control muscle movements. Motor abnormalities include walking gait, impaired balance, and loss of muscle control. CP is classified by type, by limb involvement, and/or by severity or degree of

impairment (Miller, 2005). Further description and neurology of cerebral palsy will be discussed in Chapter II.

The use of rhythmic music in gait training is a music therapy technique proven to be an effective treatment to improve functional gait for individuals suffering from neurologic disorders. Studies show improvement of gait velocity, stride length, and stride symmetry in post-stroke patients, and in individuals with Parkinson's disease (PD) and traumatic brain injury (TBI) (Thaut, 2010). Stroke, PD, and TBI are neurologic disorders typically acquired later in life. The purpose of using rhythmic music with these disorders is to activate rhythmic entrainment (phase locking between auditory rhythm and physical movement) and reconnect previously functioning motor pathways that are damaged.

As cerebral palsy also is a neurologic disorder, it is possible that the use of rhythmic music may impact walking gait for this population. Studies by Kwak (2007) and Thaut, Hurt, Dragon, and McIntosh (1998) provide compelling results for the use of rhythmic music and walking gait for patients with cerebral palsy. However, few studies have been done with this population. As the research continues, the medical and music therapy fields can learn more about the lasting effects of rhythmic music in hopes of further promoting this treatment option. To further support Kwak's (2007) and Thaut, Hurt, Dragon, and McIntosh's (1998) research and given the positive results of rhythmic music on gait training for other neurologic disorders, further studies may provide compelling results, specifically for individuals with cerebral palsy.

Rhythmic Music and Gait Training

The intrinsic quality of rhythm is a current topic of study (Trehub & Hannon, 2009). Recent medical research provides further insight into the complexity of each individual's internal 'time-keeper' (Thaut, 2005), the neural function thought to control gait keeping. Auditory stimulation may play a large role in the functionality of the internal 'time-keeper,' creating great possibilities for gait training and ambulatory treatment with music.

One of the most researched interventions in gait training is *Rhythmic Auditory Stimulation* (RAS), a Neurologic Music Therapy technique developed by Michael Thaut and is defined as

> a neurologic technique using the physiological effects of auditory rhythm on the motor system to improve the control of movement in rehabilitation and therapy. RAS is mostly used in gait therapy to aid in the recovery of functional, stable, and adaptive walking patterns in patients with significant gait deficits… (Thaut, 2005, p. 139).

Considerable research was conducted by Michael Thaut (2010) on the effects of RAS and improvement of gait patterns over the past few decades. Rhythmic Auditory Stimulation appears to be effective in improving gait patterns of individuals suffering from neurologic disorders such as post stroke patients, Parkinson's disease (PD), and traumatic brain injury (TBI) (Thaut, 2010).

The Effects of Rhythm on Movement

Within the cerebral cortex, the auditory processing area and movement area are adjacent, thus allowing interaction between the auditory and motor systems. The brain's motor response to auditory stimulus is known as the thalamic response (Crowe, 2009). The auditory system has the ability to detect

temporal patterns not only quickly but also accurately. This connection is intrinsic and does not take a conscious effort. The motor response to musical stimulus is produced at the same time as the stimulus, a spontaneous synchronization. Auditory motor circuitry occurs at the reticulo-spinal level, which mediates spinal-motor neurons that are aroused by sound. With this instantaneous and intrinsic response to auditory stimulus, the science behind the impact of rhythmic music highlights three main areas: rhythmic entrainment, auditory-motor pathway priming, and movement cueing. Further description and explanation of these areas will be discussed in Chapter II.

Rhythmic Auditory Stimulation (RAS) is a neurologic music therapy technique involving the use of auditory rhythmic cueing to illicit intrinsic and biological rhythmic movements, such as gait. The therapist begins gait training by matching the client's limit cycle, or cadence, through the tempo of the music (beats per minute). Over the training process, the therapist gradually increases the tempo, promoting functional gait patterns by increasing spatial and temporal patterns. The training targets sub-skills involved in gait, which include step cadence, stride length, symmetry of stride, velocity, and support of leg stance. As this researcher is not certified in neurologic music therapy, the current study cannot specifically use RAS, but simply addresses the impact of rhythmic music.

The current study focuses on the impact of rhythmic music on walking gait for an individual with cerebral palsy. Research addresses whether the use of rhythmic music impacts: (a) endurance (laps, distance traversed, and steps taken),

(b) cadence (steps per minute), (c) velocity (distance over time), (d) emotional responsiveness (positive or negative affect), and (e) motivation.

CHAPTER II: REVIEW OF LITERATURE

Overview of Cerebral Palsy

According to Johnston and Hoon (2006), "Cerebral palsy (CP) has been defined as a group of disorders of the development of movement and posture…" (p. 436). The term cerebral palsy is an umbrella term describing motor impairment classified in various manners. Cerebral palsy is caused by a brain lesion, in which the severity and areas of impairment are directly related to the location of the lesion. This lesion occurs in the immature brain, either during prenatal development or after birth, typically in the first two years while the brain is still in development.

Cerebral palsy frequently is accompanied by impairments and disorders in other areas such as cognitive, sensory, and perceptory functions. Often as a dual diagnosis, cerebral palsy is commonly accompanied by seizures, epilepsy, visual and hearing impairments, and cognitive disabilities. Although many individuals with cerebral palsy cognitively develop at a typical rate, mild to severe intellectual disabilities may be a co-morbid diagnosis.

Etiology. Given the various kinds of cerebral palsy, the etiology is not of great importance for treatment purposes. However, to better understand the disorder, etiology should be noted. The brain lesion may occur because of congenital developmental deformities, during the neonatal period or during the postnatal period. Congenital developmental deformities include a neural tube deficit called encephalocele, a cleft in the brain called schizencephaly, focal cortical dysplasia, or problems that occur in synaptic formation preventing

synaptic remodeling. During the neonatal phase, prematurity or problems that occur during birthing as well as brain hemorrhages may cause cerebral palsy. Postnatal trauma, metabolic encephalopathy, infections, or toxicities also are possible causes during the postnatal period (Johnston & Hoon, 2006).

Epidemiology. The prevalence of cerebral palsy has varied over time and across countries. Miller and Freeman (2005) attribute the difficulties in reporting prevalence to the wide variety of causes and difficulty in a specific diagnosis. The incidence of cerebral palsy is estimated to occur in 2 of 1000 live births and is more prevalent in males than females (Johnson & Hoon, 2006).

Classifications. The various classifications of cerebral palsy are described by *type*, by *limb involvement*, or by severity or *degree of impairment* (Peters, 2000). When classified by types, the differences focus on various symptoms and indicators:

Spastic CP: stiff movement, rigidity of muscles, constant muscle contraction, and abnormal movement patterns and posture.

Athetoid CP: flaccid, floppy muscles, inability to maintain posture, and purposeless limb movement.

Ataxic CP: loss of coordination, poor balance, swaying trunk, and slow walk positioned with feet apart and arms up for balance.

Tremor CP: shakiness in limbs, especially when initiating voluntary movement.

Rigidity CP: more severe form of spasticity and inflexible movement.

Mixed type CP is usually both Spastic and Athetosis, or tremor and Ataxia mixed with other conditions.

Atonic CP: muscle weakness with no or flaccid muscle tone and is usually seen in infants and can develop into Athetosis.

When classified by limb involvement, six types of CP are identified. If one limb is affected, the disorder is referred to as monoplegia. When one side of the body, both an arm and a leg, are affected, the disorder is referred to as paraplegia. If there is major involvement in the lower body (legs) and minor involvement in the upper body (arms) the disorder is referred to as diplegia (Dabney, Lipton, & Miller, 1997). When three limbs are affected (typically both legs and one arm), the disorder is referred to as triplegia. If all limbs are seriously affected, the disorder is referred to as quadriplegia. Finally, a third way of categorizing cerebral palsy is by severity or degree of impairment and is defined as mild, moderate, and severe (Peters, 2000). Irrespective of classification, careful individual assessment is required, as each client has a unique mixture of types.

The Motor System. Neurology of the motor system is a complex process that is still being researched. Current research highlights the importance of the Central Nervous System (CNS) in initiating, executing, and regulating motor functioning. The CNS is responsible for integrating processing through the musculoskeletal system. In order for the CNS to appropriately manage the motor system, a series of processes must occur in one or more of the five main subdivisions of the motor system; the cerebral cortex, basal ganglia, cerebellum, brainstem, and spinal cord. El Manira and Shenoy (2009) explain, “The final

motor output is the result of sophisticated integration of activities across many neural networks, each of them controlling a defined behavior" (p. 570).

Specific motor functioning is attributed to specific areas of the motor system subdivisions. Selecting and planning purposeful movements is processed through the cerebral cortex and basal ganglia. From sensory input and other factors, signals are sent by the primary motor cortex (located in the cerebral cortex) to the skeletal muscles to initiate voluntary movement. The basal ganglia helps "regulate voluntary motor activities" (Marieb, 2007, p. 239-240), through modification of signals. Next, the cerebellum comes into play, controlling equilibrium and balance of the skeletal muscles. The cerebellum is responsible for processing timing. Through sensory input, fibers are sent to the cerebellum to produce coordinated movements. Next, moving down the body anatomically is the brain stem, which provides ascending and descending tracts from the brain to the spinal cord. Responsible for visceral organ motor control, the brain stem regulates activities such as breathing that are vital to all human functioning. Next, the spinal cord plays a vital role in processing movement. Locomotion is processed through microcircuits in the spinal cord (El Manira & Shenoy, 2009). Signals are sent to and from the brain to the spinal cord and vice versa, which serve as the center for major reflexes.

Severity and impairment of cerebral palsy depends on where the lesion occurs in the brain. If the lesion occurs in the cerebral cortex, everything below it is affected (e.g. the basal ganglia, cerebellum, brain stem, and spinal cord). If the lesion occurs in the cerebellum, the brain stem and spinal cord are affected, etc.

Due to the complex nature of this disorder, etiological factors, medical factors, co-morbidity, and areas of impairment, all factors must be taken into consideration to provide treatment options.

Rhythmic Music and Gait Training for Neurologic Disorders

The broadest and most prolific writer in this area is Michael Thaut, who has done numerous studies and reviews of research with rhythmic music, specifically his technique, Rhythmic Auditory Stimulation (RAS) and neurologic disorders. Most recently, Thaut and Abiru (2010) published an article giving an overview of current research on RAS and movement disorders. Outlined in the review are studies showing the positive effects of RAS on gait training for post stroke, Parkinson's, and other patient groups, including traumatic brain injury and individuals with cerebral palsy. Outside of this review, several other studies have been published. Following is an overview of this research.

The Science Behind Rhythmic Music

Sound is processed instantaneously as an external auditory stimulus and then processed internally. Three main areas are highlighted through auditory processing of rhythmic music: rhythmic entrainment, auditory-motor pathway priming, and movement cueing.

1. Rhythmic entrainment is the process in which connections are made between the auditory and motor systems in the brain. As measured by EMG, structured sound patterns can entrain muscle activation patterns (Thaut, Kenyon, Schauer, & McIntosh, 1999).

2. Auditory-motor pathway priming is accomplished by activation of motor neurons by the reticulospinal pathways. This neural activation is created by sound stimulation, specifically rhythm. Therefore, rhythm activates motor neurons through supraspinal influences that create muscle activation. Eloctromyography (EMG) research has revealed lower extremity muscle activity changes in response to rhythm (de l'Etoile, 2010) that allow flexible gait movement and the motor recruitment patterns to operate more efficiently.

3. Movement cueing refers to all aspects of gait actions on and between heel strikes. The audible beat used in rhythmic music cues the endpoint of gait movement or the heel strike. The period of information refers to the duration between beats that serves to cue all actions between heel strikes, such as weight shift, acceleration, etc. Rhythm serves as a continuous time reference, executing the entire pattern of movement. RAS is used as an immediate entrainment stimulus or as a long-term gait-training program.

Rhythmic Music and Post-Stroke Patients

Several studies were published on the positive results of RAS and post-stroke patients. The following summarizes two studies by Thaut, McIntosh, and Rice (1997) and Hayden, Clair, Johnson, and Otto (2009).

Thaut, McIntosh, and Rice (1997) presented a study of 20 post-stroke patients ages 66-80 years. All patients were initially able, with hand held assistance, to walk 5 strides. Patients were placed into two groups, experimental and control. Treatment for the experimental group consisted of RAS enhanced physical therapy, and treatment for the control group consisted solely of physical

therapy. Both groups received treatment for 6 weeks and were administered a pre- and post-test without RAS. For RAS treatment sessions, music was chosen based on tempo, meter, and individual preference. Sessions began with 1-2 minute warm up walks to calibrate the RAS to the patients' initial walking tempo. During the 2nd and 3rd quarter of the study, the tempos were increased 5-10% based on patient capability and improvement. During the 4th quarter, the RAS was phased out of treatment to initiate independent facilitation of gait movement. Results of the study showed that the patients receiving RAS significantly improved gait velocity, stride length, and stride symmetry relative to those in the control group.

Hayden, Clair, Johnson, and Otto (2009) presented a study with 41 post-stroke patients between the ages of 55-80 years. The volunteers were placed in three groups; group one received RAS enhanced by physical therapy, group two received only physical therapy for 10 weeks followed by 20 weeks of RAS, and group three received 20 weeks of only physical therapy followed by 10 weeks of RAS. All clients concurrently received occupational therapy and speech therapy. The music was based on client preference and with a distinction of defined but not accented beats. Initially, the tempo of the RAS was calibrated to the individuals' cadence. Over the course of treatment, the tempo was increased by 1 to 3 beats per minute based on individual capabilities. The RAS session consisted of toe tapping followed by a 5-minute warm-up walk without music, then toe tapping, standing/marching/shifting weight, and 10-15 minute walk with music, concluding with seated relaxation. Results of this study indicated progress over time with all groups. Specifically, all groups improved, "…for one-limb stance,

cadence, velocity, stride length, and posture head tilt" (Hayden, et. al., 2009, p. 2191). The most notable outcome of this study was the significant gains in the group receiving RAS enhanced physical therapy in one-limb stance. This finding may indicate that RAS is more effective when used early on as a treatment intervention.

Rhythmic Music and Parkinson's Disease

As gait impairments are common among patients with Parkinson's disease (PD), RAS is a proven, effective intervention to increase, "…gait speed, stride length and swing time…" (Hausdorff, Lowenthal, Herman, Gruendlinger, Peretz, & Giladi, 2007, p. 2372). Results of the following studies by Thaut, McIntosh, Rice, Miller, Rathbun, and Brault (1996) and Hausdorff, et.al. (2007) correspond with previous findings involving the use of RAS with neurologic disorders such as stroke victims in improvement of gait patterns.

Thaut, et. al. (1996) conducted a study involving 38 participants ages 61-78 years who were diagnosed with Parkinson's disease. Participants were on a volunteer basis and were divided into three groups: experimental, self-paced, and no-training. The experimental group participated in RAS while walking for 30-minutes every day to music of three different tempos to encourage flat surface walking, stair stepping, and "stop-and-go exercises" (Thaut, et. al., 1996, p. 194). The self-paced training group participated in the same exercise program as the experimental group, without the aid of RAS. The no-training group participated in their regular, every-day activities without musical stimulus. The music was based on client-age music familiar to an elderly population. Each of the participants

chose their preferred music out of a given selection. Musical meters consisted of 2/4 and 4/4 and were all 32 measures in length with the use of a click enhancing the beat. The study was conducted over three weeks. For the RAS group, the tempos increased by 5-10% each week. All participants were given a pre- and post-test measuring EMG patterns and stride. Throughout the three-week study, gait was studied and recorded through EMG electrodes and a foot-switch system that recorded contact at the heel and various areas in the foot (first and fifth metatarsals and big toe). Results indicated the experimental group who participated in RAS improved gait training by 25%, including increase of velocity for flat surface and incline walking. Cadence and stride length also improved. The self-paced training group also improved velocity, but significantly less than the experimental group, including no increases in cadence. Participants in the no-training group showed no improvement over the three-week study. As the study concluded, "In only 3 weeks, the RAS program, which was based on increasing walking tempo gradually through rhythmic auditory cuing, was effective in shifting the subjects' intrinsic gait tempo" (Thaut, et. al., 1996, p. 199).

Exemplifying the global recognition of the use of RAS to improve gait functioning, Hausdorff, et.al. (2007) presented a study conducted at the Tel Aviv Sourasky Medical Center. The study contained two groups, 29 patients with PD, and 26 healthy volunteers based on age and gender criteria matched to the PD group. All participants were given an initial assessment to determine initial gait and cognitive ability. The study consisted of participation in a 100m walk with the use of RAS. Subjects were studied and responses recorded for six conditions

involved in walking gait. First, participants walked at their usual comfortable pace. Then RAS was added matching their comfortable pace, then again at their comfortable pace without RAS. Next, RAS was increased by 10% from the baseline tempo, and participants walked with increased RAS. They were then examined walking directly after the increase without RAS. After a 15-minute break, participants walked again at their comfortable pace. Data were recorded using computerized shoes sensitive to pressure in the foot during gait training. Results of this study indicated an increase in gait (speed, stride length, swing time) with the use of RAS for patients with Parkinson's disease. The PD group showed improvement both when RAS was set to their comfortable pace and when increased 10%. Hausdorff, et.al. (2007) explain possible reasoning for the effectiveness of RAS on gait training, "…RAS acts like a pacemaker and provides an external rhythm that is able to stabilize the defective internal rhythm of the basal ganglia" (p. 2373). This shows how rhythmic entrainment using outside sources can re-connect damaged motor neurons through rhythmic cueing.

Rhythmic Music and Traumatic Brain Injury

Hurt, Rice, McIntosh, and Thaut (1998) presented a study involving eight participants with traumatic brain injury (TBI) using RAS to improve gait patterns. Participants ranged from 25-35 years and were 4-24 months post-injury, showing little progress toward physical therapy goals. Two experiments were conducted. A pre- and post-test measured participants' progress without the use of RAS. The first involved a set of 4 walks within the same day; the participant first walked at their normal pace without RAS, then with RAS. Next they were asked to walk as

quickly as they safely could without RAS, then with RAS using a 5% increase from their 'quick' walking speed. The second experiment involved patients using RAS in their home environment for a 5-week gait training program. The therapist prescribed a certain number of minutes to walk each day to RAS set at their initial tempo and then set at their increased tempo. Both experiments used music based on tempo and meter, with a choice of different pre-selected genres. The purpose of the two experiments was to determine the effectiveness of RAS in immediate gait training versus long-term gait training. No significant improvements were made during the first experiment, concluding that immediate application of RAS may not have been effective in gait training. The second experiment, however, showed significant results in increased stride length, velocity, and cadence, concluding that long-term application of RAS can improve gait patterns for individuals with TBI.

Music Therapy and Cerebral Palsy

Peters (2000) explains the positive results of music therapy interventions for individuals with orthopedic impairments. Areas such as muscle strengthening and increasing muscle tone, elicitation and regulation of physical movement, and increasing motor coordination and control are addressed through music therapy interventions. Through selection of motivating music, movement-to-music activities, and tailoring the use of specific musical instruments to individual clients, areas of physical enhancement can be addressed through music therapy. Peters' (2000) also describes the positive outcomes of using rhythmic music for physical enhancement. "The rhythmic structure of music can be very beneficial in

helping individuals time their movements or perceive the rhythmic flow and structure of desired movement patterns" (p. 160).

Although Peters (2000) described the use of rhythmic music for individuals with orthopedic impairments, very few studies have been done specifically on the use of rhythmic music on walking gait for individuals with cerebral palsy. In her master's thesis, Kwak (2000) studied the effect of Rhythmic Auditory Stimulation (RAS) on 30 participants ranging in age from 6-20 years enrolled at a school in Korea for children with physical disabilities. Her study was later published in the *Journal of Music Therapy* (2007). In her thesis, Kwak gives an extensive overview of the neurology of the motor system with the specific technique of RAS. All participants were ambulatory but had need areas, including coordinated movement and stability during gait movement. The control group participated in regular physical therapy with no RAS, the therapist-guided group received RAS enhanced gait training from both a physical and music therapist, and the self-guided group participated in regular physical therapy as well as self-guided RAS observed by the music therapist. The difference between the RAS enhanced training and self-guided was the music therapist's active engagement in the RAS training versus training given to the participant on how to self-guide their treatment using RAS with only observation by the music therapist. All participants were given a pre- and post-test. Music was selected based on meter (4/4) and steady beat pattern. A metronome for the self-guided group and djembe drum by the music therapist for the RAS group were used to emphasize the beats during treatment. A computer program was used to measure and analyze gait

patterns. Results of the study concluded that stride length, velocity, and cadence improved during RAS treatment. The most significant improvements were shown in the therapist-guided RAS group. As Kwak suggests, to extend these findings, the study would need to be repeated taking into consideration the unique differences between individuals with cerebral palsy. Although all were diagnosed with cerebral palsy, cognitive abilities as well as specifics relating to each individual's orthopedic impairments need to be considered. She suggests more qualitative data as well as more help involved to keep participants safe while allowing the music therapist to apply the RAS intervention for future studies.

Review of research suggests that the use of rhythmic music during gait training improves variables such as velocity, stride length, and stride symmetry for individuals with neurologic disorders. Given the amount of literature explaining these positive results, further research on the impact on the use of rhythmic music with individuals with cerebral palsy may present further treatment options for this disorder. As Kwak (2007) noted in her research study, unique characteristics of each individual with cerebral palsy need to be taken into consideration to study treatment options. She also suggests stronger qualitative data when studying this population. Taking Kwak's (2007) recommendations into consideration, the current study focuses on a single subject. Analysis includes mixed methods with randomized conditions to assess the impact of rhythmic music on walking gait for an individual with cerebral palsy.

CHAPTER III: METHOD

The study conducted was a single participant, multi-element design using mixed methods under randomized treatment conditions. The researcher is a board-certified music therapist. In this design, treatment and control conditions are randomly assigned for administration and experimental effects documented by systematic changes in intercept (level), slope (change over time), and variability (change from one session to another).

Different types of data were collected. Videotapes were made of each session, which were then analyzed by the researcher. In addition, reflections from a survey and journal entries by the participant and researcher also were collected..

Recruitment and Participant Description

Recruitment for the study began with a meeting with the director of a local non-profit organization who works with individuals with special needs at the ASU music therapy clinic. The primary recruitment criterion included an individual diagnosed with cerebral palsy between the ages of 19 and 25. After explanation and discussion of the purpose of the study and recruitment criteria, a participant was suggested for participation. The researcher contacted the participant and her legal guardian via e-mail with a letter explaining the study. (See Appendix B for recruitment script). An in-person meeting was conducted in which both the participant and legal guardian signed consent forms and any questions about the study were addressed. (See Appendix C for a Sample Consent Form).

The participant chosen for this study was a 25-year-old woman diagnosed with spastic diplegic cerebral palsy. Her symptoms moderately affect her lower

limbs (diaplegia). She was chosen based on her age, diagnosis criteria, and physical and cognitive abilities. Her cognitive age was around 14-15 years; she was able to read and write. She had very strong verbal expressive and receptive language skills so was able to communicate with the researcher and understand the purpose of the study. The participant's primary impairments were in her gross motor functioning. Her main mode of transportation was in a wheelchair, although she was able to walk with a walker. For lumbar support she wore a back brace as well as ankle-foot orthoses.

Setting

Research took place at the university Community Services Building Music Therapy Clinic in the basement hallway, which measured 8 feet wide by 75 feet (25 meters) long with a tile floor. Check-in pre- and post-gait training was conducted in room 108 with a wheelchair accessible desk.

Equipment

A Generation 5 iPod and iGroove HG iPod Speaker System were used each treatment session and placed at the west end of the hallway. Each session was video recorded using a Canon VIXIA HF R21 Full HD Camcorder placed at the west end of the hallway. The participant used her own walker during gait training. A REMO Tubano drum with a shoulder strap played with a soft mallet by the researcher was used to emphasize the fundamental beat of the music. The researcher provided a journal and pens for pre- and post-check-in and reflections.

Procedures

The basic procedures included an initial assessment, followed by programming treatment music, and application of the treatment and control conditions in a random order.

*Assessment. T*o determine baseline, an assessment was administered without the use of rhythmic music and consisted of the participant (with the use of a walker) walking for one minute at the participant's comfortable rate. From the assessment, the researcher determined baseline and selected music for treatment.

Treatment music selection process. During the initial assessment, the researcher interviewed the participant about preferred music. The participant's physical therapist attended the session and led stretching activities. The researcher then had the participant walk for one minute to gather baseline data. Based on video analysis of the assessment, it was found the participant was able to walk 78 steps per minute.

The music selection process consisted of extensive research to match the client preference with an appropriate number of beats per minute. The researcher (a board-certified music therapist) used her training to specifically cater the music selection to the participant. During the intake interview, the participant shared her preference for religious and popular music and gave the names of her favorite artists. From this discussion about music, the researcher concluded that, not only the genre but also the lyrics played an important role in the participant's musical preferences. One of the participant's favorite artists was a Christian band that played parodies of many different artists using Christian lyrics. In selecting

music, the researcher located these song parodies and matched them to their original artists in order to calculate the number of beats per minute. Outside of the participants' favorite artists, the researcher selected music based on lyrical content catered to client preference. MixMeister BPM Analyzer software was downloaded and used to verify the number of beats per minute. The researcher then selected client-preferred music between 78 and 80 beats per minute or doubled to 176 to 180 beats per minute to avoid excessively slow music. For each treatment session, the researcher programmed a playlist, based on musical fluidity and rotated through 13 songs to avoid repetition during and between consecutive sessions. (See Appendix D).

Application of experimental and control conditions. The researcher worked with the participant three times a week for five weeks. Each session lasted one hour. Due to scheduling, the first three weeks consisted of one session held Mondays, with two consecutive sessions held Thursdays. The final two weeks two sessions were held Monday and one session held Thursday. The following is the session structure.

1. Pre-gait training check-in (15 minutes). Each session began in the university's Community Services Building Music Therapy Clinic room 108. The room contained a wheelchair accessible desk where the participant could sit in her walker. After discussion with the researcher about the upcoming session, the participant was prompted to fill out an emotional responsiveness survey and write in a journal about how she felt physically and emotionally prior to each session. The researcher kept a journal of verbal interactions as well as observations.

Discussing her feelings with the researcher helped the participant process what she wanted to record in her journal entries. During the first session the researcher made sure the participant understood the purpose of the journal, that journaling was trying to capture her true feelings so there were no wrong answers. She was reassured that negative feelings or fatigue were completely validated and acceptable feelings to record in her journal entries and emotional responsiveness surveys.

2. Stretching (5 minutes). Stretching and gait training took place in the university's Community Services Building Music Therapy Clinic in the basement hallway. The researcher led stretching exercises, including a 2-minute elongated hamstring stretch seated on the floor, as well as a series of stomps while standing to loosen the muscles.

3. Gait training (15-20 minutes). The location was chosen based on ease of accessibility for transportation. An indoor facility was necessary due to the extreme outdoor temperatures and with the smooth tile flooring and straight pathway the hallway served as a functional location for gait training with the assistance of a walker.

Blue tape on the floor was used to indicate a start line and also a turn around line. Each meter throughout the length of the hallway was marked. The start and turn around lines were visual markers to prompt the participant where to turn around to ensure she walked the full length measured. A white board was placed at the start line with 1-10 written. As each lap was completed, the researcher placed a slash through the number it reflected. The purpose of the

white board was for the participant to track her own progress. The total amount of laps was set before the study began in order to create a realistic goal for the subject to attain throughout the study. A maximum of 10 laps were established. The gait training sessions were terminated based on the participant's fatigue level. With the first session as the assessment period, the participant's progress was measured over a total of 14 sessions.

Prior to the beginning of the study, each session was randomly assigned to take place as a treatment or control conditions. Treatment sessions consisted of the use of rhythmic music played on an iPod through speakers with a REMO Tubano drum with a shoulder strap and soft mallet played by the researcher to emphasize the fundamental beat of the music, emphasizing where each heel strike should occur. The researcher walked alongside the participant to ensure that the drum beat was audible, as well as for safety precautions. The control sessions did not contain music or a drum beat. The researcher walked alongside the participant during control sessions also for safety precautions.

4. Stretching (5 minutes). After gait training, the researcher led a two minute seated elongated hamstring stretch.

5. Post gait training check-in and relaxation (15-20 minutes). The researcher then led the subject to the check-in room, where the participant filled out the emotional level survey and wrote in a journal about how she was feeling physically and emotionally after gait training. Again, the researcher also recorded verbal interactions and observations. When time permitted, the researcher led singing and relaxation activities to close each session. As the focus of the study

was on gait training, the singing and relaxation occurred only after all data were recorded for the gait training portion of each session.

Data Collection

Quantitative data were gathered individually by lap. The researcher analyzed each video for total steps, time walked, and time taken for turn around. To reach an accurate measure of the average steps per minute, the researcher subtracted the turn around time from the time walked to reach the total time for each gait training session. The data collected were analyzed by laps per session and compared for treatment versus control conditions. Steps per minute, total time, and total distance also were compared for treatment versus control conditions.

Qualitative data were gathered through the client's journal, and the researcher's journal (noting verbal interactions between the participant and researcher and observations of the participant). Data was also gathered using a quantitative emotional responsiveness checklist to study affect before and after each session. The data were analyzed by treatment and control condition. The participant's mother was interviewed after the last session about any improvements or negative aspects she had noticed outside of the study sessions. The researcher took notes of the interview as well as audio recorded the conversation.

CHAPTER IV: RESULTS

Gait Results

During the 5-week study, data were collected by measurements in the setting (marked distances on the floor) and from video recordings of each session. Due to technical difficulties, the second session (a control session) was not digitally recorded. For the direct measures, data were collected and analyzed for (a) endurance (laps, distance traversed, and steps taken), (b) cadence (steps per minute), and (c) velocity (distance over time).

The results are summarized for each of these variables in two ways to compare the treatment versus control sessions: line graphs that emphasize change (slope and variability) over time and a scatterplot emphasizing level of performance in the multi-element design with random assignment of conditions that control for order. Figures 3-5 and 7-9 present the time series graphs; Figures 1, 2, and 10 present data from the multi-element design.

Endurance. The subject tended to take more laps in the treatment condition as depicted in Figure 1. She completed all 10 laps in four treatment sessions as compared to all 10 laps in only two control sessions. All of the lower values for the treatment condition occurred early in the time series; contrariwise, the high values for the control condition occurred later in the time series. (See Figure 1).

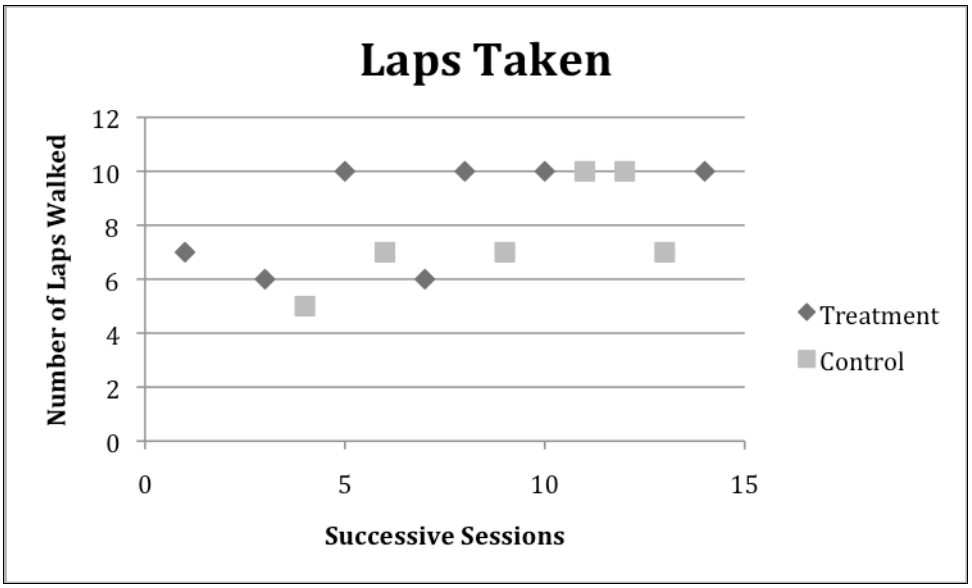

Figure 1. Multi-Element Design Depicting Treatment and Control Laps Taken in Successive Sessions.

Obviously, number of laps traversed serves as a proxy for distance (and endurance). Figure 2 reflects meters to depict the distance she was able to walk each session compared to Figure 1, the total number of laps walked each session. She traveled further distance with the treatment (rhythmic music with audible drum beat) applied than with no treatment. (See Figure 2).

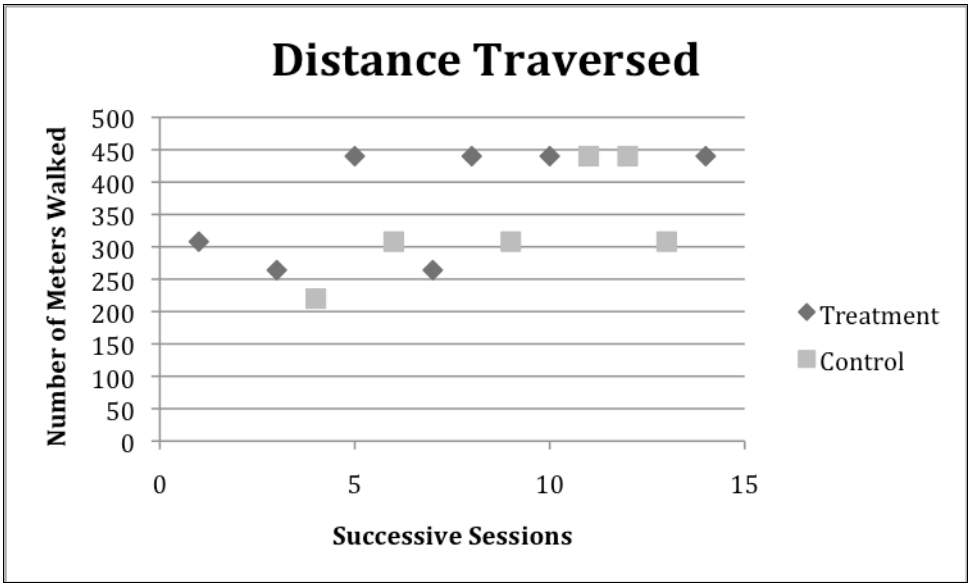

Figure 2. Multi-Element Design Depicting Treatment and Control Distance Traversed (Meters Walked) in Successive Session.

Cadence. In Figures 3, her cadence (steps per minute) is depicted for average values per session; Figure 4 presents individual values in successive sessions. Her cadence remained more consistent during treatment conditions compared to the more fluctuating steps per minute during control conditions as depicted in Figure 3. Furthermore, her rate is higher in the treatment condition, with a modest slope. Other than one dip in the level (for lap 9), the values generally improve over time. During treatment, her average steps per minute remains between 70-80. The control condition depicts a slightly steeper but more variable slope with significant increases and decreases in steps per minute. On two occasions, a significant drop occurs (lap 5 and laps 8-9) with the sudden increase from laps 9 to 10 (from 72 to 80 steps per minute). This variation results in the highest recorded value with a very wide range (from below 70 to 80). When these data are plotted in successive session laps and (not just averages in sessions) as depicted in Figure 4, the treatment condition shows a consistent range between 70-80 steps per minute, whereas the control condition shows greater variability, ranging between 35 and 85 steps per minute. (See Figures 3 and 4).

Due to the participant's progress, the beats per minute remained between 78-80 (or 156-160). Her gait pattern did not consistently exceed the baseline pace so the tempo was not increased.

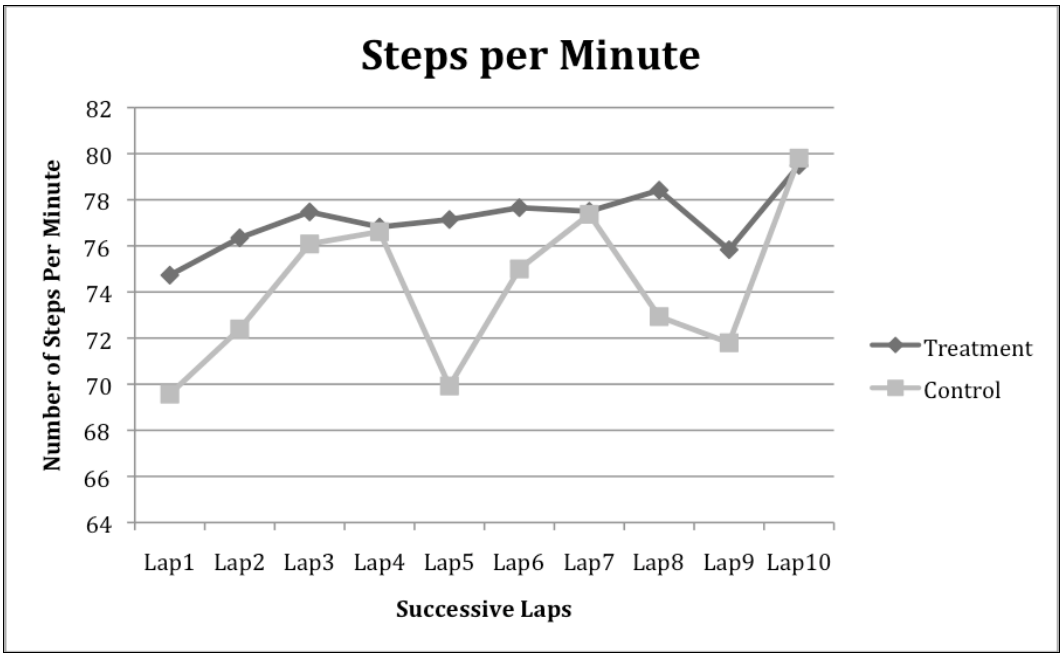

Figure 3. Comparison of Treatment versus Control on Steps per Minute over Successive Laps.

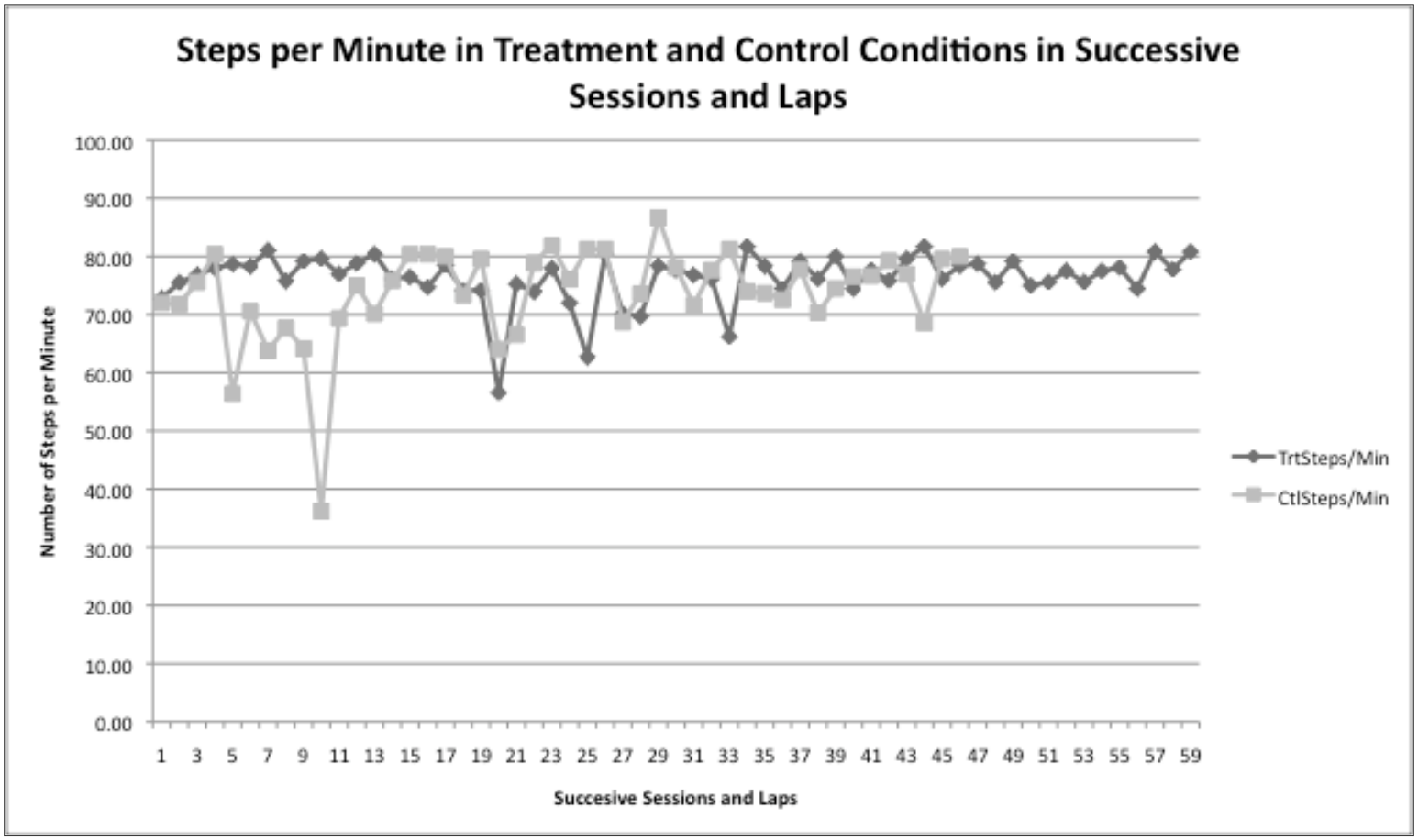

Figure 4. Comparison of Treatment and Control Steps per Minute in Successive Sessions and Laps.

In Table 1, results are displayed for total steps taken averaged over successive laps for both the treatment and control conditions. Generally, the subject took more steps and was less variable in the treatment condition over than in the control condition.

Table 1. Total Steps Taken in Successive Laps for Treatment and Control Conditions

Steps	Treatment	Control
Lap1	482	458
Lap2	467	438
Lap3	470	421
Lap4	475	415
Lap5	477	444
Lap6	475	340
Lap7	341	343
Lap8	264	141
Lap9	273	140
Lap10	261	137

When the total number of steps taken is graphed over successive sessions and laps, considerably less variation exists with the treatment over the control condition. Basically, she was more consistent in steps taken during successive sessions and laps, as depicted in Figure 5. The intercept also depicts more steps taken during control conditions. (See Figure 5).

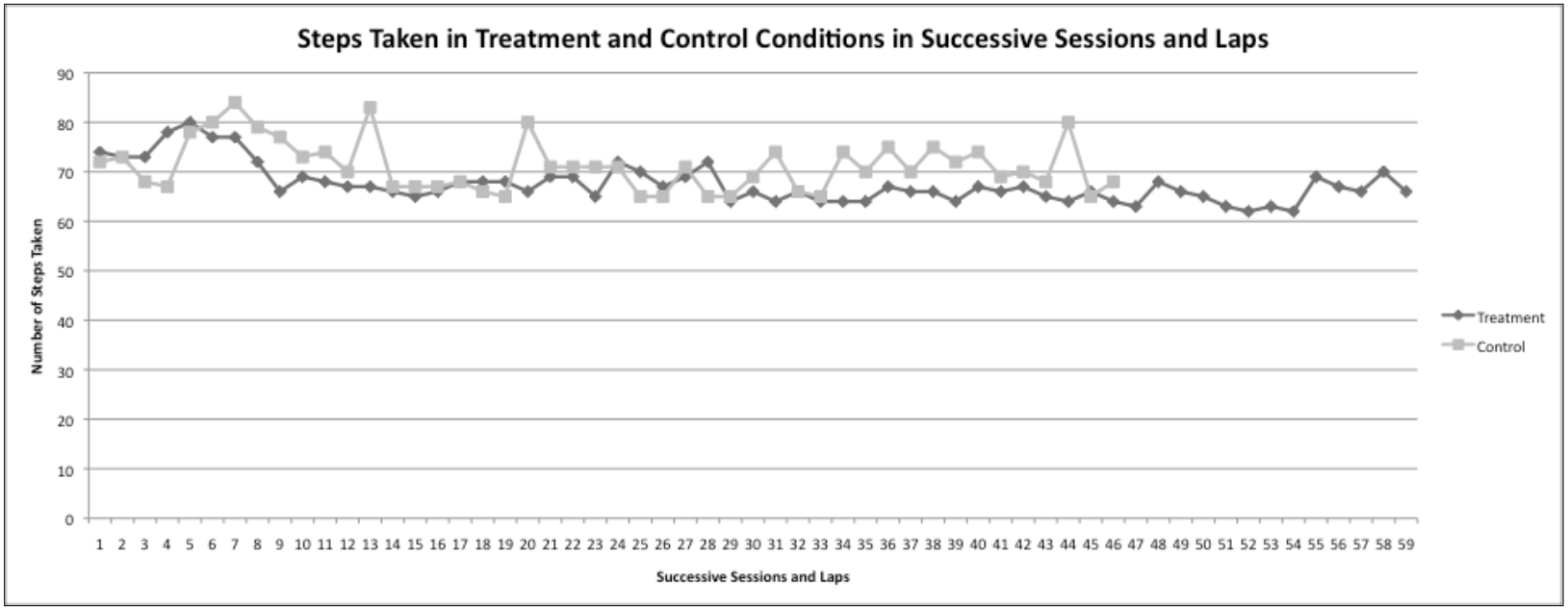

Figure 5. Comparison of Treatment and Control Steps per Minute in Successive Sessions and Laps.

Velocity. The total amount of time taken walking, turning, and lapping is depicted in Figures 6 and 7. The trend is quite consistent for both treatment and control with the exception of one value that is spiked in lap 19 for both conditions. Her total walking time was much less variable when the treatment was being implemented. Furthermore, the subject's total walking time was consistently less than during control conditions as was her turn around time. Finally, her lap walk time remained more consistent during treatment conditions than during control conditions. (See Figures 6 and 7).

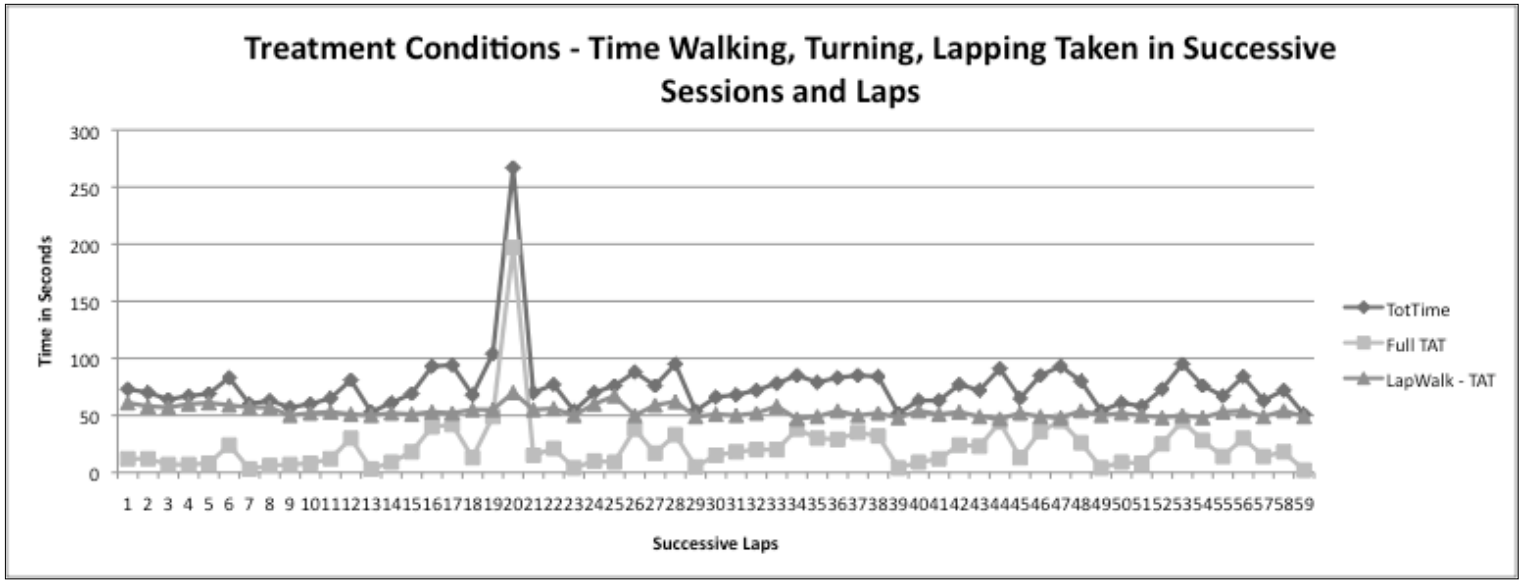

Figure 6. Comparison of Time Walking, Turning, and Lapping Taken in Successive Sessions and Laps during Treatment Conditions.

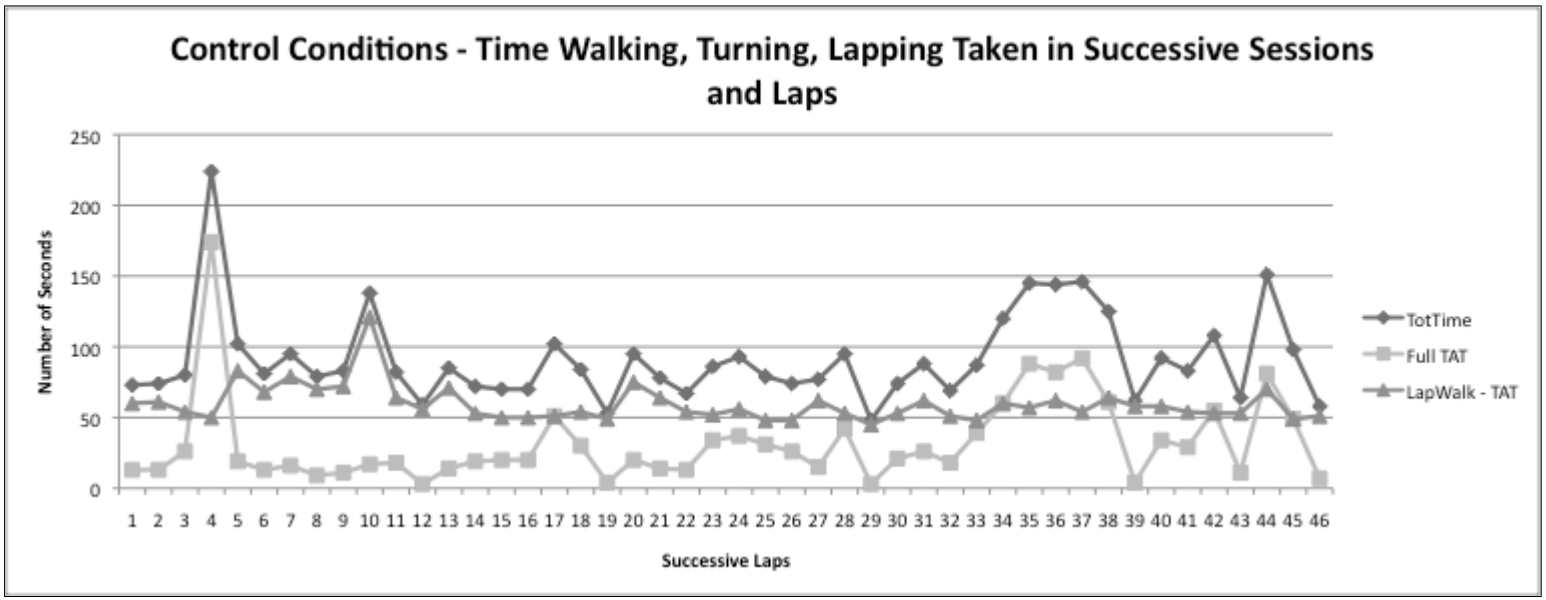

Figure 7. Comparison of Time Walking, Turning, and Lapping Taken in Successive Sessions and Laps during Control Conditions.

Figure 8 depicts a multi-element design graphic representation of velocity for treatment and control conditions. The velocity over successive sessions again depicts the randomized treatment design. The subject's overall velocity was faster during treatment conditions. She showed less variability over treatment condition than control condition. (See Figure 8).

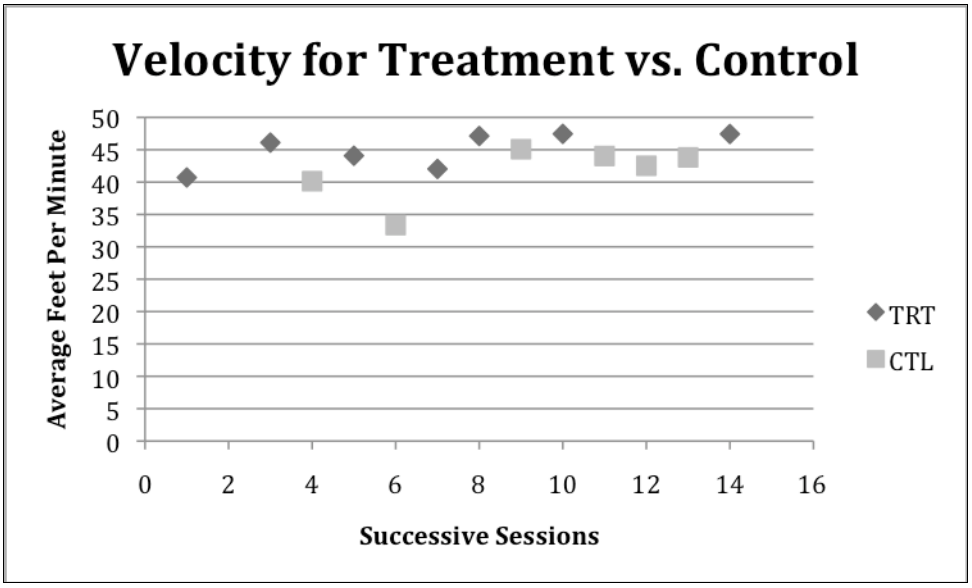

Figure 8. Mulit-Element Design Depicting Comparison of Treatment versus Control on Velocity over Successive Sessions.

In comparison of velocity in successive laps over successive sessions, the subject's velocity was less variable during treatment conditions. The intercept remained between 125-200 feet per minute during treatment conditions. The intercept shown during control conditions is much more variable between 75-200 feet per minute. (See Figure 9).

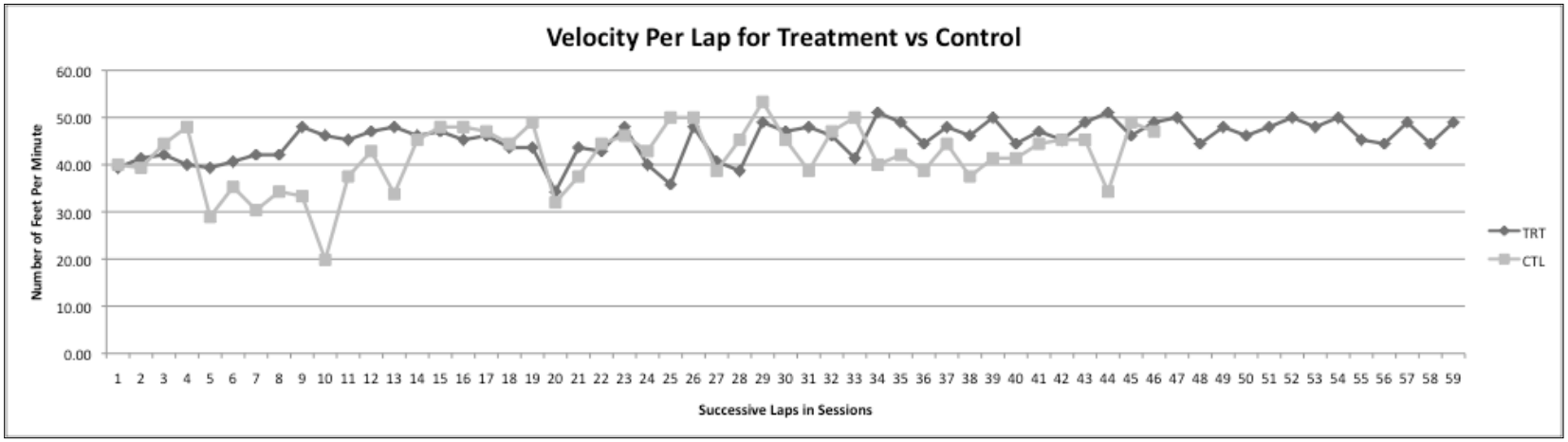

Figure 9. Comparison of Treatment versus Control on Velocity Per Lap over Successive Sessions.

Motivation/Affect Results

Background

The researcher determined prior to the study that qualitative research was necessary to provide data on the psychological impact of the use of rhythmic music during gait training for the participant. Data collection included journal entries by the participant and researcher. The participant also completed a survey on emotional responsiveness before and after each session and a post treatment survey on the impact of treatment. The session survey was set up as a Likert scale from 1-5 rating feelings of negativity (1) to positivity (5) before and after each session. The survey question asked the participant to: rate how you are feeling before the music therapy session from 1 (feeling negative/sad) to 5 (feeling positive/happy). A similar question was also given after the music therapy session.

Analysis

After completion of the 5-week study, all journal entries were transcribed and results of the emotional responsiveness survey were entered into a table by the researcher. The emotional responsiveness survey, the participant's journal entries, and the researcher's journal entries were analyzed for treatment versus control conditions. The total number of laps completed as well as session condition were taken into consideration during analysis.

Findings

The subject showed an overall increase positive affect through treatment conditions when compared to control conditions. An increase in positive affect

was evidenced through journal entries and the emotional responsiveness surveys. The subject's journal entries exemplified how much she enjoyed walking to the music and found the music itself a motivating factor during gait training. Self-pride was expressed through journaling as well as overall enjoyment in participating in the study. Through analysis of treatment and control conditions, these aspects are shown through positive statements about music, statements about music as motivation and inspiration, distraction level, and overall style of writing (i.e. use of punctuation, exclamation points, underlined words, etc.). Through the emotional responsiveness survey, the subject showed an increase in mood from before to after each treatment session, where the control sessions showed an average decrease in mood.

Also of importance was the session schedule. Due to scheduling conflicts, one day each week the subject participated in two consecutive sessions. The randomly assigned conditions resulted in each possible combination of consecutive sessions: treatment followed by control, control followed by treatment, treatment followed by treatment, and control followed by control. An overall trend occurred over the five-week study where the subject walked a further distance (more laps) during the second consecutive session (compared to the first session of the day) when treatment was applied. Likewise, the subject walked a shorter distance (less laps) during the second consecutive session (compared to the first session of the day) under control conditions. (See Appendix E).

Participant Journal Entry Analysis

Positive statements about music were reflected in both the subject's journal entries as well as the researcher's records of verbal interactions with the subject. Beginning with the first treatment session, comments such as, "The music was awesome!" or "Music was excellent!!" appeared in most treatment session journal entries. Overall great enjoyment was evidenced during treatment sessions through journal entries, affect, and verbal interactions with the researcher. As the subject is an extremely positive individual, arriving every day with a smile, the journal entries consistently reflected this positive personality (before and after both treatment and control sessions). However, the control session journal entries expressed more fatigue and a higher distraction level.

Statements about the music as motivation and inspiration were also reflected throughout the subject's treatment session journal entries. She explained, "Walking to music is really fun and interesting," and "Music good motivation." The specific music chosen was acknowledged, "Music beats were good for walking too. Great session today." Feelings of motivation were further exemplified through control session journal entries, "More motivating with music on. Nice session."

The subject had expressed verbally to the researcher that music is often distracting. Listening to a favorite song while doing chores or getting ready in the morning distracts from the task at hand, the focus becomes listening to the music. The subject expressed surprise that she was actually able to focus more on her walking while listening to music, rather than being distracted. The researcher also

noticed a large difference in distraction levels during gait training through the treatment versus control sessions. The subject seemed much more focused and motivated to keep walking during treatment sessions. The subject's treatment session journal entries reflected her awareness of her distraction level, "Not distracted as much: Which is good." Her control session journal entries express a higher level of distraction. For example, "7 laps, little tired, but still feeling good. Able to re-focus; distracted a little."

Compared to the control sessions, the subject's style of writing throughout the treatment sessions also exemplifies her increase in positive affect. Exclamation points and underlined words are consistently used, as well as smiley faces drawn next to her entries. Through her use of exclamation points and smiley faces throughout her journaling, self-pride became apparent when she would excel and complete more laps than the previous session. Her control session entries only used exclamation points when she had completed all 10 laps.

By the sixth session, the subject's journal response indicated she was beginning to transfer what she was learning during the treatment sessions to the control sessions without any prompting or assistance from the researcher. She wrote, "No music, but had songs in my head. Good work today." This occurred on a day when she was quite distracted by people in the hallway and ended up tripping over her own feet a little. She was able to get herself back on track and continue the gait training, completing 7 laps. (See Appendix F for Participant Journal Entries).

Researcher Journal Entry Analysis

Through the researcher's journal entries and the lap analysis, the findings indicate that the subject walked a further distance and completed more laps during the treatment versus control sessions. She walked a total of 59 laps during treatment sessions and a total of 51 laps during control sessions. The subject typically took fewer breaks to catch her breath during the treatment sessions. The researcher's notes indicated that, "She seemed very motivated, didn't need as many breaks to catch her breath between laps." Her distraction level was much higher during control sessions compared to treatment sessions, and the researcher often had to re-prompt the subject to continue walking and to either try to ignore any outside noise or try to keep walking while she talked, "Her pace slowed a bit while talking, but I re-prompted her to keep going. She was also a bit distracted by hallway noise, but I re-prompted to try and ignore the noise and not stop, just keep walking through it (noise was furnace, she was curious looking down the side hallways, etc.)."

As the subject expressed in her own journal entries that she found the music motivating, the researcher also noticed an increase in the subject's motivation during treatment sessions. During treatment sessions, the researcher could sense the subject's fatigue level and often prompted a short break to take a few deep breaths for safety precautions, "She wanted to push through but I sensed she needed to catch her breath. She said the music was really motivating, made her want to keep walking and listen to music, didn't want to stop." (See Appendix G for Researcher Journal Entries).

Emotional Responsiveness Survey Analysis

Before and after each session, the subject was given an emotional responsiveness survey. The survey consisted of a Likert scale rating of how she was feeling before and after each session. The scale was set at 1 (feeling negative/sad) to 5 (feeling positive/happy). The results of the emotional responsiveness survey show an increase in positive affect through treatment conditions versus a decrease in positive affect through control conditions.

Throughout the treatment conditions, the subject's emotional level either increased or stayed the same at the highest level option (5). She responded with an average rating of 4.8 pre-session increased to an average rating of 5 post-session. (See Figure 10).

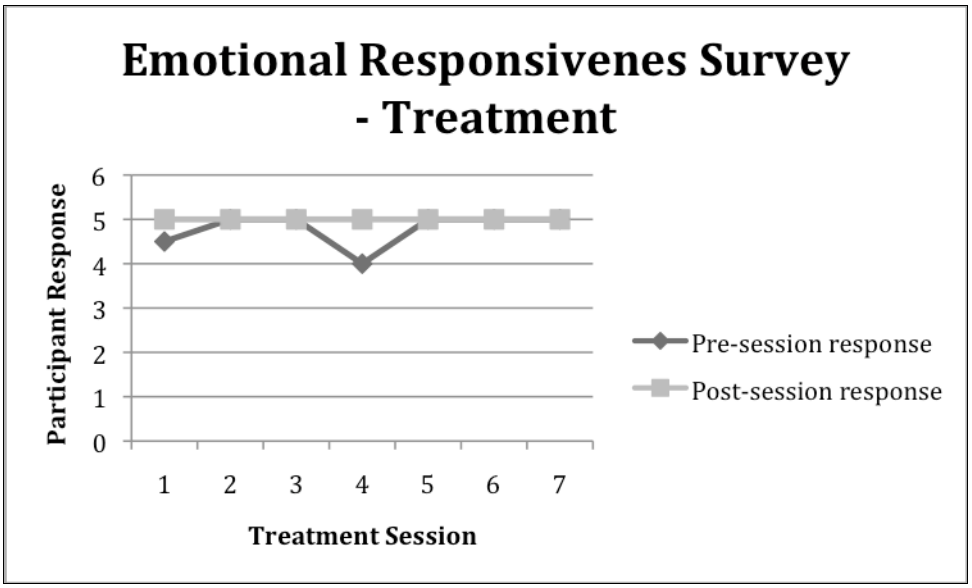

Figure 10. Comparison of pre-session response to post-session response over treatment conditions.

Throughout the control conditions, the subject's emotional level decreased in six out of seven sessions. On average she rated her emotional level at a 4.8 pre-session, and a 4.6 post-session. (See Figure 11).

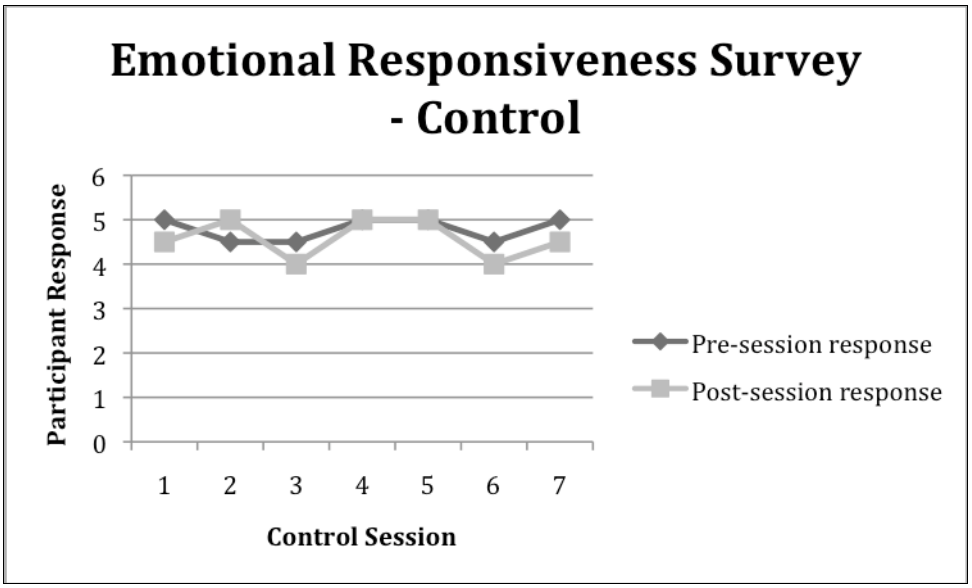

Figure 11. Comparison of pre-session response to post-session response over control conditions.

With a rating scale of 1-5, the subject's overall responses were in the top 90th percentile of feeling positive/happy. This reflects her overall positive attitude and enjoyment in participation in the study overall. However, the difference between the treatment and control ratings exemplifies the increase in positive affect through the treatment sessions. As stated throughout her journals, the subject found the use of music during gait training motivating and enjoyable. She found herself feeling more positive after gait training with music and feeling less positive after gait training without music. (See Appendix H for Sample Emotional Responsiveness Survey).

Post-treatment survey

Upon the conclusion of the study, the subject was given a post-treatment survey. The survey asked 6 post-treatment questions rating the effectiveness of the study on a scale of 1 (strongly disagree) to 5 (strongly agree). The subject rated all questions at a 5 (strongly agree). Her ratings indicate: she had a positive experience participating in the research study; the treatment process improved her walking; she learned strategies she could use to further enhance her abilities in the future; the journaling requirements for the study were reasonable; the physical requirements of the study were reasonable; and her overall mood had improved throughout the treatment process. (See Appendix I for the Post-Treatment Survey).

Post-treatment interview

The researcher interviewed the subject's mother after the study was completed. The mother made several positive comments about the subject's progress outside of the sessions throughout the study, and the researcher asked her to take note of these aspects to discuss upon completion of the study. The conversation was recorded and the researcher also took handwritten notes.

The subject's mother reported that the subject's overall endurance had increased since the beginning of the study. She showed more physical stability, and her energy level had increased. Evidenced by the subject's skin coloring and decrease in fatigue level, her mother saw an increase in the subject's overall health. Pertaining to her own self-awareness, the subject showed an increase in her logic, thinking in advance, and creating concrete goals for herself. She was

more aware of her own body and showed an increase in self-advocacy. Her mother also reported that the subject was always happy after leaving the sessions and never wanted to miss a session no matter how tired she was or how she was feeling physically prior to each session. She really enjoyed being part of the study. (See Appendix J for a transcription of the parent interview).

CHAPTER V: DISCUSSION

Summary

Literature on the use of rhythmic music, specifically Michael Thaut's (2010) technique of Rhythmic Auditory Stimulation, shows positive results in improvement of walking gait for individuals with neurologic disorders. However, his studies focus on neurologic disorders acquired later in life, such as post-stroke patients and individuals with Parkinson's disease and traumatic brain injuries. This study extends his technique to cerebral palsy, a neurologic disorder typically acquired before birth, at birth, or within the first two years before the brain fully develops. In this condition, motor pathways are damaged prior to functional development. Therapeutic interventions to improve motor functioning in children with cerebral palsy therefore focus on creating new neural networks and new pathways within the motor system.

Due to the complex nature of cerebral palsy, not all treatment options are studied for all classifications of the disorder. Impairment in the motor areas is the most common characteristic of cerebral palsy. Therefore, treatment options addressing motor control and increasing movement are the most accessible to all individuals with cerebral palsy.

More specifically, the current study addresses the impact of rhythmic music on walking gait for an individual with cerebral palsy. The study addresses whether the use of rhythmic music impacts: (a) endurance (laps, distance traversed, and steps taken), (b) cadence (steps per minute), (c) velocity (distance over time), (d) emotional responsiveness (positive or negative affect), and (e)

motivation. The study conducted was a single participant, multi-element design using mixed methods under randomized treatment conditions.

Quantitative data were collected over a 5-week period and analyzed for (a) endurance (laps, distance traversed, and steps taken), (b) cadence (steps per minute), and (c) velocity (distance over time). Quantitative data were also collected on affect through the emotional responsiveness survey completed by the participant each session, and a post-treatment survey completed by the participant. Qualitative data were collected through participant and researcher journal entries. Quantitative and qualitative data were compared for treatment versus control conditions and used to describe the subject's emotional and motivations state.

Discussion

Both quantitative and qualitative results indicated that rhythmic music did impact walking gait for the subject. The quantitative data suggests an increase in endurance, cadence, and velocity when rhythmic music was applied during gait training. Results for each of these variables were analyzed in two ways to compare the treatment versus control sessions: line graphs that emphasize change (slope and variability) over time and a scatterplot emphasizing level of performance in the multi-element design with random assignment of conditions that control for order. The randomized design showed that later in the study, the subject generalized from treatment to control, completing all 10 laps under both conditions. The emotional responsiveness survey and qualitative data suggests when music was applied to gait training, the subject's positive affect (overall mood) improved, and the subject felt her motivation also increased. As noted in

the findings from this study, most of the outcomes have not been previously documented in previous research.

The subject's endurance increased throughout the study shown by the total number of laps, total distance walked. During treatment conditions, the subject walked more laps. Her total laps and distance also increased overall from the beginning to the end of the study. These results indicate the subject may have begun to generalize what she had learned to increase her endurance during control conditions. These dependent variables have not been studied previously by others (Kwak, 2000).

Cadence is the measure of steps per minute. The subject's cadence showed differentiation between treatment and control conditions. Her cadence remained more consistent during treatment conditions compared to the more fluctuating steps per minute during control conditions. Her cadence also generally improved over time during treatment conditions. She took more steps and was less variable in the treatment condition over that attained in the control condition. Although also studied by Kwak (2007), cadence appeared to be differently affected by the treatment than she reported.

Overall velocity remained fairly consistent across treatment conditions and was also much less variable than the control conditions. The subject took less total time during treatment conditions, and her velocity was faster than during control conditions. In comparison of velocity in successive laps over successive sessions, the subject's velocity was less variable during treatment conditions.

The subject showed an increase in positive affect during treatment conditions compared to control conditions. Through the emotional responsiveness survey, the subject had a consistently slight positive increase in mood from before to after treatment sessions. Control conditions showed a slight decrease in mood from before to after control sessions.

Motivation increased with the use of treatment (rhythmic music with an audible beat). This was shown through the subject and researcher's journal entries. The subject's journal entries repeatedly reflected that she enjoyed listening to music while walking during treatment sessions, shown through the use of positive wording and exclamation points. The researcher recorded observations of the subject's affect and verbal comments, which further exemplified her increase in motivation during treatment sessions. Neither of these last two dependent variables were included in previous research (Hayden, Clair, Johnson, & Otto, 2009; Thaut, 2005; Thaut & Abiru, 2010; Thaut, McIntosh, & Rice, 1997).

The positive outcomes on emotional responsiveness and motivation may have been a function of the close match between the participants' preferences as the core for the treatment. The control condition only controlled for no music. A different control condition could have been applied comparing preferred music to non-preferred music. Further research would be needed explain of the effective component of the treatment.

Given the positive results, the chosen methods and design for the current study were appropriate for the research questions. Differing from Kwak's (2000)

thesis, the current study focuses on one subject. Selecting a single subject, multi-element design allowed the researcher to address aspects of gait training (endurance, cadence, and velocity), as well as affect and motivation. Randomized conditions created an unbiased environment to assess the impact of treatment (rhythmic music with audible drum beat).

With the vast musical resources available, there were many options to choose from when selecting music to use for this study. Also differing from Kwak's (2000) thesis study, the current study focused on subject-preferred music. In Kwak's (2000) study, client preference did not play a large role in music selection. For the current study, the researcher catered the treatment conditions to the specific subject, i.e. the use of preferred music. This may have impacted the subject's increase in mood and motivation. Using preferred music also assists in generalization during control conditions. As the subject was familiar with the music, she knew the lyrics and melodies, and by the 6th session under control conditions, it was noted in her journal, "No music, but had songs in my head." (See Appendix D for Participant Journal Entries).

Comorbid diagnoses also presented an obstacle for Kwak (2000) as cognitive functioning and physical ability of each participant varied. With the focus on a single subject, the researcher was able to individualize the treatment. Selecting a subject who was high functioning could understand the purpose of the study, as well as reflect on her own experiences allowed the researcher to gather strong qualitative data.

Recommendations for Future Research

As music therapy is a cost-effective, non-invasive treatment option (Peters, 2000), it deserves further consideration by therapists. The positive outcome of the current study as well as past and current literature highlights the effects of rhythmic music on walking gait for neurologic disorders. Given the positive results, further research on the impact of rhythmic music on walking gait for individuals with cerebral palsy is recommended.

Given weather conditions, transportation, and scheduling, the current study was conducted in an indoor hallway measuring 8 feet wide by 75 feet (25 meters) long with a tile floor. Although the tile floor was a smooth surface conducive for walking with a walker, the length and one-way direction of the hallway caused need for the subject to turn-around in two places (at the east end and west end of the hallway). In the current study having to turn around took time (for analysis, the turn around time was subtracted from the total time as turn around time did not measure functional gait steps) and created a momentary lapse in focus for the subject. Rather than simply walking at a normal pace, the subject had to focus on readjusting her walker and rotating her body to continue walking in the opposite direction. The use of a track or circular pathway would provide the opportunity to measure continuous walking, which also may allow for more accurate changes in the dependent variables.

For the current study, a mixed methods approach allowed a comprehensive analysis of the participant and treatment. A strict analysis of walking gait was necessary to study the impact of rhythmic music with an audible

drum beat. The physical gait patterns showed results based on physical attributes. The study design involved qualitative data, which lead to further insight on specific, subject related treatments. The use of the emotional responsiveness survey, as well as subject and participant journals, shed light into importance of motivational and affective aspects of this study. For treatment to be effective, it needs to not only increase the subject's physical capacities but also increase emotional, motivational factors. The use of a mixed-methods design allowed for the use quantitative and qualitative data to provide a comprehensive analysis.

The results indicate positive outcomes for one individual, which may or may not generalize to others, particularly given the many types of cerebral palsy (Miller, 2005). As mentioned earlier, given the complex nature of the disorder of cerebral palsy, a larger participant pool creates more areas for consideration during analysis. A larger sample size may lead to more generalizable conclusions in verifying the success of this treatment for individuals with cerebral palsy. With a larger sample size data could be analyzed using inferential statistics: a test of significance and effect-sizes could be documented. However this kind of design may constrain individualization of the treatment conditions to subject participants, which is an important consideration. As a consequence, selection of participants should be carefully considered. For the current study, selecting a cognitively high functioning participant allowed the researcher insight into emotional awareness and personal motivation, factors that younger children may not fully understand. Careful selection including a participant pool of adolescents and adults is recommended.

The use of randomized treatment conditions allowed the researcher to study the impact of treatment without bias. Duration of the current study was set at 5 weeks. Longer study duration may provide further positive implications of treatment conditions. Given the positive outcome under randomized conditions, a continuation of the study under a controlled design (for example an ABAB treatment design) may further exemplify the impact of treatment conditions. Using a controlled design may also expand findings into the lasting effects of treatment and support generalizability of gait improvement without treatment.

Conclusion

This study showed that rhythmic music does impact walking gait for an individual with cerebral palsy. The treatment increased endurance, cadence, velocity, affect, and motivation. The positive outcome of the current study, as well as past and current literature, highlights the effects of rhythmic music on walking gait for neurologic disorders. A mixed methods approach allowed a comprehensive analysis of the participant. Using a single-subject design allowed a more causal interpretation. However, a larger participant pool is recommended to ensure the results can apply to others. Longer duration of study also is recommended to research the lasting effects of treatment, as well as further study generalizability. Finally, a continuous walking path is recommended to allow for a more straightforward collection of data on gait patterns.

As the research continues, the medical and music therapy field may learn more about the lasting effects of rhythmic music in hopes to further promote this treatment option. Results did indicate improvement in gait training through the

use of rhythmic music in this individual with cerebral palsy, which hopefully may be further confirmed through future research.

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APPENDIX A

INTERNAL REVIEW BOARD (IRB) APPROVAL LETTER

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Barbara Crowe MUSIC
From:	Mark Roosa, Chair Soc Beh IRB
Date:	05/31/2011
Committee Action:	**Expedited Approval**
Approval Date:	05/31/2011
Review Type:	Expedited F4
IRB Protocol #:	1105006469
Study Title:	The Impact of Rythmic Music on Walking Gait for Individuals with Cerebral Palsy
Expiration Date:	05/30/2012

The above-referenced protocol was approved following expedited review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date. You may not continue any research activity beyond the expiration date without approval by the Institutional Review Board.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX B

RECRUITMENT SCRIPT

My name is Sevrina Tindal. I am a graduate student under the direction of Professor Barbara Crowe in the School of Music at Arizona State University. I am conducting a research study to look at the impact of rhythmic music on walking gait for individuals with cerebral palsy.

I am recruiting individuals to participate in music therapy sessions 3 times a week for 30 minutes for 5 weeks. The sessions will be digitally video recorded for later analysis by the researcher. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. The results of the research study may be published, but your name will not be used.

All information obtained in this study is strictly confidential. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you. In order to maintain confidentiality of your records, Barbara Crowe will keep all files in a locked file cabinet at the music therapy clinic. The video data recorded will be digital only, and will be stored on a secure password protected laptop hard drive, which will be kept in the locked file cabinet, and stripped from the secure hard drive after 3 years to maintain your confidentiality.

Your participation in this study is voluntary. If you have any questions concerning the research study, please call me at (541) 912- 7952.

APPENDIX C

SAMPLE CONSENT FORM

THE IMPACT OF RHTYMIC MUSIC ON WALKING GAIT FOR INDIVIDUALS WITH CEREBRAL PALSY

INTRODUCTION

The purpose of this form is to provide you (as a prospective research study participant) information that may affect your decision as to whether or not to participate in this research and to record the consent of those who agree to be involved in the study.

RESEARCHERS

Barbara Crowe, Professor, Arizona State University School of Music
Sevrina Tindal, student, Arizona State University School of Music

STUDY PURPOSE

The purpose of the research is to study the impact of rhythmic music on walking gait for individuals with cerebral palsy. Several studies have found positive results on the use of rhythmic music on walking gait for other individuals, however very few have explored individuals with cerebral palsy.

DESCRIPTION OF RESEARCH STUDY

If you decide to participate in this study, you will receive music therapy sessions 3 times a week for 30 minutes. The researcher will work with you using rhythmic music while doing training in walking. You will be the only participant in this study, and each session will be video recorded for the researcher to analyze. You will be asked to keep a journal of your experiences and feelings before and after each session.

If you say YES, then your participation will last for 5 weeks. Sessions will take place in a location convenient for you, as well as at the music therapy clinic. You will be the only participant in this study.

RISKS

Potential Risks may include physical harm were you to fall during gait training, however every precaution will be taken to prevent this. You will begin gait training with a walker. The researcher will be right next to you during all gait training. Dependent on progress, if the walker is no longer needed, a gait belt will be used to ensure stability. The researcher will remain behind you holding on to the gait belt handles at all times during gait training.

BENEFITS

The possible benefits from participating in this study may include improved walking gait, as well as overall well-being.

CONFIDENTIALITY

All information obtained in this study is strictly confidential. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you. In order to maintain confidentiality of your records, Barbara Crowe will

keep all files in a locked cabinet at the ASU music therapy clinic. The video data recorded will be digital only, and will be stored on a secure password protected laptop hard drive which will also be stored in the locked file cabinet.

WITHDRAWAL PRIVILEGE

Participation in this study is completely voluntary. It is ok for you to say no. Even if you say yes now, you are free to say no later, and withdraw from the study at any time.

VOLUNTARY CONSENT

Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by:

Barbara Crowe, Herberger Institute for Design and the Arts
School of Music
PO Box 870405
Tempe, AZ 85287-0405
(480) 965-7413

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk; you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480-965 6788.

This form explains the nature, demands, benefits and any risk of the project. By signing this form you agree knowingly to assume any risks involved. Remember, your participation is voluntary. You may choose not to participate or to withdraw your consent and discontinue participation at any time without penalty or loss of benefit. In signing this consent form, you are not waiving any legal claims, rights, or remedies. A copy of this consent form will be given (offered) to you.

Your signature below indicates that you consent to participate in the above study. By signing below, you are granting to the researchers the right to use your likeness, image, appearance and performance to videotape for presenting or publishing this research.

Subject's Signature Printed Name Date

_____ _____ _____

Legal Authorized Representative Printed Name Date

_____ _____ _____

INVESTIGATOR'S STATEMENT

"I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. These elements of Informed Consent conform to the Assurance given by Arizona State University to the Office for Human Research Protections to protect the rights of human subjects. I have provided (offered) the subject/participant a copy of this signed consent document."

Signature of Investigator_____Date_____

APPENDIX D

MUSIC SELECTION PLAYLIST

Artist	Song	BMP (beats per minute)
ApologetiX	Boulevard of Both Extremes	80
ApologetiX	John 1:1	156
ApologetiX	Search and You'll get Saved	157
ApologetiX	Flurry	157
ApologetiX	Come Out and Pray	158
OutKast	Hey Ya! (Radio Mix)	158
ApologetiX	Shepherd's Paradise	159
The Beach Boys	Surfin' Safari	159
ApologetiX	Stupid's Stronghold	160
ApologetiX	Yer Maker	160
ApologetiX	I Saw the Answer There	160
Lenny Kravitz	Fly Away	160
The Romantics	What I Like About You	160

APPENDIX E

SESSION SCHEDULE

Session structure depicting randomly assigned session schedule displayed by session number, week during the five-week study, day of the week the session was held, session condition, and total number of laps walked.

Session	Week	Day of Week	Condition	Total Laps Walked
1	1	Thursday	Treatment	7
2	1	Thursday	Control	5
3	2	Monday	Treatment	6
4	2	Thursday	Control	5
5	2	Thursday	Treatment	10
6	3	Monday	Control	7
7	3	Thursday	Treatment	6
8	3	Thursday	Treatment	10
9	4	Monday	Control	7
10	4	Monday	Treatment	10
11	4	Thursday	Control	10
12	5	Monday	Control	10
13	5	Monday	Control	7
14	5	Thursday	Treatment	10

APPENDIX F

PARTICIPANT JOURNAL ENTRIES

Participant Journal Entries Grouped by Treatment and Control Conditions

(Assessment)

Excited about getting started! Feeling a little weak physically. Curious about how thesis project will turn out. Hoping it will get me excited to walk more.

Treatment Session Journal Entries

Session #1 (T)
Feeling pretty good today. Excited for the session. Happy and joyful.
The music was awesome! Fun to walk to music I enjoy. Great session today. A little tired, but happy. Felt great overall.

Session #3 (T)
Pretty good this morning. Feeling good, and excited about session.
After, a little bit tired. Music was great. I still feel great. Good session. Walking to music is really fun and interesting. Not distracted as much: Which is good.

Session #5 (T)
Feeling good. Excited for session: with music.
After, a little tired. Rest in between helped. Made it to 10 laps finally!! Music was excellent!! Terrific session! Yay! Music good motivation.

Session #7 (T)
Feeling a little tired, yet good at the same time. Ready for fun session today. Feels good to walk.
After, still feeling good! Leg spasms a little bit. Good session; happy to walk.

Session #8 (T)
Feeling good. Ready for session. Inspired to walk more. I think this thesis is working and going extremely well.

Session #14 (T)
Feeling good today; but sad because it's the last session. ☹ Happy to walk again.
All 10 laps!! Motivating music! All sessions went well. Excellent sessions! ☺

Control Sessions Journal Entries

Session #2 (C)
Still feeling pretty good. Good to practice again. Hopefully, my PT will be pleased with my exercise.
A little more tired. Walking about the same. More motivating with music on. Nice session.

Session #4 (C)
Feeling better after having heat stroke Monday/Tuesday. Excited for session. Feeling good overall.
After, still feeling good. A tiny bit tired. Still felt good even without music. These sessions are helping me a lot. Don't want them to end.

Session #6 (C)
Feeling good today. Ready for session. Happy to walk. Hope session goes well.
Session went well. A little tired. Tensed up a little 'cuase people walked by. Other than this, nice session. No music, but had songs in my head. Good work today.

Session #9 (C)
Feeling good today. Little tired. Happy and delighted to walk again. Really enjoying thesis.
After 7 laps, little tired, but still feeling good. Able to re-focus; distracted a little.

Session #11 (C)
Feeling pretty good today. Excited for session. Little tired; but happy.
Good session. All 10 laps again! (first time without music.) Feeling great and happy. Fun session.

Session #12 (C)
Feeling good today. Happy to walk. Sad also that sessions are almost done. Looking forward to walking.
Did all ten laps again! Yahoo! Still feeling good. Nice session.

Session #13 (C)
Feeling good after resting and singing. Anxious to walk again.
Felt nice to walk; but tired after. Good walking!

APPENDIX G

RESEARCHER JOURNAL ENTRIES

(Assessment)
Met w/ Julie and mom to go over study and sign consent forms. Sat w/ Julie and discussed how she was feeling today. Had her write in journal. Discussed favorite music until PT arrived. PT modeled how to prompt stretching and what stretches are most appropriate before gait training.

Hamstring stretch for 2 min. keep prompting to reach all the way to toes
Right side more tight – be sure she is balanced against wall, hips centered
Gait training – walked up and down hallway (1 lap). Took about 1 minute, total approx. 150 meters (floor strips measured out every 3 feet – 25 strips each way = about 150 meters).

Hamstring stretch after gait training – 2 minutes
Journal check-in on how feeling, discussion, and some writing.
MT played soothing guitar music w/ breathing exercise
Discussion on song to end with – MT will look up songs for next time

Treatment Session Journal Entries

Session #1 (T)
Check-in
Journal writing
Julie shared after last session she felt like she might getting a blister. She was able to take care of it before it developed. Today she has the right socks on, so is more confident she won't get a blister from walking.
Stretching – 2 min.
Treatment – 7 laps total
Debrief after treatment
Little winded, enjoyed music selection, "Pretty nice" speaking about walking to 'good' music.
Music placement – little hard to hear all the way through hallway. Was placed by outlet in middle of hall. Will use an extension chord to place music at end of hall for future sessions.

Session #3 (T)
Last week as we were sitting waiting for her respite provider, Julie shared she had back surgery when she was 3. She was born with completely tight muscles – curled up in the fetal position with her arms crossed. Her parent literally had to 'pry' her limbs to get her dressed, changed, etc. Julie's mom has since made sure she appreciates her abilities and understands what it could have been like.
Julie has an extremely positive attitude and strong work ethic. She puts 110% into everything she does – persevering through any discomfort until it's unbearable. She works at a local hospital bussing tables and has been on the news and had her picture and

articles about her in the newspaper several times. Her family says she is the 'poster child' for cerebral palsy in the area. She is very used to having questions asked about cerebral palsy and participating in various treatments.
Verbal check-in/journal
Julie was in a good mood because she got to visit her grandma yesterday. Had a slow start today because she set her alarm wrong.

Stretching – HS/stomps
Gait training – about 8 min., 6 laps. Was quite winded today. Having unseasonable heat in the valley – may aid to fatigue level. Feet also got caught up a bit more today. Julie loved the music, which may make her want to go faster and she gets a little ahead of herself.

Stretching w/ guitar picking to calm mood
10 stomps to shake her legs out (was feeling some leg spasms)

Debreif/journaling
Julie said the music was great, motivating. She shared that normally when listening to music she just wants to listen and gets distracted by the music, but that wasn't the case with gait training. Has verbally told me listening to the music makes her want to keep going, even when she is tired. Today after 5 laps, she seemed fatigues, when asked how she was feeling she said her heart was racing. We took a slight break, took a few deep breaths, then she wanted to do 1 more lap. Ended at 6 laps. Although she was tired after gait training she always says her mood is great. A very positive individual.

Session #5 (T)
Check-in/journal
Still feeling good – in a good mood
Stretching – HS/stomps
Treatment session – 10 laps!! 7 laps, short break to catch her breath, deep breaths, rest for a minute, then made it all 10 laps!!
Break helped, she wanted to push through but I sensed she needed to catch her breath. She said the music was really motivating, made her want to keep walking and listen to music, didn't want to stop. She seemed highly motivated today. Had a little snack during break – most likely helped re-energize. I brought some old yearbook photos of her favorite singer to share.
Stretching
Check-in/journal to rest

Session #7 (T)
Said she's feeling a little tired during check-in. Tired but ready to "do something." Excited to have back to back music sessions today.
Stretching – HS/stomps
Gait training – 6 laps, took a few pauses to catch her breath. Hallway a bit warmer today than usual – may have contributed to fatigue.

Check-in after – tired but feels good. Her mood improved from 4 before session to 5 after gait training. Glad she walked. Having some leg spasms while sitting and journaling. Seems a bit distracted today, wants to chat, not as focused on writing. Re-prompting to finish her journal.

Session #8 (T)
Check-in – says was to "uptight" earlier, meaning her muscles were tight. Thinks she's more relaxed now, ready to walk again.

Stretching – HS/stomps

Made it all 10 laps!! Stopped in between songs for a few seconds to catch her breath. Seemed very motivated and wanted to keep going to make it to 10 laps. She was singing along to some of the songs. Recognized the new songs and said she liked those also along with the previous songs used.

Session #10 (T)
Check-in – still feeling pretty good. Re-energized after snack and rest time. Ready to walk again.

Stretching – HS/stomps

All 10 laps!! A little tired toward last few laps. Stopped to take a break and catch her breath in between laps. Said felt a little weak, but was motivated to do all 10 laps. With music seems to be a great motivator – will be tired but won't want to quit. Also possible first session of day is like a warm-up, then feels more energized, warmed-up and ready to walk more.

Check-in – tired but emotionally feeling great. Julie shared that calculating out total meters walked "makes it all worth it." Proud of herself for walking that far.

Session #14 (T)
Julie is in good spirits today, mood scale at 5. Said she is very sad it's the last session, but is excited to walk.

Stretching – HS/stomps

Afterwards, still in good spirits. Enjoyed the 2 new songs today. She seemed very motivated, didn't need as many breaks to catch her breath between laps.

<u>Control Sessions Journal Entries</u>

Session #2 (C)
Journal check-in
Mood is great – marked as a 5

Stretching – 2 min. HS elong stretch
10 stomps
Walk w/out music – control – 5 laps.
HS elong stretch – 2 min.
Debreif – more fatigues – mood decreased by .5 from before session due to fatigue.

Walked for a little more time at a slower pace, stride more uneven, right foot dragging more, slowed down several times and needed prompting to continue/finish the lap. Less talkative during and after than usual.

Session #4 (C)
Julie shared she had heat stroke after Mon. session. She saw her PT for pool time directly after the MT gait training session. Had to take a day off from work, but is feeling much better today. The Valley has been hot and a bit humid. This week has been between 108-111 degrees F.
Mom reported that Julie shared she would really miss this when we're finished.

Check-in/journaling
Stretching – HS elong/stomps
Walked 4 laps, stopped to breath, take a couple of min. break, then did one more lap at a slower pace.
HS stretch
Check-in/journal
Mood improved but fatigue increased. Shared she feels the whole thing is helping a lot – just consistent gait training is helping her practice walking.

Session #6 (C)
After last time, reported her legs were a little sore. Was tired but not too bad. Still felt she was recovering from heat stroke. Journal room was very cold today. Julie reported she had a very productive morning working with her main music therapist, helping shred papers and creating a podcast for the week. Julie is in good spirits as usual. Excited for the session and to walk today. Enjoyed seeing old yearbook photos of her favorite artist last week.

Stretching – HS/stomps

Gait training – 7 laps

Stretching – HS

Mood scale went down .5 from beginning. Some people came down into the hallway which threw her off a bit, stumbled a little and tensed up walking past them. Talked about it after and she noticed this too, said it happens a lot with her PT – she gets nervous walking around people. Shared that she has to focus and think about walking a lot when other people are around – stay on the right hand side. Says she should be used to people

watching her and getting looks but she still gets nervous/self-conscious while walking. Feels more comfortable in her wheelchair. We debriefed about this and her feelings about walking.
Session #9 (C)
Check-in – Julie is excited today, found out this morning she might get to go to Hawaii in Oct. Feeling tired, but in good spirits.

Stretching – HS/stomps

Julie walked 7 laps w/out music. Did the first 6, stopped to catch her breath and wanted to do one more. There were some people working at the end of the hall, the noise was a little distracting at times. Had to re-prompt to try to ignore the noise and keep going.

Snack, relax, singing

Session #11 (C)
Check-in/journaling
Julie is in good sprits today, as usual! She's excited for the session.

Stretching – HS/stomps

Made it all 10 laps without music! Her pace slowed a bit while talking, but I re-prompted her to keep going. She was also a bit distracted by hallway noise, but I re-prompted to try and ignore the noise and not stop, just keep walking through it (noise was furnace, she was curious looking down the side hallways, etc.).

Check-in/journal

Felt pretty good she made it all 10 laps w/out music. Said she knew she could do it, it just took some time. She shared that she thought the training w/ music helped build up her strength to do all 10 without the music.

I spoke with her mom after the session and shared she made it all 10 laps without music today. Her mom shared that at home she has seen a lot of improvement in Julie's endurance, overall health and coloring, since the beginning of the study.

Session #12 (C)
Check-in/journal
Julie shared she is feeling good today, happy to walk. She's still excited about her upcoming trip to Hawaii. She said she looked at the calendar today and is sad there is only 1 more session left.

Stretching – HS/stomps

All 10 laps! She completed all 10 laps again without music! Again, slowed a bit while talking, but was re-prompted to keep going. I also gave some instruction ahead of time that if she wanted to talk, to practice talking while still walking rather than stopping to talk. Will be good practice to ignore any outside noise and keep walking while talking.

Journal/check-in – a little tired. Scale down .5 from beginning because of fatigue but says still happy.

Session #13 (C)
Check-in – mood has improved after rest and snack (and singing).

Stretching – HS/stomps

Walked 7 laps during gait training. Her mood after the second session was down to 4.5 again due to fatigue. Was a little less distracted – less talkative. Check-in/journal – said she was pretty tired now, but it felt nice to walk.

APPENDIX H

SAMPLE EMOTIONAL RESPONSIVENESS SURVEY

Date: _____Session: _____

Rate how you are feeling before the music therapy session from 1 (feeling negative/sad) to 5 (feeling positive/happy).	1 2 3 4 5

Rate how you are feeling after the music therapy session from 1 (feeling negative/sad) to 5 (feeling positive/happy).	1 2 3 4 5

Signature:_____

APPENDIX I

POST TREATMENT SURVEY

POST-TREATMENT SURVEY

Please respond using the following rating scale:

1-Strongly Disagree, 2-Disagree, 3- Neither Agree or Disagree, 4 -Agree, 5-Strongly Agree

1. I had a positive experience participating in this research study.	1	2	3	4	5
2. I feel the treatment process has improved my walking.	1	2	3	4	5
3. I learned strategies I can use to further enhance my abilities in the future.	1	2	3	4	5
4. The journaling requirements for this study were reasonable.	1	2	3	4	5
5. The physical requirements of this study were reasonable.	1	2	3	4	5
6. I feel my overall mood has improved throughout the treatment process.	1	2	3	4	5

Additional Comments:

APPENDIX J

TRANSCRIPT OF PARENT INTERVIEW

Researcher: I was wondering if the heat would factor in and the days when we had 2 sessions, if that would…be she seemed to do alright.

Mom: I know, I was surprised. Yeah she did. She really enjoyed it.

Researcher: Yeah. She seemed really motivated every time she came in here.

Mom: Yeah, I mean it's usually her free time but she thought this was more fun than free time. She liked it. I think it helped her a little bit with thinking. She struggles with the logic and thinking.

Researcher: Yeah, ok.

Mom: But she would think in advance a little more often. I have to keep track of her goals and stuff and turn in the paperwork for her habilitation goals, and her logic and thinking skills were one thing. And I would say that improved. Because she was planning ahead and thinking of…

Researcher: Yeah, what was coming next, what was happening later that day.

Mom: Yeah, yeah. I think that's because it involved music. She does that with her music therapist too. If it involves music, she plans ahead. If it involves something else, eh. If that's selective or not, I don't know.

Researcher: (laughter)

Mom: It seems like with music she kicks in her thinking and logic skills. And her endurance, definitely, no doubt about it.

Researcher: Yeah, that's what I noticed. The major thing.

Mom: Yeah. She's never used her walked this much. Sequentially, I mean.

Researcher: Yeah, here and there throughout.

Mom: She's used 3-4 times a week now at least and it's usually maybe once or twice a month, whenever the therapist tells her to. So she was getting in it more often, and I think she was more stable. Probably because she was using it more and strengthening those muscles.

Researcher: Yes, exactly.

Mom: So the physical thing was good, and the endurance thing was good. It was a mental thing, because she started focusing more, she seemed more with it. Do you know what I mean?

Researcher: Yeah.

Mom: And getting something done.

Researcher: So the endurance, and maybe motivation too?

Mom: Yes, definitely. And because she's so social she really enjoyed it.

Researcher: Oh yeah, she was great to work with. I had fun too.

Mom: So that was good. And those things in turn, as time goes on that helps her skin problems, her energy level…

Researcher: So overall health?

Mom: Everything health wise I think. It's good for her have a goal. Because this was something she could see and touch and feel and do.

Researcher: And see her progress over time. We just talked about that, (to participant) the first day you were here, you've come so far from there.

Mom: Abstract goals she doesn't really understand, but this was concrete.

Researcher: Yes, we could mark it, how many laps she did.

Mom: Yeah, she could really see, I think that was a big help. All around it was good.

Researcher: Good that was great! Perfect!

Mom: (to participant) Did you have fun Julie? Did you enjoy it? Do you feel stronger, do your legs feel stronger?

Julie: Yeah.

Mom: I noticed too, usually she won't even look at her own feet. They turn black you with the Raynaud's.

Researcher: Yeah.

Mom: She wouldn't pay attention to it, we'd have to tell her. But since she's been doing this she's been looking at her feet, looking at her legs. Checking out her own…

Researcher: Oh. More aware…

Mom: Her own advocacy stuff. She's speaking up for her own body. It was something she'd just kind of blow off before. Now she sees how important it is because she can't dance without the body.

Researcher: (laughing to participant) See exactly! That's great.

Mom: She's always happy when we leave. She's not like, usually we're out in the heat and she's like ugh. But she's always happy when we leave.

Researcher: That's good! (to participant) Yes, you're a very positive person. That's been fun for me to work with you, puts me in a good mood too.