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Collaborative Physical and Music Therapy Interventions for Impairments of Chronic Stroke: A Case Study

Jake Leverington
University of North Dakota

Kelsey Bell
University of North Dakota

COLLABORATIVE PHYSICAL AND MUSIC THERAPY INTERVENTIONS FOR IMPAIRMENTS OF CHRONIC STROKE: A CASE STUDY

By

Jake Leverington, SPT
Bachelor of General Health Studies
University of North Dakota, 2016

Kelsey Bell, SPT
Bachelor of General Health Studies
University of North Dakota, 2016

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This Scholarly Project, submitted by Jake Leverington and Kelsey Bell in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

Cindy Flom- Meland, PT, PhD, NCS
Graduate School Advisor

David Relling, PT, PhD
Chairperson Physical Therapy

PERMISSION

Title Collaborative Physical and Music Therapy Interventions for Impairments of Chronic Stroke: A Case Study

Department Physical Therapy

Degree Doctor of Physical Therapy

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Signature: Kelly Bell SPT Signature:

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ABSTRACT

[Background and Purpose] In the United States, the annual prevalence of stroke is estimated to be 800,000.[1] Following a stroke, physical therapy (PT) interventions aim to help individuals recover from impairments such as muscle weakness and overall functional limitation. Current research supports both physical and music therapy (MT) interventions on an individual basis. The purpose of this case study was to evaluate the effectiveness of combined PT and MT interventions for strength, balance, gait, and functional activity for person following stroke. **[Case Description]** The patient is a 50-year-old caucasian female post right cerebral vascular accident (CVA) with left hemiparesis that occurred secondary to quadruple bypass surgery, two years prior to the initiation of this research. **[Intervention]** These therapy sessions were a collaboration of PT and MT techniques. PT interventions included gait training, balance training, functional strengthening, patient and family education, and home exercise instruction. MT interventions included rhythmic auditory stimulation in collaboration with PT interventions and therapeutic instrumental music performance. **[Outcomes]** The patient increased Berg Balance Scale Score by 12 points (MCD= 5 points).[2] Five Time Sit To Stand test decreased by 7.4 seconds (MCD= 2.5 seconds).[3] **[Discussion]** Collaborative PT and MT interventions lead to improved strength, balance, gait symmetry, and quality of life in treating a patient with impairments caused by stroke. Further research is needed to generalize these collaborative techniques beyond the findings of this case study.

CHAPTER I: BACKGROUND AND PURPOSE

Background. Damage to the brain caused by an interruption of blood supply is called a cerebrovascular accident (CVA), more commonly known as a stroke. Depending on the area of the brain where the stroke occurs, it can result in a number of impairments affecting a person's body. Muscle weakness, paralysis, sensory loss, dysphasia, dysarthria, and overall functional limitations are just a few of the possible outcomes following a stroke.The risk factors associated with a stroke include smoking, hypertension, physical inactivity, poor diet, obesity, diabetes, and cardiovascular disease.[4] In the United States, the annual prevalence of stroke is estimated to be 800,000 Americans.[1] The incidence of stroke is highest in African Americans and people over 65 years of age.[1] Stroke is the number one leading cause of disability and fifth leading cause of death among individuals in the United States.[1]

There are two main types of stroke, ischemic and hemorrhagic. Although ischemic and hemorrhagic strokes can cause very similar deficits, they have different causes. An Ischemic stroke is caused by a blood clot obstructing blood flow in the brain depriving it of oxygen. A hemorrhagic stroke is caused by a blood vessel rupturing leading to excessive bleeding and swelling of the brain.[5] Immediate treatment depends on the type of stroke the patient has experienced. With hemorrhagic strokes, the goal is to stop the bleeding, which most often requires surgical intervention. Ischemic strokes

are different because they require restoration of blocked blood flow, which can be resolved either through surgical intervention or pharmacological agents.

After an individual is medically stable, the multidisciplinary rehabilitation process will begin and continue throughout their lifetime. This multidisciplinary rehabilitation process will include professionals from many different fields including: Physical Therapy (PT), Occupational Therapy (OT), Speech Therapy, Music Therapy (MT), Nursing, and Medical Doctors to be brief. The role of a physical therapist in the rehabilitation process is to help the individual restore as much function as possible and assist in adaptations necessary for daily life.

Depending on the severity of the stoke, a patient may need assistance for moving in bed, transferring positions, or even standing. Physical therapists will determine what type of interventions are appropriate for each patient based on through examination abd accurate evaluation.[6] Types of interventions include gait and transfer training, assistive device training and functional strengthening. The purpose of functional, task-specific training is to help the patient regain control of functional movement patterns to do daily activities.[6] If patient deficits are more involved, the therapist will help develop compensatory strategies to allow the patient to participate as much as possible.[6] MT has many of the same goals as PT but utilizes difference techniques to achieve them. MT utilizes techniques such as Rhythmic Auditory Stimulation (RAS), Therapeutic Instrumental Music Performance (TIMP), and Musical Neglect Training (MNT) to initiate, synchronize, and direct an individual's movement. Current research on physical therapy gait training in collaboration with music therapy is very limited, but has shown significant improvements with walking in individuals

following a stroke. Gait training accompanied by rhythmic auditory stimulation produced significant improvements in cadence, step length, and dynamic gait index score with patients that had experienced a CVA.[7]

Purpose. The following case study outlines the twelve week physical and music therapy collaborative intervention program along with the resultant outcome measures. There is a plethora of research available regarding PT and MT post stroke treatment independently, but research using a collaboration of these two disciplines is very limited. Current research supports the highly repetitive nature of RAS as an effective method for gait training in patients following a stroke because of the effect it has on motor learning.[8] Regaining synchronized control of movements is often difficult for patients following a stroke. Utilizing RAS to stimulate a sense of rhythm will help stimulate areas in the brain and promote synchronized movements.[8] The purpose of this research was to evaluate the effectiveness of combined physical and music therapy interventions for strength, balance, gait, and functional activity. Supporting these combined interventions will be key in developing clinical practice guidelines for both PT and MT clinicians.

CHAPTER II: CASE DESCRIPTION

[Examination] The patient is a 50-year-old caucasian female who presented to physical therapy with a past medical history of quadruple bypass heart surgery and right CVA with left hemiparesis. The patient reported the stroke occurred secondary to her heart surgery, two years prior to the intitation of this research. The patient signed a consent form prior to the examination. The patient lives in a single story home with her husband who is very helpful and supportive. Her home is equipped with an adapted therapeutic pool with walking treadmill. She is no longer able to drive; however, her husband works from home and is able to provide transportation when needed for appointments and other life activities. She also has two adult daughters that live nearby who continue to help throughout her rehabilitation process.

Her current level of function and participation includes attending an exercise facility three days per week, using her therapeutic pool at home, and vacationing with her family. Although she was discharged from formal physical and occupational therapies, the patient wanted to continue working toward improving and maintaining her quality of life. Her goals were to increase strength and make progress with walking. Her chief complaints included slight difficulty getting on and off a toilet and not being able to see things on the left side of her body.

Systems Review. During the initial examination, the patient demonstrated slight facial droop on her left side. The patient also demonstrated deficits in left-sided vision; however, left sided neglect was ruled out due to her awareness of these limitations.

She was oriented to person, place, circumstance, but not time. She reports having occasional difficulties with dates and times. **Cardiopulmonary findings.** Past family medical history includes heart disease as reported by the patient. The patient stated she is taking the recommended dose of Lipitor as prescribed by her physician. Lipitor works by lowering cholesterol levels when they are too high. High cholesterol is a risk factor for stroke and heart disease.[8] The patient was also taking blood pressure medication as prescribed. **Neuromuscular findings.** Muscle function was assessed through the patient's ability to complete functional movements against gravity. Her left upper extremity had low tone. She was unable to grasp objects or complete any weight bearing through her left hand or shoulder. During ambulation, the patient leaned against walls or railings on her right side. Upon observation, her gait pattern demonstrated a decreased step length on the right, decreased pelvic rotation, and lateral trunk lean. She wore a knee-ankle-foot orthosis (KAFO) on her left leg to prevent knee hyperextension and foot drop. In addition to the KAFO, the patient ambulated with a single point cane in her right hand. All measures of gait were taken with the patient using her cane, due to her feeling unsafe without it. While ambulating, the patient demonstrated a step-to gait pattern on the right which consisted of a decreased step length on the right and decreased stance time on the left. She demonstrated a right shift while in a seated position, as well as during transfers and gait. **Clinical Impression.** Deficits in cognition, vision, posture, asymmetrical gait and strength were all consistent with the patient's diagnosis. The deficits in cognition mainly consisted of time orientation and were not considered to interfere with the study or interventions. This patient would

benefit from additional gait, strength, and balance training to minimize these deficits as it relates to her functional abilities.

Functional Assessments. Multiple functional assessments were used to evaluate the patient's gait, functional strength, balance, cognition, and quality of life (QOL). One of the functional assessments that was chosen to assess the patient's balance was the Berg Balance Scale (BBS). The BBS is a 14 item assessment where each item is scored 0-4. A score of 41-56 indicates a low fall risk, 21-40 indicating a medium fall risk and 0-20 as a high fall risk. The BBS was found to have a specificity of .73 and a sensitivity of .72.[9] One study found the BBS is a psychometrically sound measure of balance impairment for use in poststroke assessment.[10] The Five Time Sit to Stand Test (FTSTS) was used to assess the patient's balance and lower extremity strength. The FTSTS was found to have a sensitivity of .66 and specificity of .67.[11] The Timed Up and Go (TUG) test is used to assess mobility, strength, and balance to determine if the individual is at a risk of falling. Goldberg et al[3] found the FTSTS to be a valid measure of dynamic balance and functional mobility in older adults. Shumway-Cook et al[12] found the TUG had a sensitivity and specificity of .87 specificity when classifying fallers and non-fallers. The Cognitive Timed up and Go (Cog TUG) is often used to assess mobility, strength and balance in higher functioning individuals who are community ambulators. The cognitive TUG was found to have a specificity of .70 and a sensitivity of .57.[13] The patient's initial results of the functional measures are listed in Table 1.

Table 1.
Initial Functional Outcome Measures

Functional Measure	Score	Interpretation
Berg Balance Scale	33/56 points	Score of <45 indicates a greater fall risk
*5-Time Time Sit to Stand (FTSST)	19 seconds	Score >16.0 seconds indicates fall risk
*Timed Up and Go (TUG)	19.8 seconds	Score > 11.5 seconds indicates fall risk
*Timed Up and Go (TUG) with Cognitive Task Sequentially counting down from 20	21 seconds	

*Average of three trials

Table 2.
Initial SF-36 Domain Scores

Physical Functioning	10%
Role in Limitations Due to Physical Health	0%
Role in Limitations Due to Emotional Problems	100%
Energy and Fatigue	25%
Emotional Well Being	68%
Social Functioning	100%
Pain	80%
General Health	70%

The short-form 36 (SF-36) was used to assess the patient's quality of life at the initial evaluation and discharge. The SF-36 was shown to be a useful measurement of QOL in patients recovering from a chronic stroke.[14] The purpose of this form was to obtain a way to quantify various aspects of the patient's sense of health, self-limitation, and emotional well being. Higher scores indicate better health. The patient's results indicate the her percieved physical functioning, energy level, and fatigue are her greatest limitations of general health. The summary of the scores of each domain in the SF-36 from the evaluation are listed in Table 2.

The GAITrite analyzing system was created to provide clinicians with an objective way to quantify an individual's gait parameters.[15] Traditional methods of analyzing gait in a clinical setting include observational analysis which has shown to have poor reliability when studied.[15] To quantify our measurements of gait with and without music, the GAITrite system was used to obtain a breakdown of the patient's cadence, gait velocity, step length, and stance time. This required the patient to walk on a sensored mat under various conditions while a computer recorded her parameters.The summary of the initial gait results are listed in Table 3. All four conditions listed in Table 3 are an average of three recorded trials and the patient using her single end cane assistive device.

Table 3.
Initial GAITrite Analysis

	Cadence (steps/min)	Velocity (cm/sec)	Step Length (cm)	Stance Time (sec)
Normal Pace with No Music	87.5	42.5	L: 38.37 R: 20.43	L: 0.34 R: 0.46
Fast Pace with No Music	95.9	52.7	L:41.60 R:24.79	L: 0.32 R:0.42
Normal Pace with Music	86.5	43.5	L: 40.26 R: 20.09	L: 0.33 R: 0.45
Fast Pace with Music	89.9	46.8	L: 38.37 R: 22.06	L: 0.34 R: 0.46

L=Left, R= Right
*Music included singing, metronome, and autoharp strumming played by a MT student.

[Evaluation and Diagnosis] Functional outcome measures were used as the primary components of this examination to evaluate the patient's ability to function in everyday life. Although this patient has been discharged from formal physical therapy, there are still aspects of life that are difficult due to her impairments. Specifically, the patient has difficulty walking in the community with busy crowds and maintaining balance on uneven surfaces. Another impairment the patient still experiences is decreased strength which often makes it difficult to independently get on/off the toilet. Through the combined PT and MT interventions, there was potential for the patient to make improvements in her deficits in gait symmetry, balance, and functional strength.

[Prognosis and Plan of Care] The patient's prognosis was good due to her high motivation and willingness to continue attending therapy. Following the examination session, the patient attended a combined one hour therapy session once a week for twelve weeks. Outcomes measures were taken at the initial evaluation, with the FTSST,

TUG, and Cog TUG additionally retested halfway through. All outcomes were re-tested at the end of the 12 weeks. See Table 4 for all functional measure outcomes.

The focused short-term goal set at the initation of the study was the patient will complete 5 time sit to stand test in 16 seconds. The purpose of decreasing this score was to improve the patient's functional strength for getting on and off a toilet. The first long term goal established was to decrease the patient's Timed Up and Go (TUG) score by four seconds to allow the patient to be more independent with community mobility. The second long term goal was to increase the BBS to 38/56 to reduce the likelihood of the patient falling while ambulating in the community.

Physical therapy interventions included in the plan of care consisted of gait training, balance training, functional strengthening, patient and family education, and home exercise instruction. All of the physical therapy interventions were paired with music therapy techniques which consisted of the goal of enhanced learning and effectiveness with repetition. These interventions were chosen as a reflection of the patient's goals and deficits found in the examination findings. While the patient is in the chronic stage of her rehabilitation process, we still expected the patient to make progress toward her goals following our interventions. The implication of these goals will be especially important as she continues to age. It will be necessary to maintain her strength, balance, and mobility in order to continue functioning independently.

Interventions

The interventions implemented in this case study were focused on functional activities and the goals previously stated. After the initial evaluation, there were 12 one-hour sessions where interventions were performed, followed by another one hour re-examination session. Prior to each session, the two PT students and one MT student met to develop a session plan of interventions. As this was the purpose of our research, each PT intervention was paired with a MT technique to create a collaborative treatment plan. In this section, we will describe how the intervention strategies were performed. All sessions were supervised by a licensed physical therapist and a licensed music therapist. The patient wore a gait belt at all times during the sessions.

[Strengthening] Strength is essential in order to maintain functional mobility in patients following a stroke. Transitioning from a sitting to standing position and vice versa is an important movement for daily activities such as personal hygiene and dining at a table. Each session included a varying number of repetitions of sitting to standing paired with RAS. The autoharp was the selected instrument to perform the RAS simultaneously while the patient performed a sit to stand motion. This exercise began with the patient in sitting. The music therapy student would strum an "upbeat" on the autoharp to signal the patient to initiate her movement to go from a sitting position to standing. Once the patient was standing, there was a brief pause, then the next strum, or "downbeat" signaled the patient to initiate the descent back into her seat. This musical sequence remained constant throughout all sessions, while elements of the patient's movement were manipulated to facilitate strong and symmetrical movements. For every repetition

the patient clasped her left hand in her right in a prayer position, not using the arms of the chair to stand.

The following progressions were used throughout the intervention program to make the exercise more difficult for the patient and promote strengthening. Various conditions of the sit to stand exercise included:

- Sit to stand from standard arm chair.
- Sit to stand from sitting on a rubber disk.
- Sit to stand from elevated mat 24 inches tall with 2 inch block placed under the right foot. Repeated 5 times.
- Sit to stand from elevated mat 21 inches tall with 2 inch block placed under the right foot. Repeated 8 times.
- Sit to stand from elevated mat 25 inches tall with 4 inch block placed under the right foot. Repeated 8 times.

Sit to stand exercises were performed at every session. Multiple repetitions were performed throughout the sessions dependent on the patient's energy level. Sample repetitions utilized are listed above. Joint approximation was applied by a student therapist to the left lower extremity at the distal femur to encourage weight bearing through the affected limb and promote stability when the patient came to a standing position. Tactile cues were also given at the patient's hip to cue alignment of the trunk over the center of her body. Verbal cues were given to "look to the left" prior to standing to remind the patient to weight shift to her left side. A second student therapist provided stand-by assistance in case the patient lost her balance during the exercise.

Additional strengthening exercises included step-ups and lateral walking. For the step-up exercise, the patient stood in place on a hard surface and lifted her right foot onto a two inch step and placed it back to the starting position. This was progressed to the patient stepping up on the step and shifting her weight over the leg placed on the step to stimulate weight shifting during walking. This exercise was performed during one session; the patient did as many repetitions as possible before needing a seated break due to fatigue. Rationale for this exercise included increased weight bearing through the involved left lower extremity. Joint approximation was applied by a student therapist to the left lower extremity to the distal femur to prevent knee hyperextension during this motion. She also performed this exercise by stepping up with the right foot. A second therapist provided stand-by assistance. The previously mentioned RAS technique was performed simultaneously during this exercise to cue the patient to step on the up-beat and step down on the down-beat.

One study by Kim et al[16] found lateral walking was more effective compared to backward walking. Results showed improvements in asymmetric gait in patients following a stroke.[16] For the lateral walking exercise, we had the patient stand facing a countertop. The patient held onto the countertop with her right hand for stability when walking. She walked to both the left and the right. A student therapist walked alongside the patient making sure her hips stayed parallel to the counter and did not allow her leg to go into external rotation. The RAS technique used with lateral walking is listed in a subsequent gait traning section. Lateral walking was performed during two sessions, in a distance of 20 foot increments, until the patient fatigued.

[Balance] Motor control involves the integration of sensory and cognitive information to initiate, produce, and refine a voluntary movement. Balance impairments can result from changes in the integration and sensory aspects of motor control, such as with a stroke.[3] Post stroke impairments including decreased trunk control, impaired postural control, and restricted balance are correlated with impaired mobility and a higher risk of falling. The focus of our balance interventions was to promote strength and stability during performance of functional movements. Various balance exercises were integrated into the sessions.

One balance exercise utilized was lateral and forward weight-shifting on a swiss ball. For this exercise the patient was seated on a exercise ball with her feet on the floor. One student therapist was seated behind the patient to provide moderate assistance in helping her maintain balance. A second therapist sat in front of the patient and held a paddle drum. The patient held the mallet for the paddle drum in her right hand. The student therapist moved the drum forward and laterally to each side to challenge the patient to shift her weight in the different directions. This intervention was paired with the therapeutic instrumental music performance (TIMP) technique. The music therapist sang while the exercise was being performed. The goal of this technique was to promote smooth movement. This activity worked on several aspects of motor control such as perception of hitting the drum while shifting, and balance promoting trunk control. The drums were moved at a further distance to make the activity more challenging for the patient. In addition to the swiss ball, the patient sat on a balance disc doing the same exercise.

[Pre-Gait Training] Pre-gait exercises were utilized to work towards gait symmetry to allow the patient to ambulate in the community more efficiently. These exercises included forward and backward weight shifting. For this exercise, a line of tape was placed in front of the patient as she was standing stationary. The patient then stepped forward with the goal of putting her left toe to the line then stepping backward to her starting position. Each time she stepped forward, the patient was encouraged to increase weight bearing through her left leg. A student therapist provided stand-by assistance and provided tactile cues at the pelvis to encourage pelvic rotation to initiate the step forward.

The music technique paired with this intervention was TIMP. TIMP can be utilized to activate cortical and subcortical areas of the brain responsible for motor, sensory and cognition.[7] The music was varied throughout the sessions. For one session the patient held the mallet and hit a drum held up by the music therapist. Another time, the patient held a large guitar pick to strum the autoharp placed on a table in front of her. This exercise challenged the patient with a dual task and promoted weight bearing in her left upper extremity.

During these exercises the patient was given tactile cues. These cues were given by the student therapist at the patient's pelvis, hip and knee. At the knee the therapist applied joint approximation to encourage increased weight bearing through the affected leg. At the pelvis the patient received cues to encourage pelvic rotation and tactile cues at the hip were applied to increase step length. This exercise was progressed by having the patient perform the same exercise but add a step forward, with the addition of the step the patient integrated part of gait and put it together as a whole task.

[Gait Training] An individual's decreased ability to ambulate is often one of their biggest complaints following a stroke. In fact, 75% of individuals who have had a stroke sustain some limitations related to walking and 40% of these patients will be confined to ambulating in their home because of these limitations.[18] Due to the patient's goal to become more independent when ambulating in the community, gait training was one of our main focuses during the treatment sessions. Gait training was performed during every therapy session. A student therapist walked alongside the patient providing her cues and stand-by assistance for her balance. The walking distance during these sessions varied based on the patient's energy level and tolerance. She took seated rest breaks when needed. While performing gait training activities the patient would receive tactile and verbal cues with RAS.

Tactile cues were given by a student therapist while walking next to or right behind the patient. These cues were applied to the patients hips to increase pelvic rotation, in an attempt to normalize her gait cycle by creating symmetrical step lengths. Tactile cues can be effective at stimulating paretic muscles in individuals following a chronic stroke while ambulating at a normal gait speed or at an increased gait speed.[19] Verbal cues were given to encourage the patient to take larger steps with her right leg in order to increase her single leg stance time on the left and facilitate a more symmetrical gait pattern.

RAS is a training method that enhances motor skills by providing rhythmic stimulation to the motor centers of the brain. RAS has been utilized since the early 1990's for gait training for patients with neurological damage.[20] The RAS technique was administered by the student music therapist. She utilized various combinations of

metronome beats, an autoharp, and vocal singing. The selected cadence of the metronome was slightly slower than her typical gait speed in an attempt to increase her single leg stance time on the left. The rhythmic cues were initially set at a pace of 88 beats per minute, by the end of the 12 week period the pace decreased to 58 beats per minute. Throughout the weeks additional speeds were trialed (85, 76, 64 beats per minute). The licensed music therapist and student music therapist and adjusted speeds based on clinical experience and cuing in each particular session.

These rhythmic cues would encourage symmetry, increase step length on the right leg and single leg stance time on the left. If the patient began missing beats during her gait cycle she was instructed to stop, listen to the beat, and begin again when she felt ready. This strategy was used to promote practicing symmetrically and prevent the patient from practicing asymmetric patterns. In addition to her stopping when a symmetrical gait pattern showed signs of deteriorating, the student therapists broke up her walking into 10-15 foot increments. This would allow the patient a shorter distance to focus on taking bigger steps. Rhythmic auditory stimulation has shown to have a large impact on walking velocity, cadence, and stride length during gait of individuals post stroke.[21]

In addition to walking on a flat surface, two sessions included the patient walking on exercise mats. This exercise was selected to increased the patient's confidence when walking on uneven surfaces. The patient reported this helped her walk on sand with more confidence during her family vacation.

[Home Exercise Program] The final therapy session prior to re-examination was conducted in the patient's home. During this session, the patient walked in her

therapeutic pool at a self selected pace for 20 minutes. She was supervised by the licensed professionals and student therapists. In addition to walking, the patient completed sit to stand repetitions. In contrast to her normal sessions, the patient used her Iphone to play music instead of listening to the student music therapist playing an instrument. A music recording had been previously recorded with the same cadence and cueing she had been given during her previous therapy sessions. The patient was instructed to listen to this music while performing these exercises daily to continue working towards her goals. A written handout with detailed instructructions was provided to the patient and her husband (see Appendix).

Outcomes

The final evaluation data of the functional measures, SF-36 domain breakdown, and GAITrite analysis are listed in this section. Tables 4,5, and 6 compare the initial data collected compared to the final outcomes. The patient demonstrated improvements in balance, functional mobility, and several aspects in her overall quality of life.

The patient achieved her short term goal of decreasing her 5 time sit to stand test at her six week retest. She continued to improve decreasing her score from 19 seconds initially to 11.16 seconds at the final evaluation. Results are listed in Table 4. Our patient demonstrated a significant change when looking at the minimal detectable change (MDC) for this assessment, which is 2.5 seconds.[3] Functionally, this will allow the patient to complete daily tasks that require a change in position from sitting to standing with greater ease and less risk of falling.

Another notable change was the patient's progress on the Berg Balance Scale. The patient increased her score from 33/56 initially to 45/56 at the final evaluation, listed

in Table 4. She achieved her long term goal of increasing the total score to greater than 38/56. According to a study by Hiengkaew et al[2], the MDC for the BBS is 5 points for individuals with chronic stroke. The increase in score to a 45 is also significant because a score of less than 45 on the Berg Balance Scale has been shown an individual is at a greater risk of falling.[22]

The TUG and TUG with cognitive task were two additional measures used to assess the patient's functional mobility and balance. The patient did not achieve the goal of decreasing her final TUG score. Initial and final times are listed in Table 4 for both measures.

The SF-36 has been shown to be meaningful in measuring the quality of life in individuals in the chronic recovery phase post-stroke.[14] This functional assessment looks at eight areas of an individual's general health. The scores range from 0-100 with the higher scores indicating better health.[23] Overall the patient rated her health 10% higher at the final evaluation compared to the initial. The most notable change was the patient's perception of energy and fatigue increasing from 25%-45%. The patient's perception of her physical functioning increased from 10% to 25%. Emotional well being increased from 68%- 76%. The patient's scores remained unchanged in the limitations due to physical health, limitations due to emotional problems, and social functioning. Pain decreased from 80% to 55%. Initial and final scores for all eight domains are listed in Table 5.

Table 4.
Initial and Final Functional Outcome Measures

Functional Assessment	**Initial Evaluation**	**Week 6 Re-Test**	**Final Evaluation**
Berg Balance Scale	33/56	Not tested.	45/56
5-Time Time Sit to Stand	19 seconds (Average of 3 trials)	14.3 seconds (Average of 3 trials)	11.16 seconds (Average of 3 trials)
Timed Up and Go (TUG)	19.8 seconds (Average of three trials)	27.6 when turning right 23.9 when turning left	23.04 when turning right 22.64 when turning left
Timed Up and Go (TUG) with Cognitive Task * Sequentially counting down from 20	23.7 seconds (Average of 3 trials)	26.3 seconds (Average of 3 trials)	25.13 when turning right 22.8 when turning left

Table 5.
Initial and Final SF-36 Domain

SF-36 Domain Scores (in percentages)	**Initial**	**Final**
Physical Functioning	10%	25%
Role in Limitations Due to Physical Health	0%	0%
Role in Limitations Due to Emotional Problems	100%	100%
Energy and Fatigue	25%	45%
Emotional Well Being	68%	76%
Social Functioning	100%	100%
Pain	80%	55%
General Health	70%	80%

The initial and final GAITrite analysis comparisons are listed in Table 6. With no music, the patient increased her step length on the right from 20.43 cm to 22.28 cm as well as increased her stance time on the left at a normal pace. Gait velocity and cadence both increased when the patient walked with music.

Table 6.
Initial and Final GAITrite Analyses

	Cadence (steps/min)	**Velocity (cm/sec)**	**Step Length (cm)**	**Stance Time (sec)**
Normal Pace with No Music	Initial: 87.5 Final: 86.7	Initial: 42.5 Final: 42.7	Initial L: 38.37 Final L: 37.31 Initial R: 20.43 Final R: 22.28	Initial L: 0.34 Final L: 0.35 Initial R: 0.46 Final R: 0.49
Fast Pace with No Music	Initial: 95.9 Final: 92.0	Initial: 52.7 Final: 50.7	Initial L:41.60 Final L: 41.09 Initial R: 24.79 Final R: 24.04	Initial L: 0.32 Final L: 0.33 Initial R: 0.42 Final R: 0.46
Normal Pace with Music	Initial: 86.5 Final: 89.5	Initial: 43.5 Final: 46.3	Initial L: 40.26 Final L: 40.98 Initial R: 20.09 Final R: 21.98	Initial L: 0.33 Final L: 0.34 Initial R: 0.45 Final R: 0.47
Fast Pace with Music	Initial: 89.9 Final: 92.1	Initial: 46.8 Final: 49.5	Initial L: 38.37 Final L: 42.49 Initial R: 20.43 Final R: 22.06	Initial L: .34 Final L: 0.34 Initial R: 0.46 Final R: 0.45

***MT student provided music intervention including singing, a metronome, and autoharp strumming.**

CHAPTER III: DISCUSSION

This case report has demonstrated the 12 week collaborative intervention program between physical and music therapy in the treatment of a 50 year old female, two years following a stroke. Synchronized movement patterns are often difficult to perform following a stroke due to various deficits in strength and motor planning. The music therapy technique, rhythmic auditory stimulation, has shown to be effective in stimulating areas in the brain to produce synchronized movements, such as walking.[8] Current research lacks studies using combined music and physical therapy interventions for strengthening and gait training. The purpose of this study was to determine the effect of combined PT and MT had on various therapeutic interventions (balance, strength, and functional movements.)

With the help of physical and music therapy, the patient was able to demonstrate sufficient carry over during parts - to - whole training. Pre-gait weight shifting activities with musical cuing assisted the patient with motor control movements needed for walking. Following the combined interventions for gait training, the patient was able to increase the step length on her right leg and consequently stance time on her left leg. In addition, the patient demonstrated less lateral sway during walking. This is important for the patient's daily walking ability because a symmetrical gait pattern decreases the energy expenditure exerted while walking.

Although the patient's scores on the TUG and cognitive TUG increased from the initial to final trials, we hypothesize this is due to the patient's focus of increasing her

step length and maintaining symmetrical posture. The patient demonstrated increased time during both assessments when turning to the right. We hypothesize this is due to movement requiring the patient to initiate turning with her left leg. While the patient is aware of her deficits in movement of the left side of her body, she still demonstrates deficits in motor planning and movement initiation to the left. The patient did not state any limitations in daily activities caused by this perceived deficit.

Overall, the patient enjoyed the combined therapy sessions. She reported that friends and family members told her she was walking and moving around better than they had seen her in other stages of recovery. After the sessions were completed, the patient would make her own noises (to imitate the up and down beats) while sitting or standing from a chair. This was an additional way the patient demonstrated carryover of motor learning from the combined therapy sessions.

Limitations include the inability to generalize interventions used in this case study to the general population. This is in part due to the various limitations a patient can present with following a stroke. Without access to patient medical records, complete evaluation of the patient's cognitive impairments are unknown. Other limitations include small sample size and lack of recording the specific number of repetitions of each exercise performed.

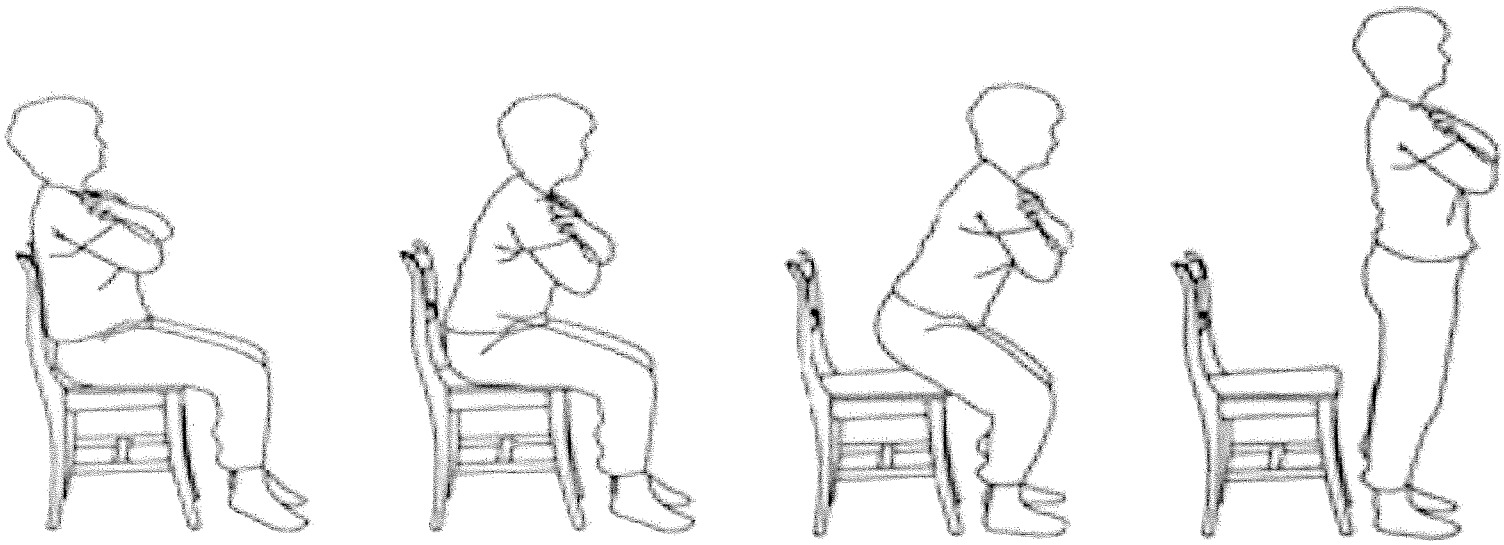
Future studies on combined physical and music therapy treatment should focus on gait training parameters such as distance, length of time, or cadence in order to make the interventions effective. Determining more specific combined intervention treatment plans would allow clinicians to create clinical guidelines that could be used for post-stroke individuals if deemed appropriate.

APPENDIX

Home Exercise Program

Sit to Stand Exercise

The purpose of this exercise is to strengthen the muscles needed to get on and off chairs throughout the day safely.



Instructions:

1. Start the music recording and listen for the cue to stand.
2. Start by scooting close to the front of the chair.
3. Lean forward shifting your weight over to the left.
4. Rise up to standing when you hear the auto-harp sound. Keep looking to the left.
5. When you hear the auto-harp again, sit slowly by feeling your legs against the chair.
6. Lower yourself down to the seat putting weight on both legs.

Repeat this exercise 5 times. Do this exercise 2 times per day.

Walking Program

Instructions:

1. Start music recording on your phone in your Files App.
2. Listen to the music recording before you start walking.
3. Begin walking with your cane, listening to the beat of the music.
4. Focus on taking "big steps" with both feet.
5. Take breaks when needed if you feel tired.

Try to walk for three minutes or until you need a rest, then take a seated break. Repeat this three times everyday.

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