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Efficacy of Therapeutic Listening® Quickshifts
in Children with Sensory Processing Difficulties

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A Culminating Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Occupational Therapy

Department of Occupational Therapy

Dominican University of California

San Rafael, California

May 2017

Signature Page

This thesis project, written under the direction of the candidates' thesis advisor and approved by the chair of the Master's program, has been presented to and accepted by the faculty of the Department of Occupational Therapy in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy. The content, project, and research methodologies presented in this work represent the work of the candidates alone.

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Abstract

Objective: The purpose of this study is to evaluate the effectiveness of Therapeutic Listening® - Quickshifts (TL-Q) to improve in 4 areas of occupation (1) self-regulation and arousal, (2) Activities of Daily Living (ADLs), (3) social interaction, and (4) sensorimotor skills in children referred to occupational therapy.

Methods: A convenience sample of three child participants in Madison, WI and two participants from Vancouver, WA receiving occupational therapy participated in an eight-week intervention of Therapeutic Listening® - Quickshifts. Pre-test and post-test measures included the Canadian Occupational Performance Measure (COPM), Clinical Observations of Motor and Postural Skills (COMPS), Beery-Buktenica Test of Visual Motor Integration (VMI) and the Sensory Processing Measure (SPM) along with qualitative parent journals and therapists' notes were used to assess changes.

Results: Variable performance was seen across participants with an overall trend toward improvement with change seen in the four areas of occupation. The Canadian Occupational Performance Measure (COPM) was the best indicator of change. All five children met their COPM goals, indicating improvements in performance and satisfaction. Most improvements were made in social interaction and self-regulation. Parent journals provided valuable insight and helped to bolster positive quantitative results.

Conclusion: Positive findings support the use of TL-Q as part of an overall sensory integrative approach to improve function and with possible benefits in (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills. The researchers outlined a simple and accessible model to encourage and help standardize future practice-based research in TL

Introduction

Sensory integration therapy (SI) is often a component of treatment for children receiving occupational therapy. SI aims to organize the nervous system so that it can optimally respond to sensory stimuli and thereby improve the individual's behavior, occupational performance, and quality of life (Ayres, 2013). Rooted in SI, Therapeutic Listening® (TL) has been used by many therapists to address a broad spectrum of goals. TL is a type of sound-based therapy that has the potential to affect physiology, and in ways less understood, to help the nervous system self-organize and learn to regulate itself appropriately. Although therapists continue its use based on positive anecdotal evidence, there are few empirical studies to provide statistical evidence for TL intervention. Therefore, it is imperative to produce supporting evidence in order to advocate for the treatment's continued usage and to broaden its implementation.

The present study focuses on Therapeutic Listening- Quickshifts (TL-Q), a shortened version of Therapeutic Listening Gearshifters that modifies music with binaural beat technology. The client listens to the TL-Q music using high-quality headphones for two sessions per day for approximately 15 minutes. The researchers examined the effectiveness of TL-Q intervention for children with sensory processing difficulties to improve occupational participation and function in areas such as (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills.

Background and Review of the Literature

Sensory Integration

Dr. A. Jean Ayres, an occupational therapist and developmental psychologist, postulated that sensory integration is an unconscious organization of sensation, i.e. touch, movement, vision, hearing, and taste (Ayres, 2013). This unconscious process of integrating the senses

helps individuals function in daily life (Ayres, 2013). Other facets of sensory integration may influence how one considers, plans, and executes movement; interacts with gravity; and interacts with tactile, visual, or auditory stimuli. As an effect of successfully integrating all, or many, of these sensory inputs, the child will respond appropriately in what is referred to as an adaptive response (Ayres, 2013). Ayres defined the adaptive response as a “purposeful, goal-directed response to a sensory experience” within an environment (p. 7). Children with sensory processing difficulties often lack adaptive responses and have hypo- and/or hyper-responsivity to sensory stimuli, which can interfere with daily function and participation (Baranek, 2007; Watling & Hauer, 2015). In this way, they are particularly suited for SI intervention.

Sensory Processing Disorder (SPD) disrupts the use of sensory information to supports posture, coordination, motor planning, and modulation of sensation, including a hyper- and/or hypo-sensitivity to certain environmental stimuli (Ayres, 2013; Reebye & Stalker 2007). Steigler and Davis (2010) suggest that over- and under-responsivity to sensory stimuli causes dysregulation and that "when people are dysregulated, they are less available for educational and social opportunities" (p. 69). Ayres (2013) suggested that the limbic system in children with sensory processing difficulties does not sufficiently motivate children toward seeking out novel experiences, which leads to learning and developmental deficiencies. Sensory processing difficulties are often seen in individuals with learning and developmental disorders, such as Attention Deficit Disorders and Autism Spectrum Disorder (ASD) (Ashburner, Ziviani, & Rodger, 2008; Baker, Lane, Angley, & Young, 2008; Baranek, 2007; Chang, Parham, Blanche, Schell, Chou, Dawson, & Clark, 2012).

For a child with poor sensory processing, being in a noisy classroom, or a classroom with buzzing fluorescent lights, may require his or her utmost effort emotionally, physically, and

cognitively to remain engaged. The therapist treating the child with sensory processing difficulties may intervene with sensory modalities to influence the integration of the offending sensory stimuli. These modalities can address the specific offending sensory stimuli or they can help with integrating the sensation by using a complementary sensory system. Sound-based therapy is an example of one such modality.

History of Sound-Based Therapy and Current Practice

The auditory system may be an avenue to assist in organizing the nervous system (Frick, 2000). The auditory system has a direct connection to the subcortical sensorimotor processing centers in addition to a network of connections to other processing centers in the brain (Frick & Young, 2009). Currently, there are a number of sound-based therapies used as sensory integration modalities, and many of them originate from the earliest concepts of Dr. Alfred Tomatis.

As an otolaryngologist in the 1950s, Dr. Alfred Tomatis pioneered new paths toward treating targeted atypical behaviors with sound. He recognized the ear as a significant sensory apparatus; particularly emphasizing the vital role played by the inner ear and its cochlear structures with relationship to the overall organization of the nervous system (Frick, 2000). The “Tomatis effect” postulates that the voice can only produce what the ear can hear (Frick, 2000, p. 2). Many modern sound-based therapy programs, including those based on the work of Tomatis, have added prevailing evidence to support various methods of treating the nervous system. In addition to Therapeutic Listening® - the focus of this study - current programs also include Auditory Integration Training, Samonas, Integrated Listening Systems, and The Listening Program (Frick, 2000).

Auditory Integration Training.

Guy Berard, a contemporary of Tomatis, originally designed Auditory Integration Training (AIT) (Frick, 2000). The program uses filtered popular music with altered sound frequencies meant to decrease hyper-sensitive hearing and increase auditory processing (Frick, 2000; Research on Auditory Integration Training, 2015). One particular study shows positive results in children with ASD including improved hearing acuity, reduction in sound sensitivity, improved visual tracking, and improved mood and calm (Al-Ayadhi, Al-Drees, & Al-Arfaj, 2013). Other studies have shown no positive behavioral changes in ASD from AIT (Mudford et al., 2000).

Spectrally Activated Music of Optimal Natural Structure.

Spectrally Activated Music of Optimal Natural Structure (Samonas) is based on the principles of music therapy. The Samonas therapeutic listening modality is concerned with specific characteristics of music such as individualization, technical quality, spatial quality, and emotional quality (Steinbach, 2008). Individualization is concerned with areas such as choice of music and level of intensity, while technical quality involves psychoacoustics, or the sensations of perceiving sound (Steinbach, 2008). The Samonas modality attempts to influence the processing of the nervous system to improve dysfunctional behavior and remedy learning difficulties (Steinbach, 2008; American Musical Therapy Association, 2015).

Integrated Listening Systems.

O'Brien-Minson (2014) asserted that Integrated Listening Systems (iLs) trains the brain to process sensory information while also improving emotional regulation. According to Alfred Tomatis' work, emotional regulation and processing is optimized alongside one's ability to focus, think, and engage at peak levels in social situations (O'Brien-Minson, 2014). The iLs

program combines auditory stimulation with physical activities focused on balance, movement, and visual motor activities (O'Brien-Minson, 2014). Activities typically encompass 15-20 minutes of listening during each session, although exact ratios vary because individual settings such as the clinic, school, or home must be taken into account (O'Brien-Minson, 2014).

The Listening Program.

The Listening Program (TLP) is a music listening method geared toward improving brain fitness (Doman, 2015). According to Doman (2015), TLP optimizes a wide range of brain performance areas including executive function, communication, auditory processing, social and emotional function, stress response, motor coordination, and creativity. Applications of TLP are applicable within a diverse array of settings including therapy clinics, schools, hospitals, homes, assisted living facilities, and military bases (Doman, 2015). Gee, et al. (2014) conducted a case control with three children ages 5-10 diagnosed with ASD in order to observe the changes in sensory processing after TLP intervention. Each child experienced two, 15-minute listening sessions for 10 weeks between two five week, non-intervention observation periods (Gee, et al., 2014). The results demonstrated that there was a change in all three case studies (Gee, et al., 2014). Measures included the SenSOR scales, the auditory defensiveness scale in the Sensory Processing Measure, and the overall total score from the Sensory Processing Measure. The SenSOR scales rate the over-responsiveness of the child to tactile, vestibular, visual, auditory, proprioceptive, gustatory, and olfactory stimuli (Gee, et al., 2014). The researchers reported a reduction in auditory defensive behaviors, such as covering the ears, as well as greater acceptance of stimuli and a decrease in sensory processing difficulties (Gee, et al., 2014).

Therapeutic Listening®.

Based on developmental and neurological principles, Therapeutic Listening® (TL) is a

sound-based intervention that possesses implications for optimizing sensorimotor function (Frick & Young, 2009). TL may affect arousal, sensory modulation, and praxis, but has also been shown to yield positive outcomes relevant to focused attention and academics (Vital Links, 2015). It also capitalizes on the vital role played by the auditory system in receiving sounds and adapting to sensations in order to enhance occupational performance. The auditory system's intimate connection to other parts of the brain allows sound to serve as a powerful approach for accessing the nervous system (Frick & Young, 2009). Within TL, four different programming series allow the therapist to tailor the listening experience according to the client's clinical needs. These programs are: The Modulated Series, The Fine Tuning Series, The Spatial Enhancement Series, and The Gearshifter/Quickshift Series. Each series hones in and addresses specific areas. As such, the Modulated Series prompts tuning in and orienting to sounds, while the Quickshift Series promotes relaxation, focus, and regulation (Frick & Young, 2009).

Therapeutic Listening®-Quickshifts (TL-Q) uses binaural beat technology to enhance alpha wave activity in the brain (Vital Links, 2015). Binaural rhythms are auditory beats that tap into the brain's ability to accurately detect disparities between two similar tones of slightly differing frequencies, played in opposite ears, and perceived as one new tone. The frequency of the 'new tone', or the binaural beat, is the difference between the frequencies of the two original tones (Stein, 2012). Thus, binaural beats possess the capacity for therapeutic benefit when they are played at frequencies similar to brain wave frequencies and incorporate alpha, delta, theta, beta, and gamma waves (Stein, 2012). The sound frequencies of the binaural beats in the TL-Q range from 9 to 12 hertz and correspond with alpha wave frequencies in the cerebral cortex. An enhanced alpha wave state allows for quiet alert focus and is conducive to adaptation and learning (Vital Links, 2015). Typically, an occupational therapist with advanced training in the

use of TL and TL-Q selects the music tracks using clinical reasoning to meet each child's specific sensory needs. The musical styles vary amongst albums, and may include Mozart, Vivaldi, contemporary compositions such as “Pop Tunes” and “Surf Jams,” or sounds that simulate natural environments (Vital Links, 2015). The music is modified to either calm or alert the child or to facilitate movement. TL-Q tracks are uniquely selected by the therapist to emphasize specific musical qualities and promote therapeutic benefits (Vital Links, 2015). As a sound-based tool, TL-Q is reported to facilitate functional improvement in various areas such as schools, homes, and clinics (Vital Links, 2015).

Supportive Evidence on Therapeutic Listening®

The evidence for TL is growing, and clinical findings have demonstrated positive changes in functioning for individuals with various diagnoses and deficits. Hall and Case-Smith (2007) studied the effects of a sensory diet and TL on children with SPD and visual-motor delays. Children were hypothesized to demonstrate fewer behaviors characteristic of SPD after TL and sensory diet interventions (Hall & Case-Smith, 2007). Participants of the study consisted of children ages 5-11 years with major sensory processing and/or visual motor integration delays (Hall & Case-Smith, 2007). Exclusion criteria included children with moderate to severe intellectual disability, Down syndrome, severe autism, and other disorders or delays. After receiving 4 weeks of a sensory diet and eight weeks of TL, children and their parents completed 4 assessments: the Sensory Profile, the Draw-A-Person (DAP) test, the Beery-Buktenica Developmental Test of Visual Motor Integration (Beery VMI), and the Evaluation Tool of Children’s Handwriting (ETCH) (Hall & Case-Smith, 2007). Results indicated that the TL program combined with a sensory diet facilitates significant improvement in children’s behavior (Hall & Case-Smith, 2007). There were also significant improvements seen in visual motor

skills (Hall & Case-Smith, 2007). Additionally, improved attention, sleeping patterns, and consistency in following directions as reported by parents were also positive results of the intervention program (Hall & Case-Smith, 2007).

Bazyk, Cimino, Hayes, Goodman, and Farrell (2010) studied the effects of TL on enhancing school performance in preschoolers with developmental disabilities. Children 3-6 years old listened to TL for 20 minutes twice a day during periods of typical classroom routine. Treatment duration ranged from 6 weeks to 5 months, depending on both the child's needs and the therapist's clinical opinion (Bazyk, et al., 2010, p. 124). The results from the study showed statistically significant improvements in all areas as reported on the parent and teacher assessments forms (Bazyk, et al., 2010). The assessments used included the Peabody Developmental Scale-2, Developmental Test of Visual-Motor Integration, Preschool Language Scale-3, Social Skills Rating System, the Sensory Profile, and the Draw-A-Person. Considering each of the assessments' strong reliability and validity, the positive results of this study provided substantial support for the use of TL (Bazyk, et al., 2010). While the existing body of research for TL supports its use, studies thus far have used an inconsistent variety of assessments and measures to accumulate evidence.

Practice-Based Evidence

TL-Q is a commonly used intervention strategy for addressing functional problems related to sensory processing, but there is very little empirical evidence to support its use. Evidence-based methodology, particularly the randomized control trial (RCT), is the prevailing and most trusted research approach to support OT practice. RCTs are considered the most rigorous of evidence-based approaches because intervention and assessment processes are standardized and extraneous variables are controlled (Portney & Watkins, 2000; Horn, DeJong,

& Deutscher, 2012). However, TL-Q is a highly individualized treatment; goals vary from client to client, and the treatment process relies on the occupational therapist's clinical reasoning. This decidedly varied therapeutic modality is difficult to measure under the constraints of the evidence-based practice (EBP) model.

Horn, DeJong, and Deutscher (2012) challenge the soundness of RCTs, asserting that strictly controlled environments are not a true representation of naturalistic settings and may not produce generalizable results. For example, people with comorbidities are frequently excluded from RCTs despite the fact that they may represent a large portion of the population in the natural setting, such as a clinic. The detailed, standardized documentation required in RCTs is not pragmatic in everyday practice. Lastly, hard research results such as treatment effects and effect sizes do not substantially differ in RCTs when compared against observational research.

On these grounds, the researchers offer an alternative to EBP. Practice-based evidence (PBE) is an observational approach that extracts evidence from practice itself (Horn, DeJong, & Deutscher, 2012). PBE offers an opportunity to measure intervention as close to how it is customarily provided. Thus, the need to replicate or create a false environment is removed entirely. Using a PBE model, assessments and interventions are administered and reported from everyday practice. PBE has the potential to capture the changes that only the intimate relationship between client and therapist can register.

TL-Q is used in homes, schools, and clinics. It can be part of a sensory diet, or an element of a long-term intervention. Considering the various settings, approaches, and inherently reciprocal nature of TL-Q therapy, PBE is the most appropriate for assessing TL-Q.

Assessments Used in Practice

In a retrospective case study analysis of therapists using TL in clinical practice, Sheehy

and Mandrussow (2015) found that therapists demonstrated little to no consistency in documentation of outcomes of intervention. Although some assessments are used more frequently than others, such as the Beery VMI, the effects of interventions were generally measured using a wide variety of assessments and subtests. Additionally, clinicians' documentation was frequently unclear, and the use of pre-test and post-test measures was inconsistent. As a result, it was difficult to report progress toward goals. The researchers concluded that future studies would benefit from assessments that can be easily incorporated into daily practice, which suggests a consistency of use such that changes can be easily reported (Sheehy & Mandrussow, 2014).

Taking into consideration all of the suggestions by Sheehy & Mandrussow (2015), four assessments fit the criteria for recommendation. The Canadian Occupational Performance Measure (COPM) has been found to be sensitive to change and possesses the capacity for an array of outcome measures, including most daily living functions (Eyssen, Steultjens, Oud, Bolt, Maasdam, & Dekker, 2011). Therefore, it is able to provide a pre-test to identify meaningful goals to focus on and a post-test to measure outcomes of the stated goals. Furthermore, it is suitable for a practice-based study because its short administration can be realistically incorporated into a therapist's regular practice.

The Sensory Processing Measure (SPM) is a well-regarded, norm-referenced assessment and is available in most clinics. Sheehy and Mandrussow (2014) found the SPM to be sensitive to change in post-test measures. Additionally, Sheehy and Mandrussow (2014) found many therapists consistently used the VMI. According to Brown, Unsworth, and Lyons (2009), the Beery VMI has satisfactory construct validity. Lastly, the Clinical Observations of Motor and Postural Skills (COMPS) was utilized by therapists for pre-testing and post-testing. Wilson,

Pollock, Kaplan, Law, & Faris (1992) found the COMPS capable of effectively discriminating between children with motor skill deficits and those without. Assessments such as the SPM, COMPS, Beery VMI, and COPM serve as measurable means of obtaining quantifiable pre-test and post-test data to support the efficacy of TL-Q in clinical practice.

Summary and Conclusions

Many clinical therapists have effectively utilized TL-Q in occupational therapy. In addition to anecdotal evidence from occupational therapy practitioners, preliminary research supports the use of auditory interventions. Still, substantial empirical evidence for its effectiveness in clinical practice is lacking. A prospective case study will help to ascertain the effectiveness of TL-Q intervention and assist with determining how to standardize the collection of data with therapists using TL-Q.

Statement of Purpose

Children referred to occupational therapy who have sensory processing difficulties are frequently treated using the SI approach. As a clinically reasoned intervention program, TL-Q uses modified music to support organization of the nervous system. Presently, few empirical studies have provided evidence for the efficacy of TL-Q. Anecdotally, the TL-Q modality has produced consistent positive results for therapists and clients alike. Therefore, it becomes imperative to produce further evidence supporting TL-Q's usage, which may lead to its broader implementation. The research questions guiding this study are:

First, what is the effect of Therapeutic Listening® Quickshift intervention in children with sensory processing disorders for improving function in (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills as measured by the COMPS, COPM,

SPM, and the Beery VMI? And, second, is a PBE methodology effective for future research studies on TL-Q?

Theoretical Framework

Sensory Integration serves as both a frame of reference and a theory. As a frame of reference, it provides intervention parameters for various sensory processing issues (Kramer & Hinojosa, 2010; Ayres, 2013). As a theory, it provides a hypothesis as to how the human nervous system is organized along with how it interacts with the environment, and makes predictions about the effects of SI (Kramer & Hinojosa, 2010; Ayres, 2013). Dr. A. Jean Ayres conjectured that within the central nervous system (CNS) the lower brain structures integrate and refine incoming sensory information before transmitting the information to higher brain structures. Lower brain structures control balance, posture, touch, regulation of behavior and digestive processes, and automatic motor skills (Parham & Mailloux, 2015). Higher brain structures, including the motor, sensory, visual, olfactory, and auditory cortices, assign meaning to the transmitted sensory information (Parham & Mailloux, 2015). After processing the sensory information, the higher brain structures store it for later recall and create an immediate behavioral response. Ayres called this response to the environment an “adaptive response” (Ayres, 2013; Parham & Mailloux, 2015, p. 259). Ayres’ theory of SI predicts that as the individual meets a task just beyond the capabilities of the individual, called the “just-right challenge,” the adaptive response will assist the nervous system in organizing itself (Kramer & Hinojosa, 2010, p. 133). This self-organization serves as an efficient process for integrating sensation more easily (Parham & Mailloux, 2015). Poor sensory integration may inhibit a child’s ability to produce an adaptive response to environmental stimuli (Ayres, 2013). A non-adaptive response would cause the child to avoid, fight against, or freeze (Ayres, 2013).

SI theory illustrates how the nervous system perceives sensory stimuli between the environment and the adaptive response - a reciprocal relationship - and how the various senses are interconnected and influence each other. TL-Q operates under the sensory integration assumption that auditory input will assist in organizing the nervous system by inducing an optimal arousal state needed for producing an adaptive response.

Methods

Design

The study conducted was a pre-test, post-test prospective case study design to examine the effects of an 8-weeks clinic based TL-Q intervention on (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills. Pretest measures included the COPM, SPM, COMPS, and Beery VMI. Therapists administered the COMPS and Beery VMI, while parents completed the SPM prior to their child's participation in the TL-Q intervention. Parents also completed the COPM during an informal interview with an occupational therapist. Pretest assessments determined a functional baseline and helped to develop measurable goals in one of the four categories listed above. Children then participated in their respective therapy sessions, which included TL-Q administration by occupational therapists with advanced training in TL-Q. The intervention consisted of a 15-minute TL-Q session administered twice daily, seven days a week for a total of eight weeks. Upon concluding all of the TL-Q sessions, parents again completed the SPM on their children, while therapists re-administered the COPM, the Beery VMI, and the COMPS. These post-test measures tracked progress made towards the identified goals. In this approach, the independent variable is the time of pre-test and post-test administration, and the dependent variable is the changes made in the areas of (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills.

Participants

Participants in the study included five children between the ages of 4 and 14 referred to occupational therapy at pediatric clinics in Vancouver, Washington and Madison, Wisconsin. Exclusion criteria included children diagnosed with seizure disorders, cerebral palsy, muscular dystrophy, and other neurological and musculoskeletal disorders. Children with moderate to severe intellectual disability (IQ 49 or less) were excluded from the study.

Participants were recruited upon the recommendation of the lead therapist at each clinic. The lead clinicians recommended and invited families to participate based on their expert clinical opinion that the child would benefit from TL-Q. This study was approved by the Institutional Review Board for the use of human subjects at Dominican University of California. Occupational therapists working at Therapeutic Resources in Madison, Wisconsin and Advanced Pediatric Therapies in Vancouver, Washington confirmed and gathered consent from the parents.

Measures and Instruments

This study measured the benefit of TL-Q for children. Functional goals were determined with the COPM during pre-test. The SPM, COMPS, and VMI determined the baseline before the intervention. After intervention, changes in the following areas were measured by the COPM, VMI, COMPS, and SPM: (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills.

Canadian Occupational Performance Measure.

The COPM is a Likert scale questionnaire designed to measure the quality of functional skills and was completed by the therapist and parent(s) during an informal interview. The validity of the COPM has demonstrated consistency in psychometric testing on convergent, discriminant, construct, concurrent, and criterion validity. In addition, 50-80% of the problems

identified on the COPM are consistently identified in other similar measures suggesting construct validity. The COPM is more sensitive than similar measures, because it is client-centered, evidence-based, and captures clients' self-perceptions of daily occupational performance (COPM, 2014).

Parents of the children included in the study were interviewed to complete the COPM during pre-test and post-test assessments. For the pre-test, the parents were asked to identify five occupational activities, or goals, to address during the study that had the largest negative impact. They were then asked to assign a number between 1 and 10 to rate his or her child's ability to perform the activity and his or her satisfaction with the activity's completion. During the post-test, parents were again asked to rate their child's performance on the five identified goals and also to rate their level of satisfaction.

Sensory Processing Measure: Home Form

The SPM utilizes a series of rating scales to assess social participation, vision, hearing, touch, taste and smell, body awareness, balance and motion, and planning and ideation. This assessment was meant to reveal results primarily in the areas of social emotional and sensorimotor performance. Parents were asked to fill out the SPM during interview sessions before and after TL-Q treatment, effectively producing a series of pre-test and post-test data for analysis.

The SPM is a Likert scale checklist that provides a complete picture of children's sensory processing difficulties in the home and at school (Kuhaneck, Henry, & Glennon, 2007). The SPM has established reliability and validity (Parham & Ecker, 2015). Content validity was defined as the extent to which a scale adequately samples the domain it was intended to measure (Parham & Ecker, 2015). To ensure content validity for the SPM, only relevant representations

of function in sensory systems, such as praxis and social interaction, were retained following comprehensive analytical review by experts. Construct validity refers to how well a test performs in measuring the theoretical construct it was intended to measure. All of the primary constructs in the SPM have maintained fidelity to Ayres' theory of SI. Convergent validity refers to the extent to which the measure has similar results to other measures of its kind. The SPM was measured against the Short Sensory Profile, the Infant Toddler Sensory Profile, and the Sensory Profile School Companion. The SPM demonstrated strong correlation to these other assessments (Parham & Ecker, 2015).

Test-retest reliability refers to the stability of scores over time. In an examination of the SPM's test-retest reliability, children were tested in two pilot studies (Miller-Kuhaneck, Henry, Glennon, & Mu, 2007). The first study had an internal consistency result of .93 and .99. In the second pilot study, the internal consistency result was .70 to .99. Miller-Kuhaneck, Henry, Glennon, and Mu (2007) found the SPM correctly classified children with typical sensory processes 92.3% of the time. While children with sensory deficits were classified correctly 72% of the time. For the researchers, this adequately demonstrated the SPM's reliability and validity when discerning sensory processing deficits in children.

Clinical Observations of Motor and Postural Skills.

COMPS consists of a series of brief motor and postural challenges, such as touching nose with eyes closed, rapid forearm rotation, asymmetrical tonic neck reflex, supine flexion, and prone extension. The test is meant to identify challenging motor areas in children. The COMPS is a norm-referenced assessment of motor and postural skills (Wilson, 2000). Clinical observations are included to validate the parent observations of general movement abilities and how they translate to performance in daily activities. The assessment requires about 15 minutes

to administer. The COMPS was shown to be consistent and reliable over time and independent of the observer (Wilson, Pollock, Kaplan, Law, & Faris, 1992). Additionally, the COMPS possesses high test-retest reliability, as well as a construct validity of 100% for children 5 and 8 years old. Construct validity was found to be at 80% for 6 to 7 year olds with an overall validity of 73.44%.

Beery-Buktenica Developmental Test of Visual Motor Integration.

Commonly used to identify children with difficulties in visual-motor integration, the VMI is sensitive to diverse environmental, educational, and linguistic backgrounds (Multi-Health Systems, Inc., 2016). The VMI is a pen and paper, tabletop assessment that asks the child between the ages of 2 and 18 years old to copy increasingly complicated shapes into an empty square. Additionally, it assesses deficits in coordinating the finger and hand movements with visual perception through 3 subtests. The subtests include visual motor, visual perception, and visual-motor integration. The visual motor subtest asks the child to copy varying lines and shapes from simple to complex, while the visual perceptual subtest assesses whether the child can identify similar shapes. The motor coordination subtest assesses whether the child can coordinate finger and hand with visual acuity to trace inside of different shapes without crossing over defined margins. Points are deducted if the child does not match the design of the shape, or if the distance between the lines of the shape is too far. The VMI had an overall average reliability of 92%. In a recent study, Brown, Unsworth, and Lyons (2009) recommended the use of the VMI for clinical practice.

Parent Journals.

Parent journals were used to gather qualitative data. Parents were asked to fill out a form with questions instructing them to observe changes in their child's behavior during the eight-

week intervention period. Parent observations were conducted in the areas of (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills.

Procedures and Data Collection

The intervention was conducted during each participant's home programs. Enrolled subjects listened through high quality headphones to one TL-Q track twice daily for eight weeks, although some music tracks were altered slightly based on the child's needs for the period. An occupational therapist with advanced training in the use of TL-Q selected the music tracks to meet each specific child's sensory needs.

Following the eight week treatment period, the COMPS, the VMI, and the SPM were completed again as a post-test to identify possible changes in occupational performance. The same procedure was applied, with the COPM being completed by parents and the therapist during a 30 minute interview.

Data Management and Analysis

Analysis of data focused on the results of the measures. The dependent variables consisted of each participant's performance on post-test measures and, specifically, changes in the 4 areas of occupation 1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills.

All data was stored on a secure university computer to which only the researchers and the advising faculty had access. Numerical identities were assigned in lieu of actual names. The transportation of data from the testing site to the university computer was conducted using a secure university email.

Pre-test data was compared against post-test data to examine the strength or degree of change after implementation of TL-Q. Data was aggregated over Microsoft Excel and organized

into tables, while charts were designed to illustrate results of the assessments over an eight week period in a graphic format. Separate Microsoft documents were created to summarize quantitative results while also incorporating qualitative data stemming from therapist observations and parent journals. Categories of both quantitative and qualitative data were coded and categorized into the 4 areas 1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills using Microsoft Excel documents to allow for comparison and contrast while ensuring the confidentiality of the participants. For example, assessment subtest results were coded as a change in one or more of 4 categories such as social interaction. Finally, data that was not collected due to factors such as a participant being too young to be assessed was noted in the Microsoft Excel document.

Results

Over the course of the study, five out of five children completed the full eight weeks. The age ranges of the participants were 4 years, 10 months to 10 years, 3 months. Participants included two boys and one girl from the clinic in Madison, WI and one boy and one girl from the clinic in Vancouver, WA.

All five participants completed pre-test and post-test assessments and followed the TL-Q regimen. Variable performance was seen with an overall trend toward improvement with change seen in (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills as measured by quantitative assessments and qualitative parent journals. The COPM was the best indicator of change. Parent journals provided valuable insight and helped to frame quantitative results.

Table 1

Participant Demographics

Participants	Gender	Age at end of intervention
1	Female	5 years, 0 months
2	Male	9 years 10 months
3	Male	10 years 3 months
4	Female	7 years 6 months
5	Male	5years 9 months

Clinical Observations of Motor and Postural Skills (COMPS) Analysis

Due to age, one participant (Child 1) did not qualify to be assessed using the COMPS, and four of five participants completed the pre-test and post-test. During the pre-test, three of four participants scores indicated generally no problems in motor and postural skills. One participant's pre-test score indicated deficits in motor and postural skills. Subtests scores in the pre-test varied for each participant, with some participants scoring well in the Asymmetrical Tonic Neck Reflex (ATNR) subtest, poorly in the Finger-to-Nose subtest, and vice versa for others.

The COMPS post-test was completed after having completed eight weeks of TL-Q therapy in the home. Three of four children showed an increase in average total scores for motor and postural skills. For Child 2, scores in all areas stayed the same with a slight increase in the ATNR performance. The Slow Motion [movement] subtest improved for Child 3, while the ATNR stayed the same, and there were slight improvements in Finger-to-Nose Touching and Prone Extension subtests. Child 3 demonstrated a very minor dip in the Supine Flexion subtest. Interestingly, Child 4 began the intervention below average and was the only child to

demonstrate further decreased scores. However, Child 4 did show improvements in the Slow Motion and the Rapid Forearm Rotation. Child 5 stayed virtually the same in all areas, but had a significant improvement in Supine Flexion. The majority of the children exhibited an increase in Total Weighted Score, and although Child 4 decreased in Total Weighted Score, he demonstrated a slight improvement in postural control.

Figure 1

COMPS Total Weighted Score scores Pre-test and Post-test

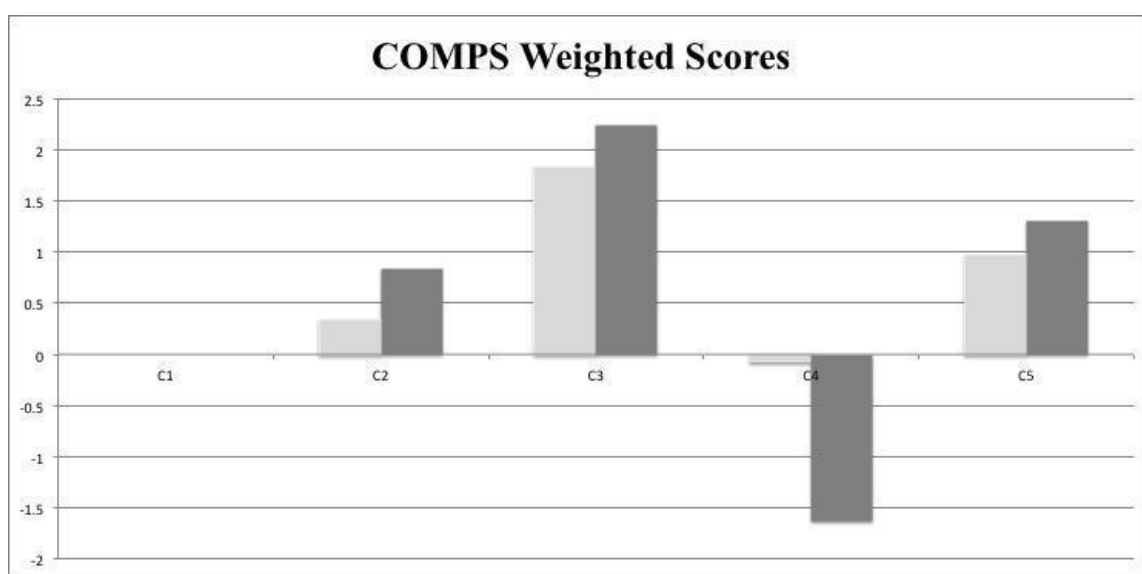


Figure 1. Pre-test is the lighter shaded bar and post-test is the darker shaded bar. C(#) = case and numbered ID. Higher scores above 0 indicate increased function. Child 1 did not meet the age requirements of this assessment.

Table 2

COMPS Pre- & Post-test Weighted Scores

Subtest	Child 1	Child 2		Child 3		Child 4		Child 5	
	Pre & Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Slow Motion	*	-							
Rapid Forearm	*	1.08	-1.44	0.84	1.4	2.42	2.2	3.63	3.96
Finger to Nose	*	7.26	7.92	29.04	29.04	4.14	5.06	1.92	1.92
Prone Extension	*	1.92	1.92	2.2	2.59	0.18	0.24	-	-
ATNR	*	1.2	1.2	0.1	0.06	-0.24	-0.4	0.96	0.96
Supine Flexion	*	0.6	0.8	-3.72	-3.72	-0.42	-0.77	1.02	1.02
TOT %	*	0.25	0.24	1.2	0.72	1.74	0.58	2.5	2.5
		0.34	0.84	1.84	2.25	-0.72	-1.63	0.48	0.48
								0.98	1.31

Note: Child 1 did not meet age requirements of this assessment

The Canadian Occupational Performance Measure (COPM) Analysis

In the COPM pre-test, parents identified goal areas where they wanted to see improvement in their child's occupational performance. The results of the COPM showed an improvement in performance along with satisfaction in all the children's targeted occupations.

Child 1 displayed the largest change in scores between pre-test and post-test assessments. These scores of "communication and expressing needs" improved dramatically. Also, the child improved in the categories of "sitting and paying attention," "strength of fine motor grasp," and "sound sensitivities." For the category of "potty training," the parent reported no change in Performance yet a reduction in Satisfaction. More precisely, the parent journal reported an improvement in bowel and bladder management after the first 2 weeks. In the third 2 weeks, the

parent reported that her child was communicating the need to use the toilet, but was not staying seated on the toilet as long as previously. In conclusion, it appears that during this study, the child was able to advance from not being able to communicate her toileting needs to being able to indicate that she needed to “go potty”. Parent journals and the COPM may indicate parent frustration with providing care for a child with sensory processing difficulties.

Between pre-test and post-test, Child 2 showed an improvement in both Performance and Satisfaction. The category of largest improvement was Satisfaction of the child’s “ability to follow directions”. The Performance of this category increased as well. The other categories of “sibling and peer play,” “continued participation when things don’t go his way,” and “distractibility at school” improved in both Performance and Satisfaction. In “intensity of meltdowns,” the child’s Performance decreased while Satisfaction increased. The parent journals do not provide insight into the improvements nor the lack of changes for this child.

Child 3 demonstrated significant improvement in Performance and Satisfaction. The area of most improvement was in “regulating arousal”. In the parent journal, the parent reported an increase in “getting to sleep” and “staying asleep,” a reduction in issues around transitioning between environments, and an increase of spatial awareness. In the categories of “rigidity,” “following directions,” and “understanding other’s feelings,” Performance also improved. “Social interaction” was reported as not changing in Performance, but the parent’s Satisfaction improved in categories of “rigidity,” “social interaction,” “following directions,” and “understanding other’s feelings”. Satisfaction improved substantially. In this case, there was a marked improvement in the Satisfaction of the parent and slight improvement in the child’s performance.

In both Performance and Satisfaction overall scores, Child 4 showed an improvement.

The most improved category was “auditory filtering/sensitivity”. She also improved for the categories of “emotional/self-regulation” and “motor planning/body awareness”. There was no change for “tactile defensiveness”. The parent journal reported that the child enjoyed listening to TL-Q and “preferring to listen before bed,” but that she refused to listen to a particular track or to engage in other activities while listening. The parent journal also reported Child 4 appeared more “relaxed,” “less irritable,” and “less excited” after listening, which reflects the improvement seen in the “auditory filtering/sensitivity” category.

For Child 5, there was a substantial increase in the Performance and moderate increase in Satisfaction. The area of largest improvement can be seen in Performance and Satisfaction in “self-confidence to try new things”. Parent journal remarks reveal that Child 5 “join[ed] with other kids in football, soccer, yoga, and tumbling all week”. The other COPM categories of “fine motor/writing/drawing,” “letter recognition,” “doing what is expected at home from parents’ directions,” and “lessen[ed] aggressive behavior toward dog” revealed a moderate improvement in Performance and Satisfaction.

Each child made significant improvements in each of the categories identified by the parents. The categories identified were reflective of significant areas that influence daily occupational performance, and therefore become important indicators of overall functioning within the family.

Figure 2.1

COPM Changes in Performance between Pre-test and Post-test

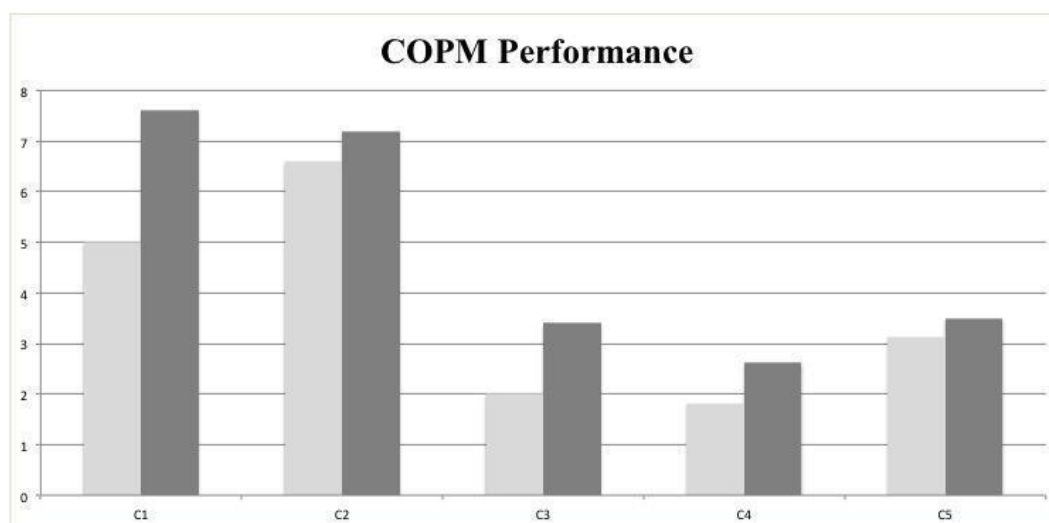


Figure 2.1. Pre-test is the lighter shaded bar and post-test is the darker shaded bar. C(#) = case and numbered ID. Higher score indicate increase performance.

Figure 2.2

COPM Changes in Satisfaction between Pre-test and Post-test

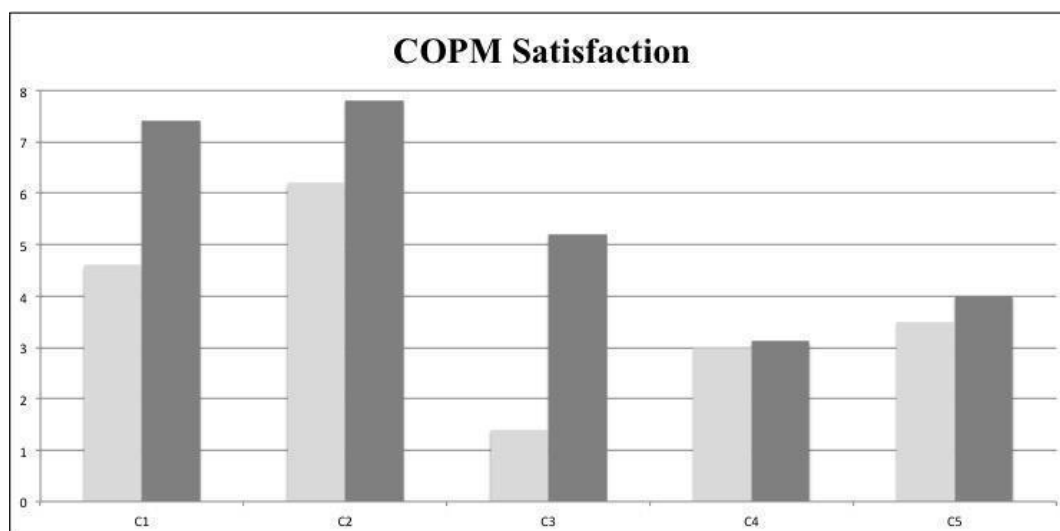


Figure 2.2. Pre-test is the lighter shaded bar and post-test is the darker shaded bar. C(#) = case and numbered ID. Higher scores indicated increased satisfaction.

Table 3

COPM Pre-test and Post-test

Subtest	Child 1		Child 2		Child 3		Child 4		Child 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Performance	5	7.6	6.6	8.2	2	3.4	3.125	3.5	1.8	2.625
Satisfaction	4.6	7.4	6.2	7.8	1.4	5.2	3.5	4	3.0	3.125

Sensory Processing Measure (SPM) Analysis

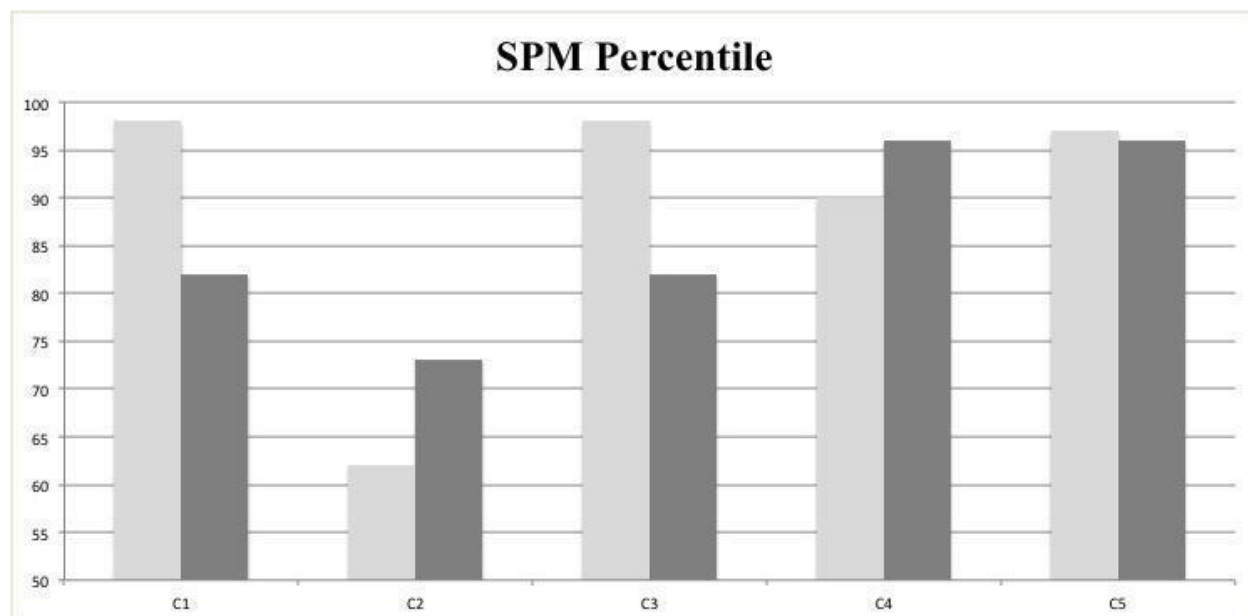
Results of comparisons between pre-test and post-test data indicate overall mixed results retrieved through administration of the SPM. It should be noted that increases in percentile ranking on the SPM are indicative of increases in severity, and as such interpretative ranges include Typical, Some Problems, and Definite Dysfunction classifications.

Upon examining the pre-test data for Child 1, performance levels on categories of Vision, Hearing, Touch, Body Awareness, Balance and Motion, and Planning Ideas were all shown to have Some Problems, while scores were within a Typical range for Social Participation. Pre-test data for Child 1 was overall indicative of Definite Dysfunction, although post-test data illustrated a moderately improved score. With the exceptions of the Body Awareness and Planning Ideas categories, scores improved in all areas and indicated performance levels within Typical range. Post-test data on the SPM showed that Child 1 demonstrated increases in Vision, Hearing, Touch, Body Awareness, and Balance and Motion alongside a significant decrease in Social Participation. No changes were observed within the Planning and Ideas category. Meanwhile, Child 2 demonstrated an overall increase in severity of sensory processing difficulties, with varied results amongst sub-tests. For example, Vision and Body Awareness stayed the same

from pre-test to post-test, but Social Participation and Planning and Ideas decreased while Balance and Motion and Hearing increased.

Child 3's performance from pre-test to post-test assessments on the SPM illustrated a different picture from Child 1 and Child 2. Performance levels on the various subtests of the SPM indicate qualifying scores primarily within the Some Problems and Definite Dysfunction ranges during the pre-test assessment. Scores stayed the same on the post-test assessment, although an increase in performance was noted in the Vision category while Body Awareness decreased. In contrast, Child 4's pre-test and post-test assessments revealed slightly more significant differences in performance, although results were still mixed. Child 4 displayed a significant increase in percentile ranking between pre-test and post-test, which was indicative of a large increase in severity of difficulties with Vision. The Balance and Motion and overall total of severity of sensory processing also witnessed a marked increase in percentile ranking. Finally, performance on the SPM for Child 5 also yielded variable results in terms of change in level of performance. Categories of Vision, Balance and Motion, and Planning and Ideas saw little to no change in percentile ranking. Severity of tactile processing difficulties increased slightly, while severity of Body Awareness deficits decreased slightly. Most noteworthy of mention was a significant decrease in percentile ranking for hearing deficits, effectively placing Child 5 within Typical ranges for Hearing.

Figure 3

SPM Percentile Pre-test and Post-test

Note. Pre-test is the lighter shaded bar and post-test is the darker shaded bar. C(#) = case and numbered ID. Higher scores indicate decreased function.

Table 4

SPM Pre-Test and Post-test Percentiles

Subtest	Child 1		Child 2		Child 3		Child 4		Child 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
SOC %	58	82	46	79	98	97	95	93	88	84
VIS %	97	79	18	18	96	86	18	66	82	82
HEA %	97	79	73	58	96	95	95	96	73	62
TOU %	97	79	69	58	96	95	95	96	88	92
BOD %	97	88	69	69	82	90	95	97	96	93
BAL %	96	79	38	16	96	93	86	95	92	93
					>9					
PLA %	92	92	31	52	9	95	84	86	86	86
TOT %	98	82	62	73	95	95	90	96	97	96
Descriptive Categories *	DD	T	T	T	SP	SP	SP	SP	SP	SP

Note. DD= Definite Dysfunction; T = Typical; SP = Some Problems

Beery-Buktenica Developmental Test of Visual-Motor Integration (VMI) Analysis

Results of the VMI across the five participants were mixed. Two children demonstrated no change between pre-test and post-test and two children had moderate to significant increases in overall visual-motor integration scores. One child demonstrated significant decrease in overall visual-motor scores.

Child 1 remained the same between pre-test and post-test. Child 2 decreased significantly between pre-test and post-test. Child 3 remained the same between pre-test and post-test. Child 4 significantly increased between pre-test and post-test, while Child 5 increased moderately. The VMI Overall Integration scores were variable and provided enigmatic data.

Figure 4

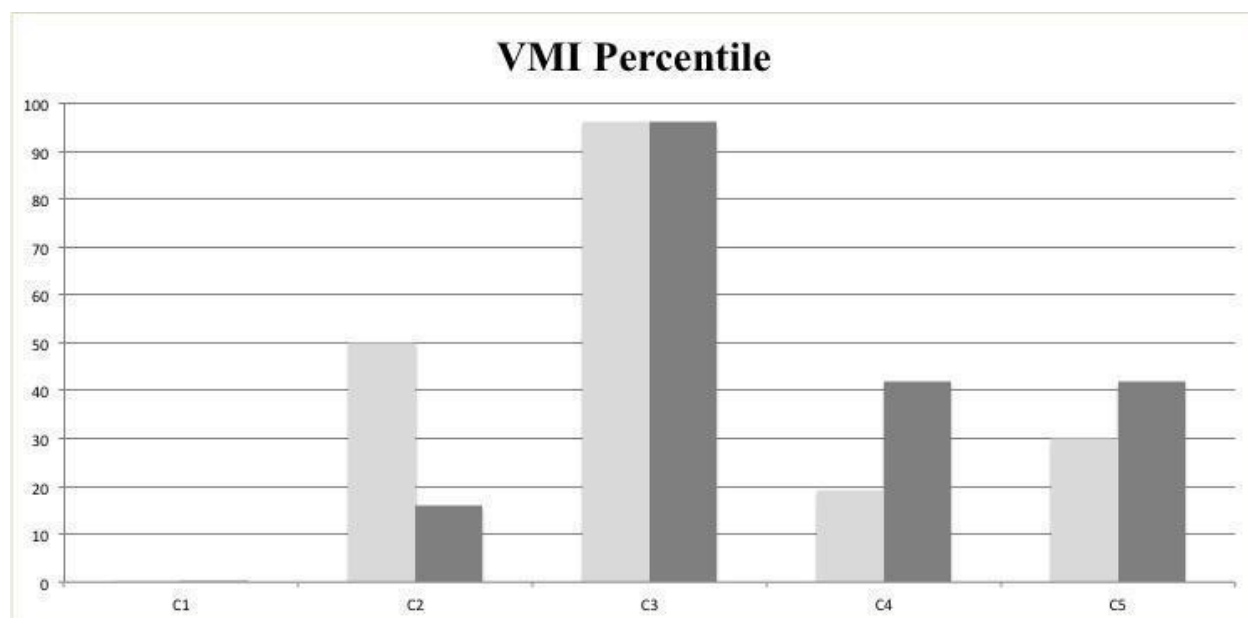
VMI Pre-test and Post-test Percentile

Figure 4. Pre-test is the lighter shaded bar and post-test is the darker shaded bar. C(#) = case and numbered ID. Higher score indicate increased function

Table 5

VMI Pre-test and Post-test

Subtest	Child									
	Child 1				Child 3		Child 4		Child 5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Percentiles	0.08	0.08	50	16	96	96	19	42	30	42
Descriptive							V			
Categories	VL	VL	A	BA	H	H	L	A	A	A

Note. VL = Very Low; A = Average; BA = Below Average; H = High

Analysis of Four Areas of Occupation

Child 1.

The OT observations mention self-regulation improvements such as initiation and increased ability to express needs indicating improved self-regulation and arousal. Additionally, Child 1 was able to play a board game independently and engage in a puzzle activity for 20 minutes, indicating increased attention. Improvements in attention were reaffirmed by the COPM. Improvements in potty training and sleeping activities indicated through qualitative data were indicative of improved ADL performance. Areas of social interaction changed, and verbal communication and confidence improved as well. Changes in these areas were also confirmed through the results on the COPM. In sensorimotor skills, the OT noted significant improvement in physical skills, balance, and fine motor skills. Additionally, the SPM indicated sensorimotor improvements such as sound sensitivity, hearing, and balance.

Child 2.

Self-regulation was not observed to increase or decrease for Child 2. The parent journals reported that the child increased his tactile tolerance particularly in regards to his clothing. This sensorimotor improvement reduced the number of times he changed his clothes and helped increase performance in ADLs. In the area of social interaction, the parent journal reported an increase in expressing humor as well as increased interacting with siblings. Child 2 was also described as being more “thoughtful” and “respectful” to his parents.

Child 3.

The parent journal indicated improvements in arousal and self-regulation by reporting that Child 3 became “peaceful” and looked “more relaxed” while listening to TL-Q, was able to go with the flow better, and had fewer “meltdowns.” Additionally, the OT reported Child 3 as

having lessened perseveration. Concerning ADLs, the parent journal noted he slept longer and more deeply, feeding improved by being able to communicate when he was hungry, and he was more compliant with routines. According to the SPM, he was assessed as improving in the area of social interaction. For the sensorimotor area, the OT observed him being more “connected” to his body, including more bodily awareness.

Child 4.

Demonstrating improved self-regulation and arousal, Child 4 was observed to be more relaxed in general after listening to TL-Q. ADLs were not addressed. For the area of social interaction, post-assessment of the COPM indicated no significant changes in emotional regulation, while review of the SPM indicated a slight increase in social participation and the child seemed more focused on the speaker during playtime. In terms of sensorimotor skills, results on the COPM indicated a slight improvement in Auditory Filtering and Motor Planning/Body Awareness, but with no changes in Tactile Defensiveness. The COMPS likewise revealed a slight increase in Rapid Forearm Rotation and Finger-Nose Touching, along with significant improvement in Prone Extension and ATNR. Minimal decreases in Slow Motion were also accompanied by a significant decrease in Supine Flexion for Child 4. Post-assessment results on the SPM indicated a decrease in Balance and Motion and significant decrease in Vision. Meanwhile, on the SPM, Hearing, Touch, Body Awareness, and Planning and Ideas slightly decreased.

Child 5.

In regards to self-regulation, the child showed improvement when meeting his COPM goal of decreased aggression towards the family dog. Parent journals report an improvement in sleep participation in addition to compliance with mealtime routines showing increased ADL performance. For social interaction, parents report an increase in Child 5’s prosocial verbal

expression as well as an increase in overt display of affection. Still, it should be noted that the OT observed a propensity to fight, inappropriate language use, and increased irritation during one therapy session.

Figure 5

Children's Progress in the Four Areas of Occupation

CASE	Child 1	Child 2	Child 3	Child 4	Child 5
Self-Regulation and Arousal	+ Initiation + Attention	N/A	+ Perseveration Arousal Rigidity	+ Focus +/- N/C in Regulation	+ Aggression
ADLs	+ Potty training + Sleep	+ Tolerates clothing	+ Sleep	N/A	+ Sleep + Feeding
Social Interaction	+ Verbal communication + Confidence + Expression	+ Appropriate Humor + Follows Directions + Decreased Meltdowns + Sibling & Peer Play	+ Reactive Behavior + Expression + Understanding others + Social participation	+ Social Participation	+ Expression + Affection + Social Participation
Sensorimotor Skills	+ Balance + Fine Motor + Body Schema + Sound Sensitivity + Hearing & Touch	+ Tactile Tolerance + Hearing Awareness + Motor + Visual Motor + Planning	+/- Body Awareness + Vision & Hearing + Balance & Motion N/C in Tactile Defensiveness - Supine Flexion	+ Auditory Filtering + Motor Planning + Rapid Forearm Rotation + Prone Extension + ATNR N/C in Tactile Defensiveness - Supine Flexion - Hearing & Touch - Balance & Body Awareness	+ Fine Motor + Hearing + Balance & Body Awareness + Planning + Visual Motor + Tactile Defensiveness

Figure. + = progress - = regression, N/A = not addressed, and N/C = no change.

Summary of Results.

Overall, results from the assessments and qualitative data such as parent journals were mixed but with a trend toward improved performance in the 4 areas. Self-regulation and arousal improved for each child, and performance levels for social interaction increased much more than they decreased. There were a few positive changes in ADL performance, while no negative observations were noted. Sensorimotor skills also largely improved more than they deteriorated.

Discussion

Child participants demonstrated improvements in behavior and occupational performance as seen through pre-test and post-test administrations, and confirmed by qualitative reports, following implementation of TL-Q. Improved sensory processing from this TL-Q intervention likely contributed to more successful performance in the four areas of occupation: (1) self-regulation and arousal, (2) ADLs, (3) social interaction and (4) sensorimotor skills. It should be noted that while assessment data revealed variable quantitative scores both positive and negative amongst five children, parent journals and therapist reports provided compelling support for functional improvements in all four areas.

For each child, results in the four areas were mixed but also demonstrated an upward trend toward improved performance. Mixed results may be explained by the concept that when experiencing treatment, the child may become more disorganized before demonstrating organized behavior (Gilfoyle, Grady & Moore, 1990). Self-regulation and arousal improved for every child, which could have further resulted in the observed positive changes in ADLs and social interaction. Similarly, improvements in sensorimotor skills may have positively impacted other performance areas as well. While there were many improvements in sensorimotor skills amongst the child participants, some also demonstrated regression. The varied results may be an

indication that the child experienced disorganization before reorganization, or regression before progression (Gilfoyle, Grady, & Moore, 1990). If the results of the study are supported by this notion, then future research may benefit from an extended length of study.

Scores on the COPM were more sensitive to change than other assessments. As an assessment, the COPM measures the most contextually appropriate goals because it adapts to clients on an individual level by addressing targeted areas. In this instance, other assessments could not demonstrate a comparable level of content validity.

Results of the SPM also indicated more positive and negative changes than other assessments. Negative changes could be attributed to different raters. For example, different parents completed the pre-test and post-test SPM home form on Child 4. Prior to TL-Q implementation, the researchers were optimistic about the SPM's ability to detect change due to Sheehy and Mandrussow's (2015) report that it had been sensitive to change. Still, significant changes in performance on some of the SPM subtests show encouraging results.

Parent journals throughout the study confirmed and provided additional insights into some of the quantitative changes. Parents stated that their children demonstrated improved interaction with peers, improved transitions, listening, and communication among other positive changes. Parents reported that their children looked forward to listening to TL-Q and understood that it helped them to self-regulate. According to one parent journal, one child demonstrated notable difficulties with completing the regimen due to a coinciding of toilet training schedule. One parent wrote, "My kid knows when he needs to do Therapeutic Listening® (TL). It has really helped him take control of his life." Another parent confided, "When listening to the music, he's very calm, sweet, talks about how much he loves me. Seems to be a very relaxing time for him." Meanwhile, therapist reports provided clinical insights into improved functioning

within the therapy environment. Qualitative measures such as these parent journals and therapist reports alongside the COPM yielded highly informative results. As a whole these results add a unique insight into how the children are functioning in daily life outside of more formal, structured experiments.

Practice-based evidence (PBE) is an appropriate solution to studying highly individualized interventions, where traditional RCTs cannot effectively capture results with such variable outcomes for different individuals. Studying TL-Q within the clinic allowed the researchers to study a realistic sample of participants who regularly use TL-Q and to track changes within a typical course of therapy. The framework used by the researchers is capable of capturing change in a variety of areas with quantitative assessments that can capture changes in many areas including (1) self-regulation and arousal, (2) ADLs, (3) social interaction, and (4) sensorimotor skills. It is reinforced with qualitative parent journals to provide insight into more subtle changes or bolster changes seen in quantitative data, or those not accounted for using quantitative measures. This framework can be easily applied in future practice-based studies because it is not unlike what is naturally occurring in clinics and uses assessments that are typically readily available to OTs in pediatric practice. It is the hope of the researchers that the practice-based framework will be applied and support more research future to support TL-Q.

The results of the present study are consistent with previous related studies. Hall and Case-Smith (2007) found that children with sensory processing disorders demonstrated significant improvements in visual-motor skills, attention, and sleep following the use of TL and a sensory diet. Similarly, this present study documents improvements in visual skills and attention. Bazyk, et al (2010) reported significant improvement for preschoolers in school performance following TL intervention. This study's parent journals revealed improved ability

to follow directions increased perseverance, fine motor skills, and handwriting skills.

The present study contributes to the knowledge base on TL research and helps to support its continued use of TL-Q in occupational therapy practice. One of the benefits of TL-Q seems to be its adaptability as an intervention for addressing behaviors and conditions by treating underlying sensory processing difficulties. Lastly, this study offers a framework for measuring results in a wide variety of performance areas that therapists can easily adopt into practice.

Limitations and Recommendations

One considerable limitation was the length of time of the study. Typically, the TL-Q program is provided on an average of 3 to 6 months, but this study was completed in eight weeks. Secondly, researchers were unable to closely monitor the implementation procedures completed at home by the parents. This created potential room for error, especially if there are inconsistencies in who reports the intervention. For example, for one child the mother completed the pre-test SPM while the father answered the post-test SPM. The study was conducted at the end of the school year and over the beginning of the summer vacation. This was a challenging time considering the many changes in schedules and the increase in extracurricular activities for the children. Third, TL-Q intervention was conducted at the same time as occupational therapy, which confounds whether changes assessed could be attributed to occupational therapy or to TL-Q. Fourth, the assessors were not blinded to pre-test and post-test administration. Lastly, the SPM and the COPM are both subjective measures and reflect a parent's interpretation of their child's performance. It is possible for parents to unknowingly altered their expectations for performance over the course of the two-month intervention period. Finally, results may not be generalizable to all populations of children with sensory processing difficulties due to the small sample size.

Further study is needed to examine the effects of TL-Q when used in conjunction with other occupational therapy interventions. Researchers have recommended using a similar study to this one, capitalizing on commonly used assessments as pre- and post-test measures in conjunction with parent journals. As much as possible, the study implementation should be conducted in a single, consistent setting such that researchers can control the consistency and accuracy of the therapeutic program. Finally, future studies should be conducted during the school year when there are fewer changes in the school's or family's schedules.

Conclusion

The researchers examined the efficacy of TL-Q intervention in children referred to occupational therapy for improving function in (1) self-regulation and arousal, (2) ADLs, (3) social interactions, and (4) sensorimotor skills as measured by the COPM, VMI, COMPS, and SPM in conjunction with parent journals.

Our positive findings support the use of TL-Q as part of an overall sensory integrative approach and to address sensory process difficulties in order improve function during performance of numerous occupations. Change may be captured in a variety of practice areas when operating from a PBE framework, because practice-based studies are generally representative of events occurring in clinics. Additionally, practice-based methodology employs the use of assessments that are typically available to OTs in pediatric practice, and it is the hope of the researchers that this framework will be applied in future research to further support the use of TL-Q intervention. Potential benefits of the study include improved performances in the four areas. Furthermore, we hope to have contributed to the current literature on TL, TL-Q, and auditory-based interventions as a whole, in addition to providing support for occupational therapists utilizing a SI approach. TL-Q is an enjoyable therapy that has shown positive effects

with few drawbacks. It is our hope that children and families who participated in TL-Q have benefited from the effect of TL.

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Appendix A

Agency and Parental Consent Forms

DOMINICAN UNIVERSITY of CALIFORNIA LETTER OF PERMISSION TO AGENCY DIRECTORS

Sheila Frick
Therapeutic Resources
6613 Seybold Road, East
Madison, WI 53719

Dear Ms. Frick:

This letter confirms that you have been provided with a brief description of our graduate thesis research study, in which you are an active collaborator. The study concerns the effects of Therapeutic Listening - Quickshifts (TL-Q) program on the functional behavior of children with autism. This letter also confirms that you give your consent for us to use the pre-test and post-test data obtained through your clinic. This study is an important part of our graduate requirements as occupational therapy students, and is being supervised by Dr. Julia Wilbarger, Associate Professor of Occupational Therapy at Dominican University of California.

As we discussed, I will make every effort to ensure that your clients' information is treated with the utmost discretion and sensitivity. If you have questions about the research, you may contact Shannon Preto as the study correspondent at the phone number or university email address below. If you have further concerns you may contact our faculty advisor, Dr. Julia Wilbarger, at (415) 257-0125 or the Institutional Review Board for the Protection of Human Participants at Dominican University of California by calling (415) 482-3547.

After my research study has been completed in December 2016, I will be glad to send you a summary of my research results.

If our request meets your approval, please sign and date this letter below and return it to us in the enclosed, self-addressed, stamped envelope as soon as possible. Please feel free to contact us if you have any questions about this study .

Thank you very much for your time and cooperation.

Sincerely,

Shannon Preto, Bryant Luong, and Ann Malloy

Email address: shannon.preto@students.dominican.edu Phone:

I agree with the above request _____

Signature _____ Date _____

DOMINICAN UNIVERSITY of CALIFORNIA

PROXY CONSENT FOR RESEARCH PARTICIPATION

Purpose and Background

Bryant Luong, Ann Malloy, and Shannon Preto, graduate students, and Dr. Julia Wilbarger, Associate Professor of the Department of Occupational Therapy at Dominican University of California, are conducting a study on the efficacy of Therapeutic Listening® - Quickshifts (TL-Q) for children with autism spectrum disorder as measured by the Functional Listening Questionnaire (FLQ), Canadian Occupational Performance Measure (COPM), and the Sensory Processing Measure (SPM). Anecdotally, the TL-Q modality has produced consistent positive results for therapists and clients alike. Therefore, it becomes imperative to produce evidence supporting its usage, which may lead to its broader implementation. We expect to find that children's functioning will improve after using TL-Q in conjunction with specific therapeutic goals in the domains of school performance, self regulation and arousal, ADLs, social/emotional skills, and sensorimotor skills. A select group of children with autism will engage in TL-Q interventions for eight weeks. Parents, teachers, and therapists will use pre-test and post-test assessments to collect relevant data. The study will be conducted in collaboration with Therapeutic Resources and Integrated Development Services (IDS) in Madison, WI.

My child is being asked to participate because s/he fits the inclusion criteria and may benefit from TL.

Procedures

If I agree to allow my child to participate in this study, the following will happen:

1. I will participate in an interview to complete one questionnaire concerning my child's development and functionality.
2. My child's direct service provider(s) will complete one assessment regarding the child's performance in their school aged clinic setting.
3. My child will participate in his/her therapy sessions as usual, which will include TL-Q under the administration of highly trained occupational therapists.
4. I will complete the post-intervention home assessment concerning my child's development and functionality.
5. My child's direct service provider(s) will complete one post-intervention assessment regarding the child's performance in school.

Risks and/or Discomforts

Potential risks to participants are minimal. One potential risk may be discomfort from the volume of the music. Another potential risk may be the child becomes disorganized or distressed after listening to the music.

Benefits

The parents may benefit in the form of their child receiving therapy from the Therapeutic Listening - Quickshifts program. The child will benefit from receiving therapy.

Costs/Financial Considerations

The cost of participating in this study is the time needed to complete the assessments.

Payment/Reimbursement

Neither my child nor I will be reimbursed for participation in this study.

Questions

Questions about this research study should be directed to the primary coordinator, SHANNON PRETO, or his faculty advisor, JULIA WILBARGER. The primary coordinator can be reached at shannon.preto@students.dominican.edu, and his advisor at julia.wilbarger@dominican.edu. Questions about your rights as a research participant should be directed to June Caminiti in the DUC Institutional Review Board Office by phone: 415-482-3547 or by email at june.caminiti@dominican.edu.

Consent

I have been given a copy of this consent form, signed and dated, to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline having my child participate in this study, or to withdraw my child from it at any point. My decision as to whether or not to have my child participate in this study will have no influence on my child's present or future status as a recipient of occupational therapy services or IDS services.

My signature below indicates that I agree to allow my child to participate in this study.

Signature of Participant's Parent/Guardian

Date

Signature of Person Obtaining Consent

Date

Appendix B

IRB application

DOMINICAN UNIVERSITY OF CALIFORNIA

INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN PARTICIPANTS

INITIAL APPLICATION

All information must be typed and submitted electronically to June Caminiti (june.caminiti@dominican.edu). Handwritten applications will be returned to researcher. A signature page must accompany all applications. Numbers in parentheses refer to explanatory sections in the IRBPHP Handbook. Please use these as a guide in providing the requested information.

APPLICANT INFORMATION (8.1)

Name: Shannon Preto

Date: 11/04/2015

School: Dominican University of California

Department: Department of Occupational Therapy

Campus or Local Address: 50 Acacia Ave. San Rafael, CA 94901

Home Address:

(Note: If different from campus/local address please provide home address for contact during periods when you may not be living on campus or locally)

Local Phone:

Work Phone:

E-mail Address: shannon.preto@students.dominican.edu

(Note: All communication regarding your application will be by email so be sure you include a functional email address)

Name(s) of Co- Investigator(s): Bryant Luong & Ann Malloy from Dominican University, Occupational Therapy Program. Sheila Frick, Tracy Bjorling and Jennifer Espinoza-Forlenza from Therapeutic Resources, Madison Wisconsin.

FACULTY ADVISOR INFORMATION: (8.2)

Name: Julia Wilbarger

Campus Phone:

E-mail Address: julia.wilbarger@dominican.edu

Note: All communication regarding a student's application will be by email. Advisers will be copied on all correspondence so be sure to provide a functional email address.

RESEARCH PROJECT INFORMATION: (8.3)

Exact Title of Study: Efficacy of Therapeutic Listening on Children with Autism

Duration of Study (cannot exceed 1 year): 1 year

Category of Review:

☐ Exempt (5.3.1)

☐ Expedited (5.3.2)

☒ Full Board Review (5.3.3)

Background and Rationale

Children with autism are frequently referred to occupational therapy. Depending on the clinic, the child may be treated from a sensory integrative theoretical framework, which often includes Therapeutic Listening® - Quickshifts (TL-Q) as an adjunct to more traditional in-clinic only treatment. However, few empirical studies have been conducted to provide evidence for TL-Q effectiveness. Anecdotally, the TL-Q modality has produced consistent positive results for therapists and clients alike. Therefore, it is imperative to produce evidence supporting TL-Q's efficacy, which may lead to its broader implementation.

The study is in collaboration with Therapeutic Resources and Integrated Development Services (IDS) in Madison, WI. A select group of children with autism who currently receive services at IDS will participate in TL-Q intervention for eight weeks. Licensed occupational therapists with expertise in the use of TL-Q employed at Therapeutic Resources will collect background information and pre-test and post-test data from parents and direct service providers at IDS. The same occupational therapists will administer and monitor the TL-Q interventions. Assessments include the Canadian Occupational Performance Measurement (COPM) and the Sensory Processing Measure (SPM), the Functional Listening Questionnaire (FLQ), and Ayres' clinical observations. Following pre-test assessment, children will receive 8 weeks of twice daily TL-Q intervention. We expect to find that children's functioning will improve in

relationship to their individualized performance goals specifically in the domains of self-regulation and arousal, ADLs, social/emotional skills, and sensorimotor skills.

Description of Sample: (*check the boxes that pertain to your sample*) (8.5)

- ☐ Patients as participants
- X - Non-patient volunteers
- X - Students as participants
- X - Minor participants (less than 18 years)
- ☐ Participants whose major language is not English (Note: include copies of translated documents)
- ☐ Mentally disabled patients
- ☐ Prisoners, parolees or incarcerated participants
- X - Other vulnerable or sensitive populations
- Please identify:* Elementary school children with autism spectrum disorder
- X - Participants studied at non-Dominican locations
- ☐ Filming, video or voice recording of participants
- ☐ Data banks, data archives and/or registration records
- ☐ There is a dual relationship between researcher and participant (explain):

Participants include between twelve to twenty children between the ages of 5-12 years old, and who have been diagnosed with autism. Parents and direct service providers will also participate by completing with pre-test and post-test questionnaires.

Recruitment Procedure:

Clients will be recruited from Integrated Development Services (IDS), an in-home and in-clinic based provider of autism treatment services. Therapeutic Resources will provide an information session for all interested parents of children receiving services at IDS. All children who meet the inclusion criteria will be invited to participate. The inclusion criteria consists of individuals ranging from 5 - 12 years of age, regular attendance at IDS program, and documentation of an autism spectrum disorder diagnosis. The exclusion criteria will include children who have previous experience with using the TL-Q program, or are diagnosed with uncontrolled seizure disorders, cerebral palsy, muscular dystrophy, or other neurological and musculoskeletal disorders not related to autism spectrum disorder.

Subject Consent Process:

See Appendix A for the Parent Consent Form. Agency consent form will be submitted in a following document.

Occupational therapists from Therapeutic Resources will distribute and collect parent and agency consent forms. Therapeutic Resources therapists will then send a scanned images of the signed forms through a secured Dominican University email.

Procedures:

Consent will be obtained from all parents. The parents will complete a background questionnaire and two assessments. The children will participate in Ayres Clinical Observations

(of motor and postural skills). Children between the ages of 5-12 years old and who have been diagnosed with autism will participate in TL-Q intervention either during their in-clinic skills-based activities and interventions or at home or both twice per day for eight weeks. Parents will complete the two assessments again at the end of the eight weeks.

Licensed occupational therapists with expertise in the use of TL-Q employed at Therapeutic Resources will collect background information and pre-test and post-test data from parents. Background and pre-test measures will be used to establish a baseline and develop goals. The primary background information tool will be the Functional Listening Questionnaire (FLQ). The Occupational Performance Measurement (COPM), the Sensory Processing Measure (SPM), and Ayres' Clinical Observation will be administered before and after the intervention period. In addition to formal pre-test and post-test measures, parents and direct service providers will be asked to complete a weekly journal on the child's behavior (see appendix B).

The FLQ is a client-centered questionnaire that aims to examine an individual's developmental and sensory motor history, and subsequent impact on function in a variety of areas of daily life. It is to be completed by parents or caregivers and is used as an initial evaluation tool to help the therapist identify areas of current difficulties and develop client centered goals. It requires about 15 minutes to complete.

The COPM is a Likert scale questionnaire designed to measure the quality of functional skills and will be completed by the therapist and parent(s) during a semi-structured interview. The outcome of the COPM is to involve the client and their family in identifying key areas of difficulty impacting their overall performance in activities of daily living. Once a list of performance area objectives are identified, the objectives are then rated on a 10 point scale of satisfaction with current performance. Objectives will be developed in each of the following areas: school performance, self-regulation and arousal, ADLs, social/emotional skills, and sensorimotor skills. The COPM requires up to 30 minutes to complete. The validity of the COPM has shown to be consistent in psychometric testing on convergent, discriminant, construct, concurrent, and criterion validity (Law, M., Baptiste, S., Carswell, A., McColl, M.A., Polatajko, H., & Pollock, N., 2014).

The SPM is a parent and teacher Likert rating scale of the child's response to everyday sensation in the home and school environments. The behaviors are an indicator of the child's responses to sensory stimuli and processing of touch, hearing, body awareness, balance and movement, planning of movement, and participation in social interaction. The SPM requires about 15 minutes to complete and can be completed in a location and time of the parent and teacher's choice. The SPM has established strong reliability and validity (Parham & Ecker, 2015).

Clinical Observations of Motor and Postural Skills (COMPS) is a norm-referenced assessment of motor and postural skills. The assessment consists of a series of brief motor challenges such as touching nose with eyes closed, rapid forearm rotation, and postural strength. The observations are included to validate the parent's observation of general movement abilities, and how they translate to performance in daily activities. The assessment requires about 15 minutes to administer.

Following treatment, the COPM, SPM and COMPS will be completed again as a post-test to identify possible changes in occupational performance. The same procedure applies, with the COPM being completed by parents and therapist during a 30 minutes interview. The SPM will be completed by the parents and requiring an additional around 15 minutes.

The setting of the study will be at IDS, an in-clinic and in-home based environment, specifically geared toward children with autism. All parents with a child attending IDS who meet the inclusion criteria will receive an invitation to participate. The consent form clearly outlines that participation in this study is voluntary, and services currently being received will in no way be affected should they choose to not participate.

During the eight week intervention period, participants will listen two times per day to one of several TL-Qs over high quality headphones.. An occupational therapist with advanced training in the use of Therapeutic Listening will select the music tracks to meet each specific child's needs. The Therapeutic Listening® program (Vital Sounds, LLC, 2006) is designed to improve a variety skill sets. This sound-based intervention uses an individually selected and sequenced series of electronically modified music albums and specialized headphones to trigger the self-organizing capacities of the nervous system. The musical styles vary amongst albums. The Quickshift music is modified using brainwave entrainment, binaural beat technology and is intended to improve communication between both hemispheres of the brain and promote a calm alert brain state. Music selections may including classical, pop or children's music or specifically selected nature sounds.

The total implementation of the study will be eight weeks following the pre-test measures. During the eight weeks of therapeutic intervention, children will listen to several TL-Quickshifts albums. The individual TL-Q album may change as frequently as every week or at least every two weeks based on the clinical judgement of the OT. Music selection and clinical reason for the music choice will be tracked.

See Appendix B for copies of the FLQ, COPM, SPM, COMPS, and weekly journal as well as copyright permissions associated with each document. Dominican University of California occupational therapy department purchased the copyright for the COPM from the publisher.

Potential Risks to Participants:

Potential risks to participants are minimal. One potential risk may be that the child becomes disorganized, or distressed, after listening to the modified music.

Minimization of Potential Risk:

The Therapeutic Listening-Quickshifts program will be conducted by a trained occupational therapist. The volume of the music will be played at a comfortable listening level thus minimizing the risk for discomfort due to music volume. When the child is listening, if they have to raise their voice to talk then the music is too loud and should be turned down. To guard against the child becoming disorganized or distressed, the therapist will be carefully and continuously monitor the child and, at the first sign, will intervene and modify the intervention. If the family or the direct service provider becomes concerned with an unusual behavior they will be able to contact the therapist immediately to consult on the music selection.

Potential Benefits to Participants:

There are no direct benefits from participating in this study. The children may benefit from the Therapeutic Listening - Quickshifts program or receiving extra attention.

Costs to the Participants:

Minimal costs incurred by the students may include minimal energy expenditure as well as time spent engaged in the TL program. The cost to the parents includes the time needed to complete the assessments and questionnaires. The costs to the teacher(s) includes the time needed to complete the assessment.

Reimbursement or Compensation to Participants:

No monetary compensation will be received for participating in this study.

Confidentiality of Records: (8.14)

X - Data will be Confidential

All participants will be assigned a number. The list of the names and the corresponding subject numbers will be kept in a separate location from the other raw and electronic data. The hard copies of the contact form will be stored in a locked cabinet in the faculty advisor's office on the Dominican University of California campus. The list of the names and the corresponding subject numbers be also be stored electronically on the computer of the faculty advisor. Again, this information will be stored in a unique folder, separate from the raw data. Only members of the research team will have access.

Data collected in Madison, WI will be stored in a locked cabinet at Therapeutic Resources. Data and consent forms will be scanned and sent via a secure email from Therapeutic Resources to the faculty advisor.