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Measuring The Outcomes of Therapeutic Listening in Children with Learning and Developmental Disabilities

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Measuring the Outcomes of Therapeutic Listening[®] in Children
with Learning and Developmental Disabilities

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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 2018

Signature Page

This thesis, written under the direction of the candidates' thesis advisor, 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

Anecdotal accounts of the Therapeutic Listening[®]-Quickshifts (TL-Q) technique report positive effects on behavior but the individualized approach requires further supporting evidence. TL-Q is an individualized sound-based intervention used to facilitate sensory processing skills and is believed to improve interpersonal, social, and cognitive skills (Frick & Hacker, 2001). This study examines the use of a standardized protocol to measure the specific outcomes of the TL-Q program using a practice-based evidence (PBE) approach for the purpose of aggregating data for clinical practice. The protocol was used to measure the outcomes of the TL-Q program in a convenience sample of 23 children, ages 3-12, with learning and developmental disabilities, including sensory processing dysfunction. The protocol was applied in a multi-center, multiple case study design, evaluating changes in sensorimotor skills, self-regulation, maladaptive behavior and activities of daily living (ADLs.) The protocol consisted of pre-test, post-test clinical assessments and semi-structured interviews including the COPM, SPM, VMI, PDMS-2, BOT-2, and a modified Clinical Observation tool. The protocol was applied over a twelve-week period and was implemented in the child's home setting in congruence with standard prescribed occupational therapy treatment. Significant improvement was seen in individualized goals and developmental posture skills. The outcomes generated from this study support the use of TL-Q in occupational therapy practice. The COPM was a valuable tool for measuring outcomes of TL-Q, suggesting that the assessment may be beneficial to implement in pediatric practice settings.

Literature Review

Music and sound are being used within a sensory integration (SI) framework to elicit positive change in children's behavior and function worldwide. Sound-based therapy (SBT) was first introduced by Dr. Alfred Tomatis, an otorhinolaryngologist, to address a variety of auditory concerns in his clients. His findings suggested that the ear plays a significant role in sensory processing and overall organization of the nervous system (Frick & Hacker, 2001). Several SBTs, which focus on the brain's ability to rewire neural pathways, have emerged from Tomatis' initial approach (Gee, Thompson & St. John, 2014). Inspired by the Tomatis Method and embedded in the sensory integration framework, Therapeutic Listening[®] (TL) is an SBT that uses electronically-altered music to improve self-regulation, sensory processing, attention, communication skills and overall occupational participation (Frick & Hacker, 2001). Many occupational therapists use SBTs, such as TL, based on the theory of sound waves retraining neural pathways for improved function (Gee et. al, 2014). The majority of research on SBTs involves qualitative or single case studies, anecdotal evidence and quasi-experimental designs to evaluate the success of these types of interventions. Studies have shown that children receiving sensory integration interventions may respond positively to SBTs, however, the supporting clinical findings provide minimal evidence to establish their effectiveness.

A true experimental design with clinical trials may not be practical, nor fully-representative of the effectiveness of TL or other SBTs due to the small populations with access to the programs, heterogeneity of clients, and the individualized nature of the intervention. Therefore, a practice-based evidence (PBE) approach may be more appropriate to represent the benefits of TL in clinical practice. Established in real-world settings, PBE is documented, measured, and reviewed within standard clinical practice, thus providing high-quality evidence

that can be generalized to larger populations as a basis for future practice (McDonald & Viehbeck, 2007).

The current study focuses on the Therapeutic Listening[®]-Quickshifts (TL-Q) program, a subset of the more widely recognized Therapeutic Listening[®] program, designed and developed by occupational therapist, Sheila Frick. The results from a previous study implemented by researchers from Dominican University of California indicated overall improvement for children with sensory processing difficulties in four identified domains (Luong, Malloy, & Preto, 2017). The domains included: activities of daily living (ADLs), social interaction, sensorimotor skills, and self-regulation. After considering the effects evaluated by Luong, Malloy, & Preto, the researchers of the current study have narrowed the intervention protocol and broadened the eligible population. The current study aims to specifically evaluate and discuss the effects of the TL-Q program, and to define a standardized protocol for gathering data supporting TL-Q productivity using a PBE approach.

Sound-Based Therapy

Sound-based therapies have shown positive results by decreasing sensory defensiveness and increasing self-regulation in children worldwide (De Vries, Beck, Stacey, Winslow, & Meines, 2015). Sound-based therapies use an individual's auditory processes to promote listening with the whole body to facilitate change in functional performance and/or behavior. SBTs are commonly used simultaneously with other sensory integration approaches during practice or as a home program (Gee, Thomsen, St. John, 2014). Tomatis' theory of sound therapy led to the development of several SBTs, including the Tomatis Method (TM), Auditory Integration Training (AIT), Integrated Listening Systems (iLs), The Listening Program (TLP), and Therapeutic Listening[®]. Each of these SBTs involves listening to psychoacoustically

modified music, but each are distinct in how the music is modified, the type of music, the number and duration of treatment sessions, and the method of delivery (Gee, Thomsen, & St. John, 2014). In some research studies, the results indicate behavioral changes but do not specifically correlate the relationship between those changes and sound-based therapy (Corbett, Shickman, & Ferrer, 2007). The evidence collected for each of these methods is also limited given the nature of the individualized treatment plans and qualitative format of the research.

The benefits of music as therapy include an increase in appropriate behaviors and decrease in maladaptive behaviors. Through a systematic review, De Vries, Beck, Stacey, Winslow, and Meines (2015) examined outcomes of music as a therapeutic intervention for children who have autism spectrum disorders and found the intervention to be beneficial and productive. The studies in the systematic review included both music used as a supplement to the therapy process as well as specific SBT interventions. The effects of SBTs were measured on sensitivity levels, behavior, and stages of learning. According to De Vries et al. (2015), sound-based therapies have been supported by a multitude of outcomes including enhanced awareness, improvement in interpersonal skills and social behavior, enhanced body awareness, self-care, and reduced anxiety. While the research demonstrates a relationship between SBTs and improvement in performance, further evidence is necessary to establish causation.

Therapeutic Listening[®]

Therapeutic Listening[®] is believed to be an effective intervention for many diagnoses with sensory-processing dysfunction, however, few studies have been able to consistently verify the benefits of this intervention. A considerable amount of research has focused on developing interventions for children with sensory-processing dysfunctions, such as autism spectrum disorder, attention deficit/hyperactivity disorder, sensory-processing disorders, learning disorders

and developmental disabilities. According to Frick and Hacker (2001), TL is a novel intervention believed to improve sensory-processing, social, and cognitive skills, yet confirming this claim will require gathering significant research to support.

TL is typically implemented for 30 minute-sessions twice daily as part of a home program or with or without direct intervention. Although practitioner directed, parents implement TL at home, in comparison to many SBTs, which are administered by trained clinicians in practice settings (Frick & Hacker, 2001). When implemented at home, the child listens to the music using specialized headphones and is not limited in what activities can be completed simultaneously. The program uses an individualized listening protocol to integrate sensory processing skills in children and facilitate occupational participation. Treatment is typically implemented for an average of three to six months (Frick & Hacker, 2001)

Therapeutic Listening[®]-Quickshifts (TL-Q) uses electronic modifications, along with the organized, rhythmical sound patterns in music, to stimulate neuroplasticity within the nervous system (Frick & Hacker, 2001). The modifications slightly alter the frequency coming through each headphone, which causes the brain to create and register a balanced new frequency, known as the binaural beat. The Quickshifts technique uses binaural beat technology to increase alpha brainwave activity in order to quickly shift alertness and set up the nervous system for optimal success (Vital Links, 2016). The program is intended to improve communication between both hemispheres of the brain to promote inter-hemispheric collaboration and produce a calm, alert state (Vital Links, 2015). The effect of the therapy is designed to cause a quick shift in the brain to promote focus and attention before working or to calm and organize the brain after a stressful event.

In a randomized controlled study, Wahbeh, Calabrese, Zwickey and Zajdel (2007) found that binaural beats stimulated a certain set of brain waves measured by an electroencephalogram (EEG) machine. The researchers concluded that this technology had the potential to externally affect the state of the brain. Binaural beat technology emphasizes the use of inter-hemispheric integration to organize the brain's ability to focus and attend to the current environment (Wahbeh, Calabrese, Zwickey, & Zajdel, 2007). Research is growing in support of the influence of the electronically modified binaural beats on social and learning behaviors including improved social communication, cognition, vigilance, memory, and reduced levels of anxiety. An increase in empirical research, rather than anecdotal evidence, is needed on the actual implications of binaural beats and SBTs on the reduction of negative behaviors related to social skills and learning processes (Vernon, Peryer, Louch, & Shaw, 2014).

Supportive evidence for Therapeutic Listening[®].

The limited research on Therapeutic Listening[®] studies the effects of the intervention on several different diagnoses and in multiple settings. Hall and Case-Smith (2007) evaluated the effects of the TL program, not exclusive to the Quickshifts technique, on children with sensory processing disorders and visual motor delays. The controlled trial implemented the TL program in conjunction with the children's sensory diet intervention protocol (Hall & Case-Smith, 2007). The children received four weeks of a traditional sensory diet intervention before receiving eight additional weeks of TL in combination with the sensory diet. Sensory diet interventions included specific activities such as massage, rocking, and chewing gum (Hall & Case-Smith, 2007). Each TL program contained specific CDs and an individualized daily schedule, which the families implemented. The music on the CDs was modified to process music through alternating high and

low frequencies and the CDs were rotated every three weeks to prevent habituation (Hall & Case-Smith, 2007).

The Hall and Case-Smith study (2007) used four standardized assessments at baseline and post-test to measure sensory responsiveness and visual–motor improvement: the Sensory Profile, the Draw-A-Person test (DAP), the Beery-Bukentica Developmental Test of Visual Motor Integration (VMI), and the Evaluation Tool of Children’s Handwriting (ETCH). Parents were asked to keep a listening log during treatment to document the frequency of the home program as well as any changes in the targeted behaviors (Hall & Case-Smith, 2007). At the conclusion of the study, the children showed improvement in auditory, tactile, and multisensory processing as well as emotional regulation and behavioral outcomes as indicated by the scoring on the Sensory Profile. The results of the VMI for the visual subscale revealed significant improvement through the combination of sensory diets and TL. The ETCH findings revealed that TL interventions correlated with improvements in lowercase letters, numbers and overall legibility in terms of handwriting (Hall & Case-Smith, 2007).

In addition to the Hall and Case-Smith study, Bazyk, Cimino, Hayes, Goodman, and Farrell (2010) used a single-subject research design to study TL program in support of traditional occupational therapy for a population of children with developmental disabilities. The research found accelerated rates of development in social skills, fine motor, visual-motor, gross motor, verbal and nonverbal communication following the implementation of TL. The heterogeneous sample of preschool children initially listened to modulated music with progression to Samonas CDs, which deliver higher frequencies to stimulate brain activity (Bazyk et al., 2010). The children’s teachers collected data on the duration of the listening sessions, the CDs used, and kept observation logs, which the OTs used to monitor the children’s responsiveness. The results

demonstrated improvement for every child, except one, in at least two of the five areas including: fine-motor, language, visual-motor, social, and sensory processing (Bazyk et al., 2010).

Abbott (2011) completed a study focused on the effects of TL in children with ASD and explored the outcomes of social and emotional goals for children and their parents. The single-subject research design evaluated the progress of three preschool-aged children over the course of a 16-week TL program. TL was implemented for the duration of the study and parents kept a journal focused on any changes toward identified goals as well as parent stress levels (Abbott, 2011). The study found improvement in each of the participant's goals specifically related to social behavior and communication. Although improvements were recognized, the causal relationship with the TL program could not be objectively identified (Abbott, 2011).

Using a phenomenological approach, Wink, McKeown and Casey (2017) discussed parents' perspectives on using a TL home program with children diagnosed with sensory processing disorders. The study identified parental concerns of behavior prior to using TL, goals for the program, associated behavioral changes with the program, and asked parents to define the practical implementation of the TL at home (Wink, McKeown, & Casey, 2017). The study used purposive sampling to recruit ten families who completed a thirty-minute systematic interview in a community-based pediatric OT clinic in England (Wink, McKeown, & Casey, 2017).

Findings pointed to perceived improvements in at least one aspect of the child's self-regulation skills, including increased emotional regulation, improved task perseverance, and reduced aggressive, anxiety-related behaviors. Parents reported consistent, positive changes in sleep and improved tolerance for gross motor play associated with reduced anxiety after implementing the TL program. Reports also reflected that TL brought a sense of calm, decreased tantrum-like behavior, and changed the child's demeanor, which improved the child's

participation in social opportunities, family life, and daily activities. The feasibility and practicality of the home program enabled high parent engagement (Wink, McKeown, & Casey, 2017). Despite music and duration being prescribed by the therapist, the TL therapy provided parents with the jurisdiction to use a problem-solving approach to choose when the child listened to the music, what the child did while listening, and the therapy also provided opportunities for child collaboration through different parental strategies (Wink, McKeown, & Casey, 2017). The program allowed parents to consider their unique knowledge of their child's preferences and motivators to enhance a routine for cooperation that was practical within the child's daily schedule. Parents identified an improvement in family life with the convenient implementation of the TL home program (Wink, McKeown, & Casey, 2017).

Overall, research suggests the outcomes of Therapeutic Listening[®] have powerful implications as a supplement to traditional occupational therapy, as well as the potential to be a stand-alone intervention for certain populations and diagnoses. Sensory processing, attention and arousal, and emotional regulation are all identified concerns for children who have learning or developmental disabilities. Interventions recommended to address these concerns are often included within a multitude of therapy protocols, as in the Hall and Case-Smith study (2007) where children with sensory processing disorders (SPD) were introduced to TL in addition to continued OT. Children with autism often have auditory difficulties including auditory defensiveness or low auditory discrimination. Abbott (2011) suggested that these children might use different parts of their brain to process sound, which may result in challenges with social communication. The published studies, which identify the positive outcomes of TL, provide support to continue interventions using the TL program for children with learning and developmental disabilities. The studies have implications for improvement through the TL-Q

intervention, however, the evidence is not strong enough to confirm these findings in the current research.

Appraisal of Current Research

Few studies have been able to consistently document the effectiveness of the SBT intervention. Research has demonstrated that binaural beat technology in electronically modified music can impact social and learning behaviors including: social communication, cognition, vigilance, memory, and reduced anxiety. As the gap in research for SBTs remains, studies aiming to evaluate the effectiveness of SBTs must be conducted to provide supporting evidence for the use of the SBT as an intervention. A PBE protocol is recognized as an option to appropriately measure the benefits of Therapeutic Listening[®]-Quickshifts in clinical practice to bridge the gap in SBT research.

Controlled-trial research may not thoroughly reflect the effectiveness of TL due to the small population sizes, heterogeneity of participants, and the individualized nature of the therapy, thus hindering generalization of the intervention to larger populations (Gee, Thomsen, & St. John, 2014). Further, clarification of how to choose a specific method of sound therapy has not yet been identified for clinical use. TL used as a therapeutic intervention requires improved support for reliability during implementation and further research to verify the benefits. The evidence for TL is currently a collection of shared anecdotal experiences from skilled practitioners and a handful of single-case study and quasi-experimental studies. Given the individualized nature of the intervention, the most natural results may come from a practice-based evidence approach to gathering data.

The nature of the PBE approach allows practitioners to apply traditional practice methods to identify and measure specific interventions generated in real-time, and thus collecting high-

quality data for clinical intervention. The PBE framework allows therapists to maintain standard clinical practices while implementing the method in question, thus providing rich, natural evidence of the therapeutic process as it occurs within the clinic setting. The PBE framework allows for a natural setting in which the individual is most likely to display symptoms or evidence worth measuring for data gathering purposes.

Summary and Conclusions

Various SBTs, such as TL, can be effective in increasing positive outcomes and reducing the negative behaviors associated with ASD, sensory processing disorders, learning disorders and developmental disabilities. However, the current demand for evidence-based practice requires further analysis of TL outcomes in order to adequately support the use of this individualized intervention in OT practice. Furthermore, the current body of research does not include generalizable evidence for a larger population. Practice-based evidence may be the key to providing evidence for the effectiveness of SBTs, especially TL. Research can be analyzed and generalized through PBE in a standardized way to identify the impact of TL with larger sample sizes. The purpose of the present study is to refine a protocol for documenting and measuring clinical change in clients who receive TL as part of the intervention process. A protocol will establish standards for data aggregation to encompass the unique therapy program and provide standardization for the effective implementation of TL. The development and application of this protocol may lead to increased use of TL by practitioners worldwide once a standardized method of data collection and measurement tools for outcomes are established.

Statement of Purpose

Sound-based therapies are frequently used by occupational therapists but there is minimal evidence that currently measures the outcomes of these interventions consistently. Studies have

shown that TL can increase personal and interpersonal skills for an individual including sensory processing skills, visual motor integration, and emotional regulation. The demand for evidence-based practice requires an increase in the analysis of TL outcomes to establish TL as an effective intervention. Randomized controlled trials may not be fully representative of TL productivity, due to the individualized nature of this SBT. Therefore, a practice-based evidence approach (PBE) may be more appropriate for measuring the outcomes of TL. PBE collects real-world data in real-world time and then synthesizes the results into guidelines for practice (Swisher, 2010).

This study attempts to answer the following question: Is Therapeutic Listening®-Quickshifts an effective intervention for children with learning and developmental disabilities? A simultaneous inquiry is: How can a TL-Q documentation protocol be standardized to promote a foundation of practice-based evidence? The protocol for collecting data is intended to evaluate any changes in sensorimotor skills, social and emotional skills, self-regulation and arousal, maladaptive behaviors, and ADLs in a convenience sample of children with learning and developmental disabilities, including sensory-processing dysfunction through a PBE approach. The protocol established in this study consists of clinical assessments along with continued traditional OT intervention implemented by the licensed occupational therapists administering the TL-Q program. The researchers hypothesized that this group of assessment tools were feasible for all licensed OTs participating, given that most therapists already have access to these tools in their clinics for standard practice. The protocol was designed to establish an effective method to support the continued aggregation of practice-based evidence for TL-Q to be implemented by clinicians worldwide.

Theoretical Framework

Practice-Based Evidence

The scope of PBE requires incorporating clinical practice within the considerations of cultural context through the process of providing expert evaluation, assessment, and intervention. PBE is a novel approach for enhancing collaboration between researchers and practitioners by representing a range of treatment services that are accessible, culturally acceptable, and shown to be effective among families and providers (McDonald & Viehbeck, 2007). The use of PBE allows for inclusion of diverse range of clients and populations while also analyzing the homogenous factors among them. The PBE approach contrasts the cause-and-effect model of traditional research protocols, which aim to designate clients as research subjects for specific data gathering (Swisher, 2010). PBE provides the opportunity to collect evidence from practice in order to compile data in real-time. This approach may provide opportunities to implement results into standardized guidelines for practice, making this method applicable to practitioners worldwide (Swisher, 2010).

Sound-based therapies have the potential to be used in a variety of settings within a PBE framework in order to accumulate data for the effectiveness of the techniques. By a cultivating practice-based evidence approach, TL can establish support as a suitable intervention for children with sensory-processing disorders. Current health policies require an increase in evidence in order to further assess TL outcomes to adequately support the effectiveness of the intervention. In contrast to randomized controlled trials, PBE can capture a more comprehensive perspective of the way interventions like TL are effective. The evidence must be established with standardized results gathered through reflective responses and clinical assessments (Swisher, 2010). The effectiveness of TL can evolve by further defining the intervention using PBE.

Sensory Integration

Therapeutic Listening[®] is embedded in the Sensory Integration (SI) framework. SI is defined as the means to which the nervous system receives messages from sensory input and then integrates that information into appropriate motor and behavioral responses, thus affecting individual functional performance (Ayres, 1972). The brain organizes sensory information from the environment and produces a motor output in order for an individual to move, learn, and behave in a functional way. The SI framework is based on the assumption that sensory integration dysfunction accounts for many deficits in occupational performance and proposes that SI can increase functional performance for children who have difficulty processing sensory input (Ayres, 1972). SI is centered on the sensory experience, neuroplasticity, and occupational performance, and the framework challenges sensory-processing skills using praxis, discrimination, postural functions and sensory modulation within a context of play and social interaction (Dunbar, 2007).

The most essential concept for both SI and the TL program is to enhance brain activity to formulate new synapses so the individual can learn new processes. SI establishes an explanation of how the processing of sensation affects motor performance, learning, and behavior (Dunbar, 2007). The TL intervention utilizes a specifically modified sound-based program to enhance sensory-processing capacities and body movement. The child listens to modified music to stimulate active listening with the whole body in order to organize the perceived input into appropriate movement and behavior within the environment. Therapists implementing TL adapt the core concepts of SI to create a just-right challenge. The TL program is unique for each individual and is designed to be conducive to meeting the needs of that individual. The therapist creates the program in a sequence and duration that best supports the child using skilled clinical

reasoning. TL is typically used in conjunction with other sensory integrative modalities such as sensory diets and the addition of the TL intervention triggers the self-organizing capacities of the nervous system to elicit behavioral change in children (Frick & Hacker, 2001).

Ethical and Legal Considerations

Guidelines set out by the American Occupational Therapy Association (AOTA) Code of Ethics and the Dominican University Institutional Review Board for the Protection of Human Participants (IRBPHP) were followed to insure the safety and well-being of all who were involved in this research project. The principles of beneficence, nonmaleficence, autonomy, veracity, justice, and fidelity were considered throughout the course of this research. To preserve the ethical basis of this study and the integrity of all those involved, a specific protocol was implemented to ensure the confidentiality of the participants in the study.

Before beginning the intervention, licensed occupational therapists from each respective clinic obtained signed informed consent from their clients. Signed consent forms were scanned and sent to the researchers via secure Dominican University email and stored on the faculty advisor's password-protected computer. All the licensed occupational therapists implementing the research went through an online webinar training on the process of how to legally obtain consent and how to ensure research participant's rights including the right to withdraw and keeping information confidential. Each participant was provided with a personal code at the beginning of the study. Researchers were blinded to all demographic information of clients excluding age, gender, and diagnoses to ensure confidentiality. Each clinic had access only to their respective electronic folder for data upload. The researchers sent electronic and physical packets to the clinics with each client's coded number to maintain confidentiality.

The TL program posed minimal risks to those who participated in it, but proper precautions were taken to minimize those risks. A child may have had a negative reaction to the TL program after listening to the altered music. The child may have become over-stimulated, stressed, or anxious causing emotional distress. There was a risk of attrition due to these negative behaviors and parents were given the right to discontinue treatment at any time. Parents were informed of a risk of feeling stressed in administering and complying with the TL program. Risk for harm to the participant were minimized by reducing the volume of the modified music, careful observation of participant reactions by parents and licensed OTs, and educating administrators on proper use of the TL equipment and program. All practitioners had previous advanced training and experience in using TL prior to this study. OTs educated parents on the correct way to administer the TL program and cautioned regarding the potential risks. Families who may have felt stressed were encouraged to speak with their respective OT who can provide emotional support. The researchers expected the TL program to be beneficial to those who participated in the study, and did not intend for any harm to occur.

Design

Using a mixed-methods design, participants completed twelve weeks of the TL-Q intervention at home as a supplement to current occupational therapy services. During the intervention period, participants listened 30-minutes twice daily to a TL-Q music selection over high-quality, specialized headphones. Based on the clinical reasoning of the licensed occupational therapist administering the program, playlists and music may have changed as frequently as once a week, or once every two weeks, to meet the individualized needs of each child. All licensed practitioners were previously trained in the use of TL-Q and have clinical experience in conducting the program with other clients prior to the study. Assessments were

administered in a pretest-posttest fashion at baseline and after the twelfth week. Qualitative data was gathered in weekly parent logs throughout the course of the twelve-week program.

Participants

Seven clinics from across the United States identified 23 eligible children aged 3-12 (22 male, 1 female) receiving occupational therapy services. Clinics were chosen under the criteria that at least one practitioner at each clinic had experience and advanced training in using TL-Q. Clinicians could not administer the TL-Q program unless previously trained in its use. Using a purposive sampling method, the clinics were directed to select participants based on the following criteria: children 3 to 12 years of age currently receiving OT services for learning or developmental disabilities and demonstrating sensory integrative concerns. Families were only approached if the child was recommended to use TL-Q as part of the intervention program following an initial evaluation or reevaluation. The exclusion criteria included children who have previously received Therapeutic Listening[®] or any other listening program in the past or have been diagnosed with a seizure disorder. Participants' parent/guardians were provided with the specialized headphones and music needed to complete the program and a journal to report progress. Informed consent was obtained by the participating clinicians and forwarded to Dominican University of California researchers via a secure email. This study was reviewed and approved by the Dominican University of California Institutional Review Board (IRBPHP Approval # 10535).

Data Collection Procedures

The quantitative outcomes of the TL-Q program were collected using a six-assessment protocol. The assessments included: the Canadian Occupational Performance Measure (COPM), the Sensory Processing Measure (SPM), Beery-Bukentica Developmental Test of Visual Motor

Integration (VMI), Peabody's Development of Motor Skills (PDMS-2), Bruininks-Oserestsky Test of Motor Proficiency (BOT-2) and a modified Clinical Observation Assessment. The PDMS-2 and BOT-2 are dependent on age and only one of the two tests was administered to any given participant. Along with the formal measures mentioned, parents were asked to complete a weekly journal on the child's behavioral changes. All assessments were individually owned by the clinics who participated in the study, except the modified Clinical Observation Assessment, which was shared by the Vital Links clinic as a methodology for specifically collecting data for this research study (Vital Links, 2017). Clinicians administered these assessments in accordance with clinical practice, applying standard testing protocol. All measures were used at pre-test and the final post-test. The expert level clinicians administered the assessments and the researcher analyzed the data received.

Canadian Occupational Performance Measure.

The COPM is an evidence-based, Likert-scale questionnaire with scores ranging from 1-10, designed to measure the quality of participants' daily occupations (Law, Baptiste, Carswell & McColl, 2014). The assessment analyzes the participant's ability to perform personalized goals and the participant's satisfaction with their performance on the 1-10 scale. This assessment is typically used with an adult population, however there is no specific age range identified. The measure provides opportunities for children and families to identify personalized goals for improvement. The assessment was completed by the licensed OT and parent(s) during a semi-structured interview. The COPM provides a client-centered approach to define and identify problem areas impacting performance in activities of daily living. The COPM focuses on performance in all areas of life including self-care, social interaction, and leisure. The tool

allowed parents to prioritize and rate their satisfaction of their child's performance in all activities of daily living during pre- and post-tests (Law, Baptiste, Carswell & McColl, 2014).

Sensory Processing Measure.

The SPM was used to measure the effectiveness of the TL-Q program on sensory processing skills in the home that included: social, visual, hearing, touch, body awareness, balance, and play contexts (Parham, Ecker, Kuhaneck, Henry & Glennon, 2010). The SPM is an integrated system of rating scales that assesses sensory processing difficulty, praxis and social participation in children. The SPM is a multi-environment assessment that helps form a complete picture of children's sensory functioning. The scaled forms are to be completed by parents, teachers and other professionals to grasp a holistic view of children's sensory processing capabilities in the home, school and community. Higher scores indicate higher levels of sensory processing dysfunction. Standard scores and percentile ranks are used to define the level of processing. The SPM provides critical information about whether sensory processing issues are, or are not, contributing to behavioral changes. The SPM is a valuable instrument in determining what type of interventions are appropriate for each child as well as in measuring the outcomes of therapy post-intervention. The SPM takes approximately 15-20 minutes to administer. Forms are typically used with ages 5-12. The SPM Preschool (SPM-P) forms are used to assess ages 2-5 years. Licensed occupational therapists and researchers are necessary to interpret the results (Parham, Ecker, Kuhaneck, Henry & Glennon, 2010).

Beery-Bukentica Developmental Test of Visual Motor Integration.

The VMI was used at pretest and post-test to measure the outcome of the TL-Q program on visual motor integration. The VMI is a norm-referenced assessment designed to measure visual motor integration skills, visual perceptual skills and visual-motor coordination abilities

(Beery, 2010). The assessment consists of three different categories: copying lines and shapes through pen-and-paper tasks, identifying shapes and objects that are identical, and tracing the interior of different shapes while staying within the shape's lines (Beery, 2010). The VMI takes approximately 10 minutes to complete and is administered by a licensed OT (Beery, 2010).

Motor skills assessments.

Therapists were asked to complete a motor skills assessment for each participant, given the choice between the PDMS-2 and the BOT-2. The PDMS was used for the children under the age of four years, otherwise, therapists were encouraged to use whichever assessment they were more comfortable with or whichever they had access to.

Peabody's Development of Motor Skills-2.

The PDMS-2 was used at pretest and posttest to measure the effectiveness of TL-Q on the motor development of young children between the ages of three and five years old. The assessment is norm-referenced and used to identify any delays in fine and gross motor development (Folio & Fewell, 2000). The PDMS-2 assesses six subtests: reflexes, stationary, locomotion, object manipulation, grasping and visual motor integration. The PDMS-2 requires a child to follow specific pen-and-paper directions and/or perform a set amount of tasks. Each subtest can be completed individually during separate sessions (Folio & Fewell, 2000). After identifying any deficits, the assessment can be used to evaluate a child's progress in motor development. The PDMS-2 must be administered by a licensed OT in the clinic (Folio & Fewell, 2000).

Bruininks-Oseretsky Test of Motor Proficiency-2.

The BOT-2 was used at pretest and posttest to measure the outcomes of TL-Q on the gross and fine motor development of children older than four years old. The BOT-2 consists of a

variety of full-range, goal-directed activities for the child to complete (Bruininks, 2005). The BOT-2 has eight subtests; four subtests define gross motor proficiency through bilateral coordination, balance, running speed, agility, and strength; the other four subtests define fine-motor proficiency through precision tasks, fine-motor integration tasks, manual dexterity, and upper-extremity coordination (Bruininks, 2005). Each subtest requires 10-15 minutes to complete.

Clinical Observation Assessment.

A modified Clinical Observation Assessment derived from the Ayres (1972) original recommendations for clinical observations, as well as the Sunbeck Quality of Movement checklist. The Clinical Observation Assessment was specifically developed for this study by Sheila Frick (Vital Links, 2017). The Clinical Observation tool provided formalization for clinically observing occupational performance and motor development to gain a clear picture of a child's specific strengths and weaknesses in motor and balance skills. The tool included observations of supine flexion, somersault, prone extension, body flexion, one foot standing, standard Romberg, stand from sit transition, hopping, sequential finger touching, storing coins (finger to palm translation), manipulating pencil (in hand rotation). Observations are rated using a 0-3 rating scale, zero indicating inability to complete task, one indicating partial ability to engage in task, two indicating partial mastery, and three indicating complete mastery. The screening tool prompted a score to help identify motor coordination problems in children.

Parent journals.

Every participant's family was sent home with a parent journal to complete at the end of each week. The journal included twelve feedback forms to observe the child's progress using -2 to +2 scoring measures and a section for general comments or observations (see Appendix A).

The journal was provided to collect qualitative data regarding the child's progress as identified by caregivers at home. The feedback form also included a set of guiding instructions on how to refine answers for each section of the questionnaire.

Results

Data Analysis

The data gathered from the clinical assessments and parent logs were collected by the licensed occupational therapists working in conjunction with the researchers. Analysis of the quantitative data from the standardized assessments was conducted using SPSS (IBM Corp, 2013). Paired sample t-tests compared the pre- and post-test results of the total average scores of each assessment population versus each child's individual scores and each subtest of the COPM, SPM, and the modified Clinical Observation Assessment. A preliminary content analysis of the qualitative data was conducted to review the outcomes reported in the parent logs. Future implications for further analyzing the qualitative data are being considered for the benefit of clarifying the clinical reasoning behind the application of the TL-Q protocol.

The data was collected from five of the seven clinics after the twelve-week protocol was completed. Two clinics were unable to provide the compiled data. Across the other five clinics, three children dropped out of the study due to family needs or summer travel disruptions. Upon conclusion of the study, complete data was available for 13 children. Substantial post-test data was missing for three children and they were excluded from data analysis. Researchers speculate the large number of assessments and testing required for this study created a challenge for some clinicians to complete all the assessments. Similarly, for some children only certain assessments were administered. For example the VMI was only completed by three of the clinics and only six motor assessments (BOT-2 and PDMS-2) were collected. Due the small number, these

assessments were not further analyzed. The small number of these assessments gathered may be a result of limited access to the assessment and prioritizing assessments due to time constraints or appropriateness for the child.

Participant Demographics

Seven clinics initially recruited 23 children to participate in the study. One clinic dropped out and a second clinic was unable to provide data for the three children who participated. At pre-test, 17 children were enrolled, however completed data was only reported for 13 children at the conclusion of the study (see Table 1). Ages ranged from 3-12 with a mean age of 7.8. The children were reported as having a range of diagnoses, from autism, attention-deficit/hyperactivity disorder, sensory integration disorder, generalized anxiety disorder, developmental coordination disorder, and some undiagnosed. All the children were already receiving occupational therapy services at the time of recruitment.

Table 1

Participant Demographics

Client Code	Gender	Age	Diagnosis
DCT 001	M	10	Autism
DCT 002*	M	13	Autism
DCT 003*	M	8	ADHD
DCT 004*	M	8	Autism
DCT 005*	M	3	Autism
APT 001*	M	9	Dyspraxia; Hypotonia; Communication Disorder; SPD
APT 002	M	11	Asperger's
APT 005	M	7	Developmental Delay
APT 006*	M	5	Developmental Coordination Delay
FKT 001	M	7	PTSD
FKT 002*	M	11	Undiagnosed
FKT 003*	M	7	Autism
FKT 004*	F	4	Undiagnosed
KUT 001*	M	11	ADHD; Sensory Integration Disorder.
KUT 002*	M	7	Developmental Coordination Disorder; ADHD
KUT 004*	M	5	Generalized Anxiety Disorder; Sensory Processing Disorder with Dysregulation
TRC 001*	M	4	Undiagnosed

Note. The asterisks represent participants with complete data. Total =13.

Canadian Occupational Performance Measure Analysis

The COPM was particularly sensitive in identifying change in performance and satisfaction of individualized family goals (see Figure 1). Families most commonly identified goals related to challenges with routine, gross motor activities, emotional regulation, and social communication. The pre- and post-test means and standard deviations of the average COPM performance and satisfactions scores are reported in Table 1 for the 12 children who were able to

complete both pre- and post-testing. The results of two-tailed paired t-test comparison between the pre- and post-test indicated improvements in the average ratings of the performance and satisfaction of individualized family goals. On average, results demonstrated a two-point gain in performance and three point gain in satisfaction ratings.

Figure 1

COPM Average Performance and Satisfaction

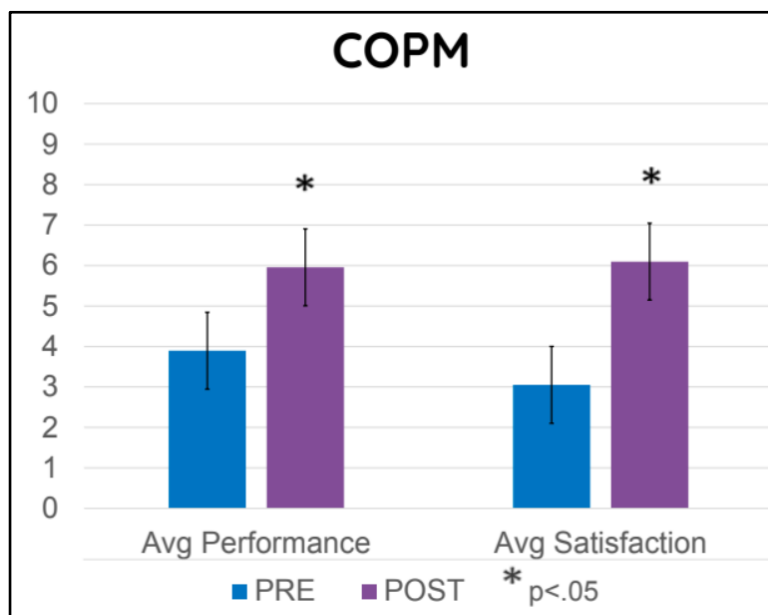


Figure 1. Pre-test is the blue bar and post-test is the purple bar. The asterisk indicates statistical significance of $<.05$. Higher scores indicate increased function.

Table 2

COPM Pre-Test and Post-Test Results; Reported for 12 Children

	Pre		Post		t(df)	p
	M	SD	M	SD		
Average Performance	3.9	2.6	6	1.2	-2.17(11)	<0.05
Average Satisfaction	3.1	1.6	6.1	1.3	-5.80(11)	$<.001$

Note. COPM = Canadian Occupational Performance Measure, M = mean, SD = standard deviation.

Sensory Processing Measure Analysis

The pre- and post-test total scores for the SPM indicated some improvement in sensory processing over the course of twelve weeks. The total score and sensory subtest did not significantly improve, however, social participation did change significantly at the .05 level but only without correcting for multiple t-tests using a Bonferroni correction. Improvement was identified in all subtests of the SPM except touch, in which regression was observed for six of the eight children who completed post-test scores. A decrease in percentile rank on the SPM demonstrates a decrease in severity of sensory processing deficits. The average percentile ranking decreased for the total score and most subscales except touch (see Table 2.)

Figure 2

SPM Average Pre-Test and Post-Test Percentile Score Comparison

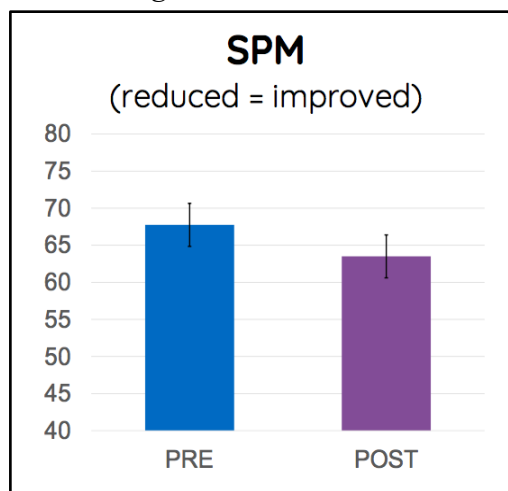


Figure 2. Pre-test is the blue bar and post-test is the purple bar. The asterisk indicates statistical significance of $<.05$. Higher scores indicate increased function.

Table 3

SPM Pre-Test and Post-Test Results; Reported for 8 Children

	Pre		Post		t(df)	p
	M	SD	M	SD		
Social	65.6	5.7	62.1	6.2	2.82(7)	0.026*
Visual	60.1	9.5	59.1	8.6	.64(7)	0.542
Hearing	65.8	7.1	62.2	4	1.86(7)	0.105
Touch	62	10.7	65.4	9.8	-1.77(7)	0.117
Body Awareness	62	7.7	60.9	7.7	.57(7)	0.589
Balance	61.9	10.3	57.6	6.7	1.38(7)	0.209
Planning and Ideas	70	8	66.6	9.9	1.11(7)	0.305
Total	67.6	7.9	63.5	4.9	1.58(7)	0.159

Note. SPM = Sensory Processing Measure, Bod. Awareness = Body Awareness, M = mean, SD= standard deviation. Lower score indicates improvement. Significance level of $p < .05$. *

Significance level of $p < .007$ ** correcting for multiple comparisons.

Clinical Observations Analysis

Fifteen children completed the pretest for the eleven-task modified Clinical Observation. Post-test results were not provided for four of those children. The results for the children who reported both pre- and post-test are reported in Table 3. Children showed improvement or maintained their level of function for every measure (see Figure 3). Multiple children improved from an initial score of 0 (unable to do task) to a score of 2 or 3 indicating partial mastery. One child initially reported scores of 0 in every measure at pre-test, and after the twelve-week period demonstrated improvement in five of the eleven measures. All but prone extension and sequential finger touching showed significant change at the $p < .05$ level, but only somersault and one foot standing balance remained significant after correcting for multiple t-tests with a Bonferroni correction.

Table 4

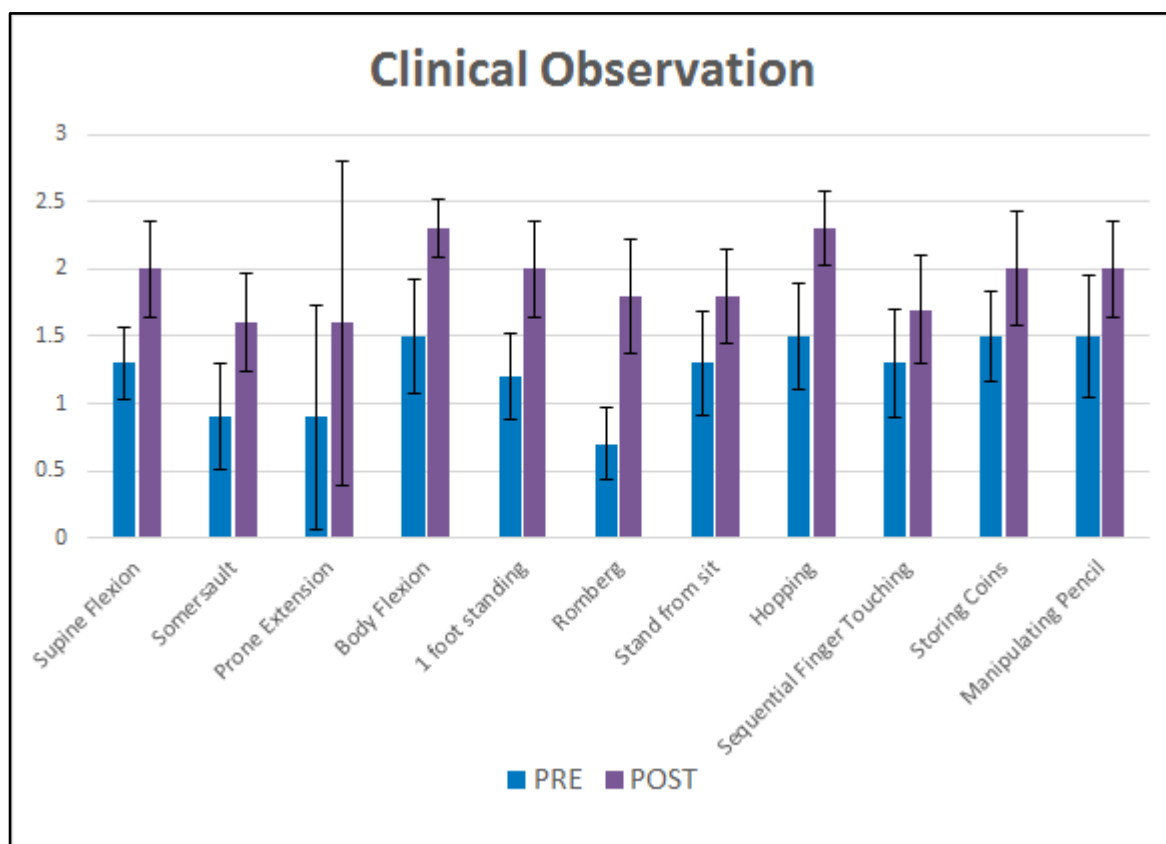
Clinical Observations Pre-Test and Post-Test Results; Reported for 11 Children

	Pre		Post		t(df)	p
	M	SD	M	SD		
Supine Flexion	1.3	0.9	2	1.2	-3.07 (10)	0.012*
Somersault	0.9	1.3	1.6	1.2	-3.73 (10)	0.004**
Prone Extension	0.9	0.8	1.6	1.2	-2.39(10)	0.072
Body Flexion	1.5	1.4	2.3	0.7	-2.45 (9)	0.037*
1 foot standing	1.2	1.1	2	1.2	-4.50 (10)	0.001**
Romberg	0.7	0.9	1.8	1.4	-2.78 (10)	0.019*
Stand from sit	1.3	1.3	1.8	1.2	-2.63 (10)	0.025*
Hopping	1.5	1.3	2.3	0.9	-3.07 (10)	0.012*
Sequential Finger Touching	1.3	1.3	1.7	1.3	-1.46 (10)	0.176
Storing Coins	1.5	1.1	2	1.4	-2.63 (10)	0.025*
Manipulating Pencil	1.5	1.5	2	1.2	-2.89(10)	0.016*
Total	13.6	10.5	21	10.5	-9.34(10)	0

Note. M = mean, SD = standard deviation.

Significance level of $p < .05$. * To correct for multiple comparisons, a significance level was set at 0.004 **.

Figure 3

Clinical Observations Pre-Test and Post-Test Comparison*Figure 3.* Higher scores indicate increased function.**Qualitative Findings**

A limited preliminary qualitative data analysis reviewing parent logs and COPM goals indicated that family identified goals most commonly reported challenges with routine, gross motor activities, emotional regulation, and social communication. Some preliminary themes include: ADLs, communication skills, social interaction, sleep, sensory experience, school and behaviors, emotional regulation, and motor skills. Some notable quotes are reviewed in Table 5. The quotes generally demonstrate improvements and successes identified during the therapy

intervention study timeframe. The categories indicate areas many families and children identified as requiring improvement at pretest.

Table 5

Notable Preliminary Parent Quotations

Emotional Regulation	“Regulated frustration, signals of distress were short. Cried briefly for moments, but slowed his breathing and moved on with cheerful attitude.”
Sleep	“Nine to eleven hours of sleep. No night waking. No naps needed. Some bedtime prompts.”
Motor Skills	“Increase in desire for gross motor activities, like bike riding.”
Social Interaction	“Approaching children his own age and asks if they will be his friend”
School Behaviors	“More on task with school work, asked to do extra work and focused well to complete regular plus extra work.”

Discussion

The results demonstrate the benefits of including Therapeutic Listening[®]-Quickshifts as an intervention within a sensory integration framework for addressing personal, developmental, sensory, and motor goals for children. Overall, significant improvement was demonstrated in individualized goals, as measured by the COPM, and in posture and balance as measured by Clinical Observations. The SPM and motor assessments did indicate overall improvement, however the results did not produce significant findings. Analysis of qualitative statements in the parent logs reveals generalized improvement in social skills and emotional regulation. The evidence collected through the PBE framework supports the use of TL-Q as an intervention which can be used in the home and clinical setting as measured by the resulting improvement in assessments and personal goals. Standardized protocols for skilled interventions are essential for clarified clinical reasoning in evidence based practice.

The practice-based data collection protocol for the TL-Q program used both norm and criterion referenced assessments to produce reliable and valid outcomes appropriate for application to clinical practice. The goal of this study was to create a standardized protocol, as such is unavailable in the current literature, for producing consistent data reflecting the effectiveness of Therapeutic Listening[®]-Quickshifts in a population of children. The routine of implementing the TL-Q protocol and using the standardized assessments were a strength to data analysis within the PBE framework. However, the pragmatic demands of the protocol resulted in a lack of post-test follow up, limiting the accumulated data. Further, the significant requirement for paperwork, assessments, and weekly logs proved to be an overwhelming task for most clinics and participants, resulting in missing data.

As a primary study completed on supporting the use of TL-Q as an intervention, the results of the data report positive support from the assessments compiled by the five occupational therapy clinics. The majority of the children were able to complete the pre- and post-test measures for the COPM, SPM, and the modified Clinical Observation. These measures encompassed identified personal goals based on daily function, motor and balance, and sensory regulation abilities. As a sound based therapy, TL-Q demonstrates potential for improving sensory, motor, and developmental skills within the sensory integration framework.

Based on the pre- and post-test data for personalized developmental goals, participants demonstrated improvements over the course of the twelve-week TL-Q program. The COPM proved to be the most sensitive to change in performance and satisfaction of occupational goals suggesting that the assessment is appropriate for measuring the effects of TL-Q. The findings from the COPM also provide evidence for using the measure in pediatric settings despite to the measure's intended use with adult populations. The personalized family goals were consistent

with overall intervention goals and parent log prompts. The most common themes from the COPM were targeted at gross motor development, consistent sleep patterns, social-communication skills, decreasing meltdowns, and maintaining family routine.

The slight improvements in total sensory processing, as measured by the SPM, are likely attributed to the improvements in overall occupational performance, which were also reflected in the COPM and parent logs. The social skills measure on the SPM demonstrated the greatest improvement over the twelve-week study. However, the clinics were inconsistent with the versions and subtests of the SPM, limiting the sections of reportable data relevant to the study. All other SPM subtests indicated some improvement except touch. Further analysis of sensory processing is recommended for future research to closely analyze the true effects of the TL-Q program on the tactile sensory system. The average declined score on the SPM subtest on touch did not mirror the positive findings reported in the parent logs. This suggests possible error in data collection among either parents, therapists and/or researchers, as well as possible bias during data collection given the qualitative nature of the measure. The SPM assessment captured success and improvement for sensory registration and response for the children by the end of the study, but overall was least sensitive to change.

The modified Clinical Observation included eleven measures for postural control, motor coordination and balance. The objective measurements from the Clinical Observation showed improvements in the specific areas of body flexion, supine flexion, one-foot standing balance, and Romberg. For the remaining measures, all children maintained functional status or improved in function. The positive change of children being unable to complete tasks, to mastering them, may be a result of improved vestibular functioning due to reduced sensitivity to external stimuli through the inter-hemispheric integration of the TL-Q sound therapy.

Potential Limitations

The implementation of the TL-Q program protocol was limited to the pediatric population for this study, although TL-Q can be used across all ages. Researchers recruited a small and purposive convenience sample of 23 children from seven clinics. The sample was collected from private clinics, making it likely that the participants were of higher socioeconomic status. Dropout and incomplete post-test assessments resulted in a much smaller final sample. In attempt to enhance compliance and treatment implementation consistency, parents were provided with a folder of weekly logs to reinforce the accountability for implementation of the intervention. Similarly, therapists were provided with weekly clinical reasoning logs, however, this method was deemed ineffective given the resulting data collected. This study presents data from a twelve-week program that began in April and ended in midsummer. Based on the current data collection results, future researchers should consider conducting a similar study during the school year and consider gathering feedback from the participants' teachers for further analysis.

No measure of direct frequency for OT services for all participants was available. The twelve-week protocol does not provide ample time for measuring developmental processes or long-term outcomes. Two of the primary measures, the COPM and the SPM, are participant-report measures and thus subject to bias. The modified Clinical Observation sheet could also potentially have bias in the scoring process. This could be eliminated in the future by independent and blind video scoring. There was also potential for measurement sensitivity issues due to the short 12-week time frame. Finally, the major limitation, also inherent in a PBE approach, is the lack of a control condition and the ability to separate the effects of TL-Q from direct OT intervention.

Future research should focus on measuring TL-Q as an independent intervention to further support the effectiveness of the SBT. The nature of implementing the trialed six-assessment protocol proved too demanding for the clinicians, resulting in reduced the data collection for most children. However, results overall show potential for implementing TL-Q as part of a sensory integration treatment plan within OT practice.

Conclusion

Implications for Practice

The overall improvement of the participants from the TL-Q implementation demonstrates the advantage of including this SBT in practice. The researchers collected t-data through the pre-and posttest protocol, supporting potential for observing the change and benefits of TL-Q in practice. The COPM assessment provided specific and individualized opportunities to observe tangible progress for participants and their families to set personal goals within a twelve-week period. This assessment may be a valuable addition to pediatric practice for the support of clarifying family goals, and demonstrating intervention progress. The proposed protocol supports the implementation of TL-Q and provides adequate data through the practice based evidence approach in practice. The PBE method is valuable for developing the TL-Q protocol within traditional practice given the individualized nature of the treatment and the process of implementing clinical reasoning for each child's personal success.

Recommendations for Future Research

Further research is required to continue to identify a best practice protocol for implementing TL-Q as an intervention to collect data for evidence based practice. Ideally, the research will provide supporting evidence for the effectiveness of the TL-Q technique. The incorporation of both qualitative and quantitative data created a more comprehensive analysis of

lived experiences of families as well as standardized outcome measures. Further qualitative and quantitative data analyses are necessary to accumulate data through this PBE protocol in clinical settings. Future studies would benefit from reducing the number of assessments required and simplifying the data collection process. Researchers may benefit from providing a weekly electronic prompt to clinics to promote ongoing data collection, rather than at the end, to allow for fewer errors and missing information to be identified early. If this study were to be replicated or repeated, researchers should be considerate of the timing during which the program is conducted. Future studies should consider gathering data from practitioners using the TL-Q program to document the clinical reasoning supporting the use of specific TL-Q tracks.

The current evidence of sound-based interventions in occupational therapy is growing, but still limited. More in-depth research is required to support the use of sound based interventions like TL-Q. This particular research study was completed with the intention to contribute evidence to the current body of literature. Additionally, this study aimed to describe the effectiveness of TL-Q and the methods by which TL-Q should be measured.

Therapeutic Listening[®]-Quickshifts can support the improvement of sensory processing, posture, and the performance and satisfaction of individualized goals for children with developmental or intellectual disabilities. Of the six assessment tools used throughout this study, the COPM and Clinical Observations proved to be the most effective in measuring changes in the outcomes of TL-Q on pre- and post-tests. Further research should be completed to refine a protocol for best practice in delivering the TL-Q program. Suggestions for follow-up studies include: reducing the number of assessments, completing the trial during the school year, and using a randomized-control design.

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Appendix A

Parent Journals

Therapeutic Listening Quickshifts: Parent Feedback Form

Child ID _____ Album Completed: _____

Date & Week number: _____ Completed by: _____

Functional Areas:

(-2 = significant negative change, 0= no change, +2= significant positive change)

A. Sleep -2 -1 0 1 2

B. Attention -2 -1 0 1 2

C. Play & Social Skills -2 -1 0 1 2

D. Emotion/Behavior -2 -1 0 1 2

E. Activity Level -2 -1 0 1 2

F. Communication -2 -1 0 1 2

G. Motor Skills -2 -1 0 1 2

H. Self-care -2 -1 0 1 2

I. Other

Additional Comments or Observations: (please include any relevant details/feedback regarding the changes referenced above, or any changes in routine, family situation, etc.) Continue on back as needed.

Appendix B

First Page of Clinical Observations

Assessment Clinical Observations		Date: _____
Activities	Movement Considerations Checklist	Scoring:
Prone Extension	<input type="checkbox"/> Maintain prone extension for 20 seconds <input type="checkbox"/> With head vertical to floor <input type="checkbox"/> With lateral stability (trunk does not lean to either side) <input type="checkbox"/> With arms over head & off mat <input type="checkbox"/> With no more than 35 degrees' knee flexion <input type="checkbox"/> Counts out loud with no vocal strain, gasping, or marked change in prosody over speaking voice	0 = Cannot assume upper extremity component of prone extension 1 = Can assume upper extremity component of prone extension & maintains for 5 seconds- lateral instability allowed 2 = Can assume all components of prone extension for 10 seconds – no lateral instability, vocal strain, etc. 3 = Target behavior
Supine Flexion	<input type="checkbox"/> Maintain supine flexion for 20 seconds <input type="checkbox"/> With chin tuck <input type="checkbox"/> With lateral stability (trunk does not lean to either side) <input type="checkbox"/> With rounded bottom (buttocks off floor) <input type="checkbox"/> Crossed arms and legs allowed <input type="checkbox"/> Counts out loud with no vocal strain, gasping, or marked change in prosody over speaking voice	0 = Cannot assume upper extremity component of supine flexion 1 = Can assume upper extremity component of supine flexion with chin tuck and maintains for 5 seconds 2 = Can assume and maintain all components of supine flexion for 10 seconds 3 = Target behavior
Somersault	<input type="checkbox"/> rolling forward (somersault) with chin tuck <input type="checkbox"/> starting from a squat position <input type="checkbox"/> rolling over head onto back <input type="checkbox"/> and coming to a sitting position <input type="checkbox"/> with lateral stability (does not roll to a side; rolls straight)	0 = Cannot do somersault- rolls over shoulder onto back rather than neck (cannot maintain chin tuck) 1 = Can do somersault rolling over neck & maintaining chin tuck- lateral instability and not coming to sit allowed 2 = Can do somersault maintaining chin tuck & lateral stability- not coming to sit allowed 3 = Target behavior