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Case Report

Making Intensive Voice Treatment (LSVT® LOUD) Accessible for a Child With Autism Spectrum Disorder (ASD) and Mixed Dysarthria Using a Novel, Pre-Treatment Protocol

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Abstract

Although motor speech disorders (dysarthria, apraxia) are not currently considered core symptoms of autism spectrum disorder (ASD), reviews of clinical reports reveal a significant prevalence of these disorders among children with ASD. This report examines implementation of LSVT® LOUD, an established intensive treatment protocol developed originally for individuals with hypokinetic dysarthria secondary to Parkinson's disease and recently successfully applied to children, in the treatment of a child with dysarthria and ASD. Because this child was initially deemed unstimulable for intensive treatment, a novel pre-treatment protocol was implemented. Following the pre-treatment protocol, outcomes resulted in significant immediate and long-term gains in multiple parameters of functional communication. This report supports consideration of a pre-treatment protocol before intensive interventions such as LSVT LOUD.

ABBREVIATIONS

ASD: Autism Spectrum Disorder, **LSVT®** LOUD**:** Lee Silverman Voice Treatment, **MSVP:** Maximum sustained vowel phonation, **SPL:** Sound pressure level, **LSVT:** Lee Silverman Voice Treatment, **s:** Seconds, **dB:** Decibel, **Hz:** Hertz

INTRODUCTION

Autism spectrum disorder (ASD) is a prevalent neurodevelopmental disorder observed in childhood characterized in part by deficits in perspective-taking, social interaction, cognitive-communication, and sensorimotor integration.(1) Although motor symptoms are not currently considered core symptoms of ASD, reviews of clinical reports show motor delays and impairments, such as hypotonia, dyspraxia, and oromotor deficits, are highly prevalent in this population. (2-4) Although consistent prevalence figures are not documented, Shriberg (3) estimated that a substantial portion of children with neurodevelopmental disorders such as ASD have comorbid motor speech disorders. Among the 47.7% of children with concurrent neurodevelopmental disorders and motor speech delays, 13.3% were diagnosed with dysarthria and 4.9% were diagnosed with dysarthria and Childhood Apraxia of Speech (CAS). As a result, children with ASD may experience a wide range of speech, voice, and prosodic deficits in addition to more commonly reported disorders in language.(2,5,6) While speech-language pathologists (SLPs) are familiar with therapies to address the cognitive-communication challenges this population faces, treatments for managing motor speech disorders within the ASD population remain scant.

Dysarthria in the ASD population is characterized by lower vocal fundamental frequencies (F0), higher vowel formant frequencies, reduced maximum phonation times (MPT), reduced variation in speech duration and speech loudness (i.e., average sound pressure level (SPL) and difficulty with loudness control), and greater variability in lexical stress ratios.(5,6) Disordered articulation has also been described in these children, though it is challenging to determine the contribution of dysarthria in these impairments, as the majority of research within this category

focuses on the symptoms and prevalence of CAS.[6] Consequently, to our knowledge, effective intensive motor speech treatment approaches in pediatric dysarthria for people with ASD have not been explored.

A speech treatment protocol known as LSVT LOUD has a significant amount of documented efficacy for the treatment of hypokinetic dysarthria secondary to Parkinson's disease (PD) (7-10) and also has been shown to be effective in the management of pediatric dysarthria secondary to cerebral palsy and Down syndrome. Existing literature on the efficacy of LSVT LOUD as a treatment option for pediatric dysarthria has been promising, with researchers reporting positive outcomes in acoustic measures and listener perception. (11-15)

LSVT LOUD is unique in a number of ways. It uses a single treatment target of healthy loudness as a trigger for a wide distribution of effects across the entire motor speech production system. (10) Post-treatment improvements have been documented in respiratory kinematics, electromyography (EMG) activity, vocal fold closure, acoustic measures (e.g., MPT, vocal SPL, fundamental frequency variability, articulatory precision), listener perception variables (e.g., voice quality), speech intelligibility and language function.(16) A single treatment target with limited cognitive complexity resulting in distributed effects offers a potentially viable treatment option for people with dysarthria and ASD (Figure 1). (7-10, 17, 18) LSVT LOUD adheres to principles of motor learning and activity dependent neuroplasticity, such as intensity of practice, repetition, saliency of materials and activities used, performance accuracy and specificity of training. It is delivered in an intensive dosage (16, one-hour sessions, four days per week for one month) with a high effort mode of delivery both within and across treatment sessions. (8-11, 19) It teaches target behaviors via modeling and a verbal cue for loudness, resulting in an increase is overall amplitude of movement and subsequent normal though greater than baseline loudness levels. This intensive dosage is in contrast to traditional treatment paradigms, which are less intensive and provide verbal instruction for multiple targets. LSVT LOUD also addresses sensory processing and internal cueing deficits that limit learning and generalization into functional speech production (10), which may be relevant in the ASD population.

Importantly, the treatment target trained in LSVT LOUD is elicited through modeling target behaviors, which children with autism are responsive to and which minimizes explicit verbal instructions (20), allowing a child's system to implicitly self-organize to achieve a goal. (21) Further, the use of a singular training target, which reduces cognitive load, may result in a greater chance of compliance during treatment and of improvements in communicative competence and speech

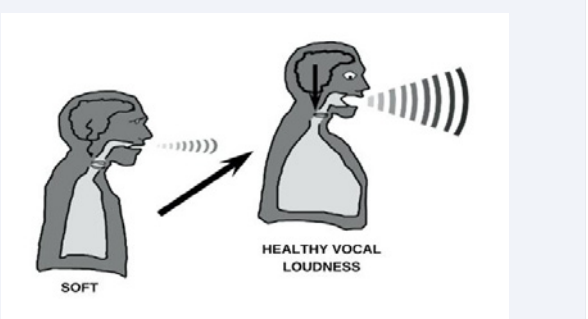

Figure 1 Schematic showing spreading effects of healthy vocal loudness across the speech mechanism. Permission granted by LSVT Global, Inc.

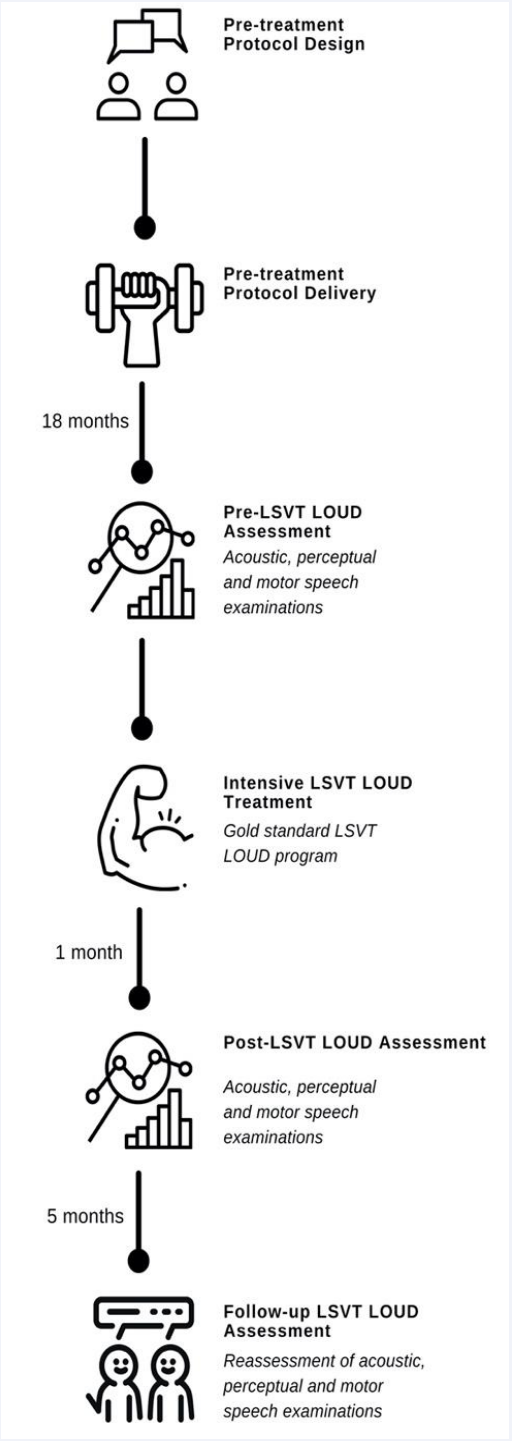

Figure 2 Schematic showing overall therapeutic timeline from pre-treatment protocol design, pre-treatment protocol delivery, pre-LSVT LOUD assessment, intensive LSVT LOUD treatment, post LSVT LOUD assessment, to follow-up LSVT LOUD assessment.

intelligibility. Given the existing cognitive load necessary to address deficits in social communication, children with ASD may benefit from a motor speech treatment that is less cognitively demanding, thus enabling them to be able to dedicate more resources to functional communication.

Previous studies have documented children with autism are capable of intensive behavioral and speech treatment regimens. (22, 23) Research has also shown that the use of task-specific, repetitive, and active practice with increased numbers of practice trials results in marked improvements across several domains (22, 23) in children with autism. This suggests they may be able to participate in and benefit from an intensive mode of treatment utilizing a specific treatment target and repetitive, active practice. As such, LSVT LOUD has the potential to be a valuable treatment for pediatric dysarthria.

Despite the potential benefits of choosing LSVT LOUD for speakers with pediatric dysarthria and ASD, some of these children who have the potential to benefit from it may not be immediately ready for intensive motor speech intervention. However, to our knowledge, there are no reports detailing specific protocols or criteria that could be used to prepare a child for participation in this type of intensive intervention program. Thus, there is a need for a pre-treatment protocol to prepare these children to have access to the benefits of an intensive dosage of LSVT LOUD.

In the context of this report, adaptations and supports needed for a child with ASD and mixed dysarthria initially deemed unable to participate in an intensive treatment protocol are examined and documented. A pre-treatment protocol was administered for 18 months to ultimately prepare the child to receive LSVT LOUD. This report describes the use of this novel pre-treatment protocol, which permitted learning of the exercises within the LSVT LOUD protocol and make gains in overall loudness (SPL) and intelligibility for improved communicative effectiveness.

CASE PRESENTATION

Participant

At the onset of this intervention, the child was a 16.5-year-old male. Medical diagnoses provided by a pediatric developmental neurologist included ASD and severe mixed dysarthria. Historical speech and language diagnoses included significant cognitive, language, and sensorimotor disorders, as well as a history of CAS. He received 14 years of traditional speech treatment, which primarily focused on the production of selected phonemes and word approximations to address CAS and incorporated a variety of language-based approaches provided with a low treatment dosage.

Upon intake, primary verbal communication characteristics consisted mainly of single word and rote phrase approximations. The speech diagnosis of mixed dysarthria and the severity of the speech disorder (severe) were determined by consensus by three SLPs through audio samples and interview. (24-26) Results of standardized and informal assessment measures and observed speech and voice characteristics revealed severe dysarthria, characterized by reduced strength, range of motion, speed, and coordination of oral motor structures, resulting in reduced articulatory accuracy, MPT, loudness and pitch ranges in maximum performance tasks and in speech, lexical stress ratios, breath support and control, and intelligibility of attempted utterances. In addition, a monotone intonation pattern, fast rate, output limited to word or short phrase approximations, imprecise articulation, dysfluencies and prosodic abnormalities were noted. At the time of the initial assessment and stimulability testing, the child was unable to volitionally inhale despite models or cues and was unable to consistently respond to cues to increase loudness. Maximum sustained vowel phonation was <1s with amplitude levels of vowels and speech approximations were <50db SPL at a 30 cm microphone to mouth distance. This, in addition to physical and behavioral challenges that impacted his tolerance for repeated daily practice and intensive intervention, resulted in a lack of stimulability or candidacy for the program. However, the parent and child expressed a great desire to attempt to participate in the intensive program. Therefore, a pre-treatment protocol consisting of a less intensive series of steps that built skills in a hierarchical manner and in preparation for the intensity of practice needed for LSVT LOUD was trialed (Figure. 2).

Procedures

An 18-month, pre-treatment protocol in the form of low dose, low frequency treatment that gradually increased in sessions per week and intensity within sessions was prescribed to develop an increased tolerance for specific speech motor exercises. The pre-treatment protocol was administered in three stages, each lasting six months.

Goals for stage 1 for the pre-treatment protocol (zero-to-six-months) focused on establishing a response to multisensory models to be able to establish volitional inhalation, deepen inhalation, and sustain exhalation; pair phonation with exhalation; build tolerance for repetitive practice and establish behavioral supports; and establish strategies to increase compliance and attention. Through a multisensory approach and gradual faded cueing presented within a repetitive mode of practice, the child could volitionally inhale, exhale and sustain exhalation in response to visual cues. Once the coordinated movement of inhalation and exhalation was established, the goal became to pair sustained exhalation with phonation, thus beginning to move the coordinated movement pattern of inhalation and exhalation into speech production. To address behavioral concerns, the SLP collaborated with the child's caregivers to establish supports and develop strategies for continued improvement. Breaks in motor practice, longer sessions to accommodate movement breaks, increased reinforcement and behavioral counseling were utilized at this stage for support.

Goals for stage two of the pre-treatment protocol (6-12 months) focused on stabilizing healthy phonation of normal loudness, extending phonation duration, and teaching pitch manipulation while maintaining normal loudness and developing the endurance to complete 15 repetitions of each of two daily voice exercises (i.e., 15 repetitions of Maximum Duration Sustained Vowel Phonation; 15 repetitions of High Ah; 15 repetitions of Low Ah) designated by the LSVT LOUD protocol, within 25 minutes.

Goals for stage three of the pre-treatment protocol (12-18 months) were centered around developing endurance to read of

Table 1. LSVT LOUD treatment protocol.

LSVT LOUD	
Focus of treatment	Healthy Vocal Loudness
Dosage	Increased movement amplitude directed predominately to respiratory-laryngeal systems Individual treatment session of 1 hour, 4 consecutive days per week over a 4-week period
Effort	Push for participant perceived effort
LSVT LOUD Daily Exercises • Maximum sustained movements completing multiple repetitions of tasks, minutes 1-12 • Directional movements completing multiple repetitions of tasks, minutes 13-23 • Functional movements, minutes 24-30	Sustain the vowel "ah" in a good-quality, loud voice, for as long as possible Say the vowel "ah" in a good-quality, loud voice gliding high in pitch; hold for 5 seconds Say the vowel "ah" in a good-quality, loud voice gliding low in pitch; hold for 5 seconds Participant reads 10 self-generated phrases he/she says daily in functional living (e.g., "Good morning") using the same effort and loudness as he/she did during the maximum sustained movements exercise
LSVT LOUD Hierarchy Exercises, minutes 31-55 Purpose Method Exercises	• Train rescaled vocal loudness achieved in the Daily Exercises into context-specific and variable speaking activities • Incorporate multiple repetitions of reading and conversation tasks with a focus on vocal loudness • Exercises increase in length of utterance and difficulty across weeks, progressing from words to phrases to sentences to reading to conversation, and can be tailored to each participant's goals (e.g., communicate at work or with caregivers) and interests (e.g., speak on topics of golf, cooking)
Assign Homework Exercises to be completed outside of the therapy room, minutes 56-60 Duration and repetitions on treatment days (4 days/week) Duration and repetitions on nontreatment days (3 days/week) Conversational Carryover Assignment Difficulty level	• Subset of the Daily Exercises and Hierarchy Exercises; 10 minutes, performed once per day • Subset of the Daily Exercises and Hierarchy Exercises; 15 minutes, performed twice per day • Participant is to use the louder voice practiced in exercises in a real-world communication situation • Matched to the level of the hierarchy where the participant is in treatment
Shaping techniques Purpose and approach	• Train vocal loudness that is healthy and within normal limits (i.e., no unwanted vocal strain) through use of modeling ("do what I do") or tactile/visual cues
Sensory calibration	• Focus attention on how it feels and sounds to talk with increased vocal loudness (self-monitoring) and to internally cue (self-generate) new loudness effort in speech
Objective and subjective clinical data collected during each treatment session	• Measures of duration, frequency, and sound pressure level • Documentation of percentage of cueing required to implement vocal loudness strategy • Observations of perceptual voice quality • Participant's self-reported comments about successful use of the improved loudness in daily communication • Participant self-reported perceived effort
Abbreviations: LSVT®: Lee Silverman Voice Treatment	

Table 2. Initial Assessment, Post Pre-Treatment Protocol, Pre-Post and five-month Follow-up LSVT LOUD data for maximum duration sustained vowel phonation, vocal sound pressure level for sustained vowels, vocal sound pressure level for speech phrases, highest maximum fundamental frequency and lowest fundamental frequency and maximum fundamental frequency range.

Measure	**Initial Assessment**		**Post Pre-Treatment Protocol**		**Pre-LSVT LOUD**		**Post-LSVT LOUD**		**Follow-up**	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Maximum sustained vowel phonation (MSVP) (s)	0.50	0.55	1.88	0.35	2.72	0.62	8.51	2.59	12.98	1.41
Vocal sound pressure level (SPL) of a sustained vowel (dB)[a]	40.00	0.00	70.64	1.19	73.37	2.57	84.92	0.86	85.50	1.00
Vocal sound pressure level (SPL) of speech (dB)[a]	45.00	7.07	45.00	7.07	48.10	11.03	69.00	9.90	70.50	7.78
Highest maximum fundamental frequency range (Hz)[b]	–	–	320.00	96.12	367.17	96.27	293.83	75.14	304.17	12.06
Lowest maximum fundamental frequency range (Hz)[b]	–	–	200.83	32.12	191.17	42.89	155.5	10.05	160.00	6.66

Abbreviations: MSVP: Maximum sustained vowel phonation; **SPL:** Sound pressure level; **LSVT:** Lee Silverman Voice Treatment; **s:** Seconds; **dB:** Decibel; **Hz:** Hertz

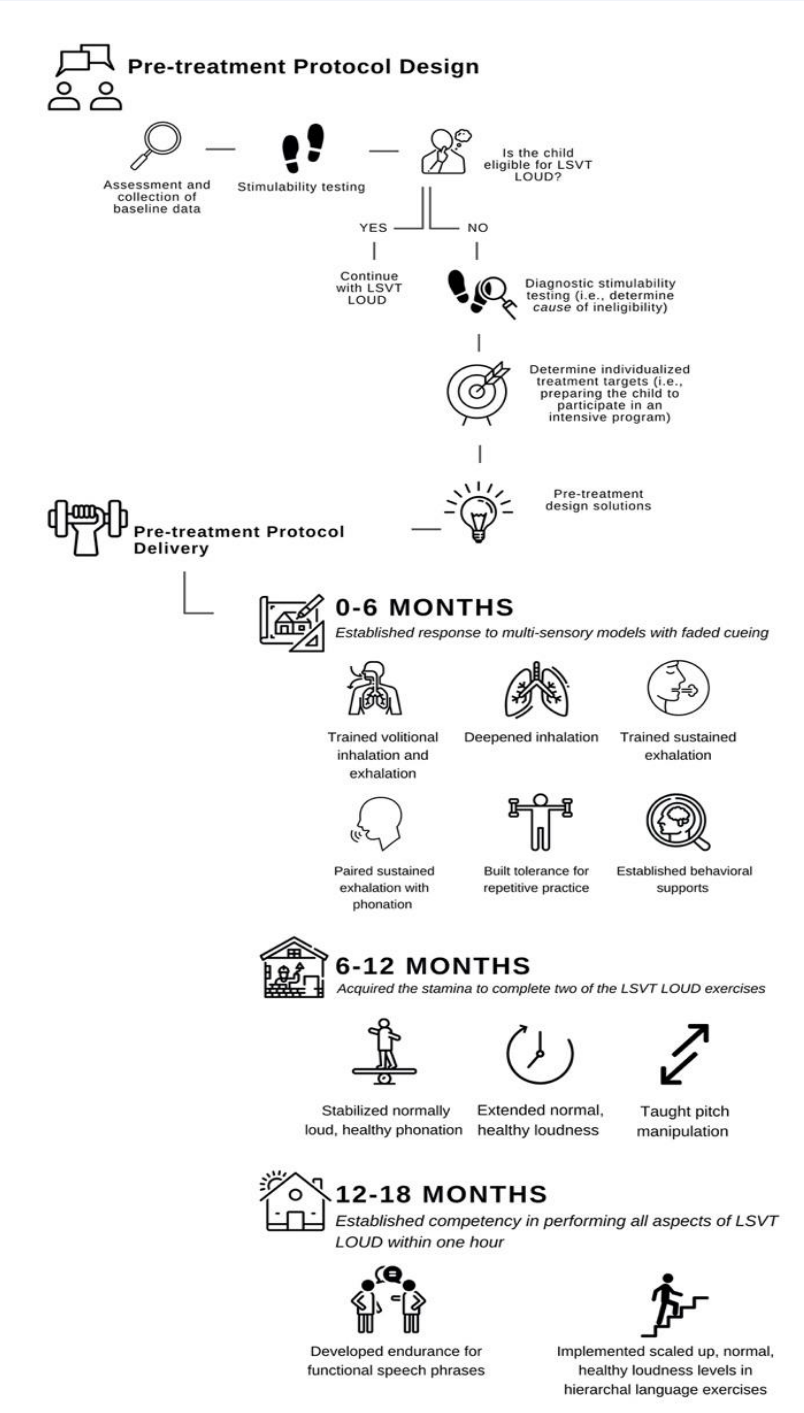

Figure 3 Schematic showing pre-treatment design, including pre-treatment protocol specifications at 0-6 months, 6-12 months, and 12-18 months.

a list of ten functional phrases within five minutes and implement scaled up, normal loudness levels in hierarchical language exercises for an additional 25 minutes (i.e., words, phrases, sentences, and supported conversation), with dual tasking added when appropriate. Once competency in performing all aspects of the program was established in under an hour, candidacy for the intensive LSVT LOUD protocol was confirmed.

The LSVT LOUD protocol was then administered. A summary of key LSVT LOUD treatment elements is provided (Table 1). For a full description of the treatment protocol, please see.(10)

Data Collection

Acoustic and perceptual testing and a motor speech examination were completed prior to beginning, immediately following, and five months post LSVT LOUD. Acoustic samples were collected using a SPL meter at a consistent microphone to

mouth distance of 30cm from session to session. Six repetitions of each task were collected at each session and mean values were used to reflect maximum sustained vowel phonation (MSVP), maximum phonation frequency range (MPFR), and maximum sound pressure level (MSPL) in a sustained vowel, and MSPL in speech. The functional impact of treatment upon communication was assessed by gathering perceptual data from the parent, caregiver and child. A visual analog scale (27,28) was used to rate 10 variables of speech, voice, and spoken communication.

Significant improvements were noted in acoustic measures from the time of the initial assessment completed prior to administration of the pre-treatment protocol through testing before and after LSVT LOUD. Following the pre-treatment protocol, the child had demonstrated the ability to learn and follow through with the LSVT LOUD intensive protocol. Significant improvements in acoustic measures collected at a 30cm microphone to mouth distance were noted, including MSVP, SPL of a sustained vowel, and SPL in speech phrases. All tasks were repeated six times. No improvements were made in highest or lowest maximum F0 range. Overall improvements were noted for speech and intelligibility, though variability due to behavior and cognitive-communication disorder was noted. Gains were maintained five-months post treatment, with improvements in all four areas and a significant increase in MSVP (Table 2). Previous disfluencies contributing to unintelligibility were absent during post-testing and follow-up.

Both the parent and child reported improvements in "breathing associated with speech, speech intelligibility and initiation and participation in a conversation." The child also reported improvements in ease of speech production, an ability to breathe and control speech, and confidence speaking with individuals.

DISCUSSION

In conclusion, LSVT LOUD was found to be successful in producing significant gains across acoustic and perceptual variables and in improving multiple parameters of functional communication in a child with dysarthria and ASD. More importantly, improvements were maintained, as reflected in post-testing at the five-month timepoint. Given significant improvements evidenced despite initial testing showing lack of stimulability, this report motivates serious consideration of appropriate pre-treatment protocols to allow more children to benefit from LSVT LOUD and other intensive interventions. Currently, those who do not immediately show signs of stimulability, who are unable to follow behavioral models or cues and who are unable to commit to intensive treatment, either physically or mentally, are not considered candidates for LSVT LOUD. An individualized pre-treatment protocol would permit children to be reached and benefit from intensive programs even when not immediately ready to participate at the time of the initial assessment and stimulability testing session.

The findings of this case report are significant as they are the first, to our knowledge, to use an evidenced-based, intensive treatment, LSVT LOUD, to treat motor-speech disorders among the ASD population. This report also documents the first case, to our knowledge, to implement a novel pre-treatment protocol for a child who was not initially eligible for an intensive treatment protocol, but who ultimately benefitted from the completion of it. While research continues to support the efficacy of intensive treatment, some children are prevented from receiving it given cognitive, physical or behavioral challenges. This case is a preliminary step in addressing ways clinicians can make LSVT LOUD accessible for a greater number of children. Much further study is necessary regarding treatment of pediatric dysarthria, especially among the ASD population. This case report illustrates a need for researchers to study how clinicians can accommodate the comorbid conditions that this and other populations may face through use of a pre-treatment protocol which can allow more children to access the benefits of LSVT LOUD and other intensive interventions.

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CONFLICTS OF INTEREST

Jessica Galgano's affiliations include Open Lines Speech and Communication PLLC in New York, New York, NYU Grossman School of Medicine in New York, New York, and LSVT Global, Inc. in Tucson, Arizona. Grace Ji Yan Tsang is affiliated with Open Lines Speech and Communication PLLC in New York, New York. Lorraine A. Ramig is affiliated with the Department of Biobehavioral Sciences, Teachers College, Columbia University, New York, New York, National Center for Voice and Speech, Denver, Colorado, Department of Speech-Language and Hearing Sciences, University of Colorado, Boulder, Colorado, and LSVT Global, Inc., Tucson, Arizona.

REFERENCES

1. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5). 5th ed. Washington, D. C: American Psychiatric Association. 2013.

2. Ming X, Brimacombe M, Wagner GC Prevalence of motor impairment in autism spectrum disorders. Brain Dev. 2007; 29: 565-570.

3. Shriberg LD, Strand EA, Jakielski KJ, Mabie HL. Estimates of the prevalence of speech and motor speech disorders in persons with complex neurodevelopmental disorders. Clin Linguist Phon. 2019; 33: 707-736.

4. Bhat AN. Is motor impairment in autism spectrum disorder distinct from developmental coordination disorder? A report from the SPARK study. Physical Therapy. 2020; 100: 633-644.

5. Velleman SL, Andrianopoulos MV, Boucher M, Perkins J, Averback K et. al. Motor Speech disorders in children with autism. In: Paul, R, Flipsen, P, editors. Speech sound disorders in children. San Diego, CA: Plural Publishing. 2009; 141-180.

6. Shriberg LD, Paul R, Black LM, Van Santen JP. The hypothesis of apraxia of speech in children with autism spectrum disorder. J Autism Dev Disord. 2011; 41: 405-426.

7. Levy ES, Moya-Galé G, Chang YHM, Freeman K, Forrest K, Brin MF et. al. The effects of intensive speech treatment on intelligibility in Parkinson's disease: A randomised controlled trial. EClinicalMedicin. 2020; 24: 1-11.

8. Ramig LO, Sapir S, Countryman S, Pawlas AA, O'Brien C, Hoehn M et

al. Intensive voice treatment (LSVT®) for patients with Parkinson's disease: A 2 year follow up. J Neurol Neurosurg Psychiatry. 2001; 71: 493-498.

9. Ramig LO, Sapir S, Fox C, Countryman S. Changes in vocal loudness following intensive voice treatment (LSVT®) in individuals with Parkinson's disease: A comparison with untreated patients and normal age-matched controls. Mov Disord. 2001; 16: 79-83.

10. Ramig L, Halpern A, Spielman J, Fox C, Freeman K. Speech treatment in Parkinson's diseas: Randomized controlled trial (RCT e). Mov Disord. 2018; 33: 1777-1791.

11. Fox CM, Boliek CA. Intensive voice treatment (LSVT LOUD) for children with spastic cerebral palsy and dysarthria. J Speech Lang Hear Res. 2012; 55: 930-945.

12. Levy ES, Ramig LO, Camarata SM. The effects of two speech interventions on speech function in pediatric dysarthria. Journal of Medical Speech-Language Pathology. 2013; 20: 82–87.

13. Levy ES. Implementing two treatment approaches to childhood dysarthria. Int J Speech Lang Pathol. 2014; 16: 344–354.

14. Boliek CA, Fox CM. Therapeutic effects of intensive voice treatment (LSVT LOUD®) for children with spastic cerebral palsy and dysarthria: A protocol I treatment validation study. Int J Speech Lang Pathol. 2017; 19: 601–615.

15. Reed A, Cummine J, Bakhtiari R, Fox CM, Boliek CA. Changes in white matter integrity following intensive voice treatment (LSVT LOUD®) in children with cerebral palsy and motor speech disorders. Dev Neurosci. 2017; 39: 460–471.

16. Mahler LA, Ramig LO, Fox C. Evidence-based treatment of voice and speech disorders in Parkinson disease. Curr Opin Otolaryngol Head Neck Surg. 2015; 23: 209–215.

17. Sapir S, Spielman JL, Ramig LO, Story BH, Fox CM. Effects of intensive voice treatment (the Lee Silverman voice treatment [LSVT]) on vowel articulation in dysarthric individuals with idiopathic Parkinson disease: Acoustic and perceptual finings. J Speech Lang Hear Res. 2007; 50: 899-912.

18. Ramage A, Fox C, Halpern A, Ramig L. Improved verb use in Parkinson's disease following intensive voice treatment. Movement Disorder Society Virtual Congress. 2020: 35.

19. Boliek CA, Fox CM. Individual and environmental contributions to treatment outcomes following a neuroplasticity-principled speech treatment (LSVT LOUD) in children with dysarthria secondary to cerebral palsy: A case study review. Int J Speech Lan Pathol. 2014; 16: 372-385.

20. Rogers SJ, Hayden D, Hepburn S, Charlifue-Smith R, Hall T, Hayes A. Teaching young nonverbal children with autism useful speech: A pilot study of the Denver model and PROMPT interventions. J of Autism Dev Disord. 2006; 36: 1007-1024.

21. Schmidt RC, Fitzpatrick P. Dynamical perspective on motor learning. In H. Zelaznik (Ed.) Advances in Motor Learning and Control. Champaign, IL: Human Kinetics. 1996; 195-223.

22. Eikeseth S, Smith T, Jahr E, Eldevik S. Intensive behavioral treatment at school for 4-to 7-year-old children with autism: A 1-year comparison-controlled study. Behav modif. 2002; 26: 49-68.

23. Wan CY, Bazen L, Baars R, Libenson A, Zipse L, Zuk J et. al. Auditory-motor mapping training as an intervention to facilitate speech output in non-verbal children with autism: A proof of concept study. PloS one. 2011; 6: e2550

24. Fox CM, Boliek CA. Intensive voice treatment (LSVT LOUD) for children with spastic cerebral palsy and dysarthria. J Speech Lang Hear Res. 2012; 55: 930-945.

25. Levy ES, Chang YM, Ancelle JA, McAuliffe MJ. Acoustic and perceptual consequences of speech cues for children with dysarthria. J Speech Lang Hear Res. 2017; 60: 1766-1779.

26. McAuliffe MJ, Kerr SE, Gibson EM, Anderson T, LaShell PJ. Cognitive–perceptual examination of remediation approaches to hypokinetic dysarthria. J Speech Lang Hearg Res. 2014; 57: 1268-1283.

27. Kempster G. A multidimensional analysis of vocal quality in two dysphonic groups [dissertation]. Evanston (IL): Northwestern University. 1984.

28. Schiffman SS, Reynolds ML, Young FW. Introduction to multidimensional scaling. 1st Edn. New York: Academic Press. 1981.

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