Report on the Impact of LSVT LOUD in Improving Communication of a Preschool Child and a Young Adult With Cerebral Palsy

Rapport clinique de l'impact du protocole LSVT LOUD pour améliorer la communication d'un enfant d'âge préscolaire et d'un jeune adulte ayant une paralysie cérébrale

Annie Joëlle Fortin
Alexandra Hamel
Frédérique Asselin-Giguère
Simone Poulin
David H. McFarland

KEYWORDS
CEREBRAL PALSY
DYSARTHRIA
LSVT LOUD

Annie Joëlle Fortin[1], Alexandra Hamel[1], Frédérique Asselin-Giguère[1], Simone Poulin[2], and David H. McFarland[2,3,4]

[1]Centre hospitalier universitaire Sainte-Justine, Montréal, QC, CANADA

[2]École d'orthophonie et d'audiologie, Faculté de médecine, Université de Montréal, Montréal, QC, CANADA

[3]School of Communication Sciences and Disorders, Faculty of Medicine, McGill University, Montréal, QC, CANADA

[4]Centre de recherche du Centre hospitalier universitaire Sainte-Justine, Montréal, QC, CANADA

Editor:
Karine Marcotte

Abstract

This clinical report presents real-world clinical data on the use of Lee Silverman voice treatment (LSVT LOUD) to improve the communication of one preschooler and one young adult with cerebral palsy. Each client received LSVT LOUD per protocol with 16 individual 1-hour-long therapy sessions, four times per week over a period of 4 weeks. Standard LSVT LOUD acoustic measures that included average vocal intensity during sustained vowel phonations and sentence repetitions and maximum duration of sustained vowel phonations were collected pre- and posttreatment. LSVT LOUD and our own perceptual ratings were also used to assess treatment effects from the caregivers' (and teacher's) perspective on speech, voice, and communicative participation. Our clinical findings revealed significant posttreatment increases in average vocal intensity during sustained vowel phonations for both clients and during sentence repetitions for the preschooler. Follow-up data from the young-adult client collected 3 and 20 months posttreatment revealed gains in average vocal intensity that were maintained well beyond the end of treatment. Our clinical findings also revealed significant increases in maximum duration of sustained vowel phonation pre- to posttreatment for the preschooler only. For the young adult, significant differences were found between pretreatment and the 20-month follow-up data. Perceptual ratings revealed improvements in communicative effectiveness, participation, and speech (for both clients) and velopharyngeal function (for the young adult) posttreatment. Combined, these clinical findings demonstrated to us the potential of our clients to increase their communicative abilities to be heard and understood well beyond what we thought were their clinical boundaries.

Abrégé

Le présent article clinique rapporte des données cliniques « réelles » relatives à l'utilisation du protocole *Lee Silverman voice treatment* (LSVT LOUD) pour améliorer la communication d'un enfant d'âge préscolaire et d'un jeune adulte ayant une paralysie cérébrale. Conformément au protocole LSVT LOUD, chaque patient a reçu 16 thérapies individuelles d'une durée d'une heure à raison de 4 séances par semaine sur une période de 4 semaines. Les mesures acoustiques standard du protocole LSVT LOUD, qui incluaient l'intensité vocale moyenne de phonations soutenues et de phrases répétées et la durée maximale de phonations soutenues, ont été recueillies pré- et post-traitement. Une mesure perceptuelle suggérée dans le protocole LSVT LOUD et des mesures perceptuelles fréquemment employées dans nos milieux cliniques ont également été utilisées pour évaluer l'effet de l'intervention perçu par l'entourage des patients sur la parole, la voix et la participation communicative. Nos données cliniques ont révélé une augmentation significative de l'intensité vocale moyenne des phonations soutenues post-traitement pour les deux patients et de l'intensité vocale moyenne des phrases répétées pour l'enfant d'âge préscolaire. Les données de suivi du jeune adulte recueillies 3 et 20 mois post-traitement ont révélé que les gains sur le plan de l'intensité vocale moyenne se sont maintenus bien au-delà de la fin du traitement. Nos données cliniques ont également révélé une augmentation significative de la durée maximale des phonations soutenues post-traitement pour l'enfant d'âge préscolaire seulement. Pour le jeune adulte, une augmentation significative de la durée maximale des phonations soutenues a été constatée entre les données recueillies prétraitement et celles recueillies 20 mois post-traitement. Les mesures perceptuelles ont révélé des améliorations post-traitement au niveau de l'efficacité de la communication, de la participation communicative et de la parole (pour les deux patients), ainsi qu'au niveau de la fonction vélopharyngée (pour le jeune adulte). L'ensemble de nos résultats cliniques nous ont montré que nos patients ont le potentiel d'améliorer leurs habiletés de communication pour être entendus et compris bien au-delà de ce que nous pensions être leurs limites cliniques.

Clinical Context

Cerebral palsy (CP) is a heterogeneous group of permanent impairments in motor function caused by nonprogressive lesions or abnormalities in the developing brain at any time from pregnancy through early childhood (Rosenbaum et al., 2007). It is one of the most common causes of neurodevelopmental motor disabilities, affecting approximately 0.21% of children born worldwide (Oskoui et al., 2013). Dysarthria resulting from disruptions in respiratory, phonatory, articulatory, prosody and/or velopharyngeal processes is the most common motor speech disorder in individuals with CP (Mei et al., 2020). Audible inspirations, monotone pitch, reduced loudness variation, harsh voice, imprecise consonant and vowel articulation, prolonged phonemes, short phrases, reduced rate, reduced stress, prolonged intervals between words or syllables, hypo- and/or hypernasality often characterize the speech of persons with CP (Mei et al., 2020; Nordberg et al., 2014; Schölderle et al., 2016; Workinger & Kent, 1991). These impairments reduce the intelligibility of words in isolation, sentences, and/or discourse (Hustad, 2007; Hustad et al., 2012, 2019; Mei et al., 2014, 2020), even when the severity of the dysarthria is mild to moderate (Hustad, 2007; Mei et al., 2020). Impaired communication consequent to CP and reduced intelligibility may negatively impact the ability of individuals with CP to express their needs, to start and maintain conversations, and to develop friendships (Connaghan et al., 2022; Mei et al., 2015; Pennington & McConachie, 2001), resulting in social isolation and reduced independence (Connaghan et al., 2022; Mei et al., 2014). These communicative impairments may also create behavioural issues related to an individual's frustration with communication breakdowns (Mei et al., 2015).

As speech-language pathologists in a large pediatric hospital system in Montréal, Québec, we regularly see children and young adults with these communicative impairments and the social consequences of dysarthria consequent to CP. We evaluate and treat individuals from 0 to 21 years of age in our hospital, rehabilitation centre, and specialized schools (Centre de réadaptation Marie-Enfant du Centre hospitalier universitaire Sainte-Justine, 2015a, 2015b, 2019). Our typical clinical approaches with these individuals have been traditional motor speech treatments that target one speech subsystem at a time (Hustad, 2010; Love, 2001; Workinger, 2005) and articulation treatments that focus on facilitating the acquisition of new phonemes and syllable structures in a hierarchical manner using external, multimodal feedback (visual, auditory and/or tactile cues; Hustad, 2010; Love, 2001). Both of these types of traditional therapies are given with a low intensity mode of treatment. Our typical approach has also included compensatory communication strategies such as the use of augmentative and alternative communication systems (Hustad, 2010) as needed.

As part of our regular clinical practice, we probe the available research literature to determine the availability of evidence-based treatments to improve the communication abilities of the individuals with CP seen in our clinical facilities. Prior to the case studies presented in the current report, an informal review of this literature drew our attention to three treatment approaches: the speech systems approach by Pennington et al. (2006, 2010, 2013, 2018, 2019), Lee Silverman voice treatment (LSVT LOUD) by Boliek, Fox, and colleagues (Boliek & Fox, 2014, 2017; Ertan et al., 2022; Fox & Boliek, 2012; Langlois et al., 2020; Levy et al., 2013; Moya-Galé et al., 2022; Reed et al., 2017), and the speech intelligibility treatment approach by Levy and colleagues (Carl et al., 2022; Levy et al., 2021; Moya-Galé et al., 2021).

Of these three treatment approaches, LSVT LOUD appeared to be the most promising for our specific clinical context for several reasons. First, the standardized protocol and well-established training and certification process provided all of the necessary information/documentation and online support needed to implement the protocol within our own clinical environments. Second, LSVT LOUD's low task complexity and low cognitive load using a single treatment focus on vocal loudness (Fox & Boliek, 2012) appeared to be ideal for our clients with CP who, similarly to what has been reported in the literature (Gabis et al., 2015; Mei et al., 2020), frequently have concomitant lower intellectual functioning and/or language difficulties. Third, and in contrast to the speech intelligibility treatment that is delivered in a camplike environment (Carl et al., 2022; Levy et al., 2021; Moya-Galé et al., 2021), LSVT LOUD's 60-minute, individual treatment sessions, 4 days per week, for 4 weeks was more easily implemented in our clinical context. Finally, we were encouraged by the promising results of the application of LSVT LOUD in driving the neuroplasticity potential of individuals with dysarthria consequent to CP (Bakhtiari et al., 2017; Reed et al., 2017) to improve their speech production abilities (Bakhtiari et al., 2017; Boliek & Fox, 2014, 2017; Ertan et al., 2022; Fox & Boliek, 2012; Langlois et al., 2020; Levy et al., 2013; Moya-Galé et al., 2022; Reed et al., 2017). These findings were in turn supported by the extensive clinical-research literature of the successful application of LSVT LOUD to other adult and pediatric populations, including Parkinson disease (for which it was initially designed; Ramig et al., 2018; Ramig, Sapir, Countryman, et al., 2001; Ramig, Sapir, Fox, & Countryman, 2001), Parkinsonian plus syndromes

(Countryman et al., 1994), adults without neurological disease or voice disorders (Ramig, Gray, et al., 2001), stroke (Mahler & Ramig, 2012; Mahler et al., 2009; Wenke et al., 2008, 2010), traumatic brain injury (Wenke et al., 2008, 2010), multiple sclerosis (Baldanzi et al., 2022), ataxia (Lowit et al., 2020; Sapir et al., 2003), Down syndrome (Boliek et al., 2022; Langlois et al., 2020; Mahler & Jones, 2012), and autism (Galgano et al., 2021).

The initial application of LSVT LOUD with individuals with CP was by Fox and Boliek (2012). They recruited five children with spastic CP between 5 and 7 years of age for an exploratory study. Four individuals were treated with LSVT LOUD, and a nontreated child acted as control. Despite some differences in the clinical findings of their participants, significant gains posttreatment were found on at least one of the acoustic measures of duration, frequency range, intensity, or harmonics-to-noise ratio in all four treated children.

Later studies amplified these results and revealed that, although LSVT LOUD with individuals with CP targets increased vocal loudness, its spread of effects extended to voice quality, pitch range, speech intelligibility, articulatory precision, and resonance (Boliek & Fox, 2014, 2017; Ertan et al., 2022; Langlois et al., 2020; Levy et al., 2013; Moya-Galé et al., 2022; Reed et al., 2017). Results of parental interviews have also indicated that LSVT LOUD may improve functional daily activities and social participation by helping individuals with CP to be better understood, increasing their confidence in their abilities to communicate orally, and enabling them to gain a voice among the members of their family by expressing their interests and wishes more frequently (Boliek & Fox, 2017). Furthermore, and of particular importance to our main therapeutic objectives (see below), we became aware of the maintenance of treatment gains in vocal intensity in individuals with CP following LSVT LOUD for up to 4 months (Moya-Galé et al., 2022) and for resonance up to 3 months (Boliek & Fox, 2017). Because we are interested in the functional impact of our therapy, we were also encouraged to learn of maintenance of gains in sentence intelligibility up to 3 months (Langlois et al., 2020) and social participation up to 6 weeks (Fox & Boliek, 2012; but see lack of maintenance of single word intelligibility in Boliek & Fox, 2017, and Langlois et al., 2020).

Based on this research literature, the well-defined protocol and training process, and the applicability to our clients and treatment centres, LSVT LOUD was selected as the treatment protocol of choice, and the two treating clinicians of the present report took the initiative to be trained and certified in LSVT LOUD and to use LSVT LOUD in their own clinical environment to treat the communicative impairments of two of their clients with CP. Because to our knowledge no case study had previously documented the application LSVT LOUD in a nonresearch environment and in daily clinical practice to treat the communicative impairments associated with CP, we decided to document the effectiveness of the clinical application of this treatment approach using standard LSVT LOUD and our own clinical measures. *It is important to note that this clinical initiative was not a research project.* The success that was observed encouraged us to share our clinical findings with the hope that they might prove useful to other clinicians working in similar clinical environments. The present clinical focus article, therefore, presents real-life clinical data of the application of LSVT LOUD with two individuals with CP, one preschool-age client and one young adult who was receiving school and therapeutic services in our clinical network in the province of Québec.

Clinical Approach

Sharing of Clinical Information

Clinical case studies are exempt from ethical review and approval because they do not meet the definition of research (K. Sénécal [Advisor for Research Ethics at the Université de Montréal], personal communication, April 3, 2020). They do, however, require written consent to share clinical information, and such permission was received from the mother of Client 1 (the preschool-age client) and from Client 2 (the young adult).

Client Characteristics and Therapeutic Objectives

Client 1

Client 1 was a 5-year-old girl with the medical diagnosis of mixed (spastic quadriparesis and dystonic) CP related to hypoxic ischemic encephalopathy and a Gross Motor Function Classification Systems score of III (Palisano et al., 1997). The client was receiving rehabilitation services at the Centre de réadaptation Marie-Enfant (the rehabilitation centre affiliated with the Centre hospitalier universitaire Sainte-Justine in Montréal, Québec) with various healthcare professionals, including speech-language pathologists and physical and occupational therapists, since 1 year of age. Audiological evaluation reported normal hearing. The client was bilingual in French and Spanish. Intervention was provided in French.

Although the client's receptive language abilities were age-appropriate, expressive language abilities were very limited (e.g., use of short and simple sentences, limited conversational topics). The client was identified as having moderate-to-severe dysarthria by the treating clinician

using the Functional Communication Measures of the American Speech-Language-Hearing Association (1997). The specific type of dysarthria was later identified by another speech-language pathologist as being spastic dysarthria. Clinical evaluation revealed poor respiratory-phonatory coordination, weak and sometimes tense voice, articulatory inaccuracies, lip and tongue movement incoordination, and movement execution delays. These speech characteristics resulted in inappropriate pauses within words and sentences, slow and effortful speech, imprecise articulation, and communication breakdowns with conversational partners. Uncontrolled movements of the head and arms during speech were also observed. This client was not responding well to traditional speech treatments.

The primary therapeutic objectives for this client were to increase vocal loudness and speech intelligibility and to improve communication with peers.

Client 2

Client 2 was a 19-year-old French-speaking male with a medical diagnosis of spastic quadriparesis CP and a Gross Motor Function Classification System score of III (Palisano et al., 1997). At the time of the treatment, the client was enrolled in a special education program at the École Joseph-Charbonneau, a specialized high school in Montréal for children, teenagers, and young adults aged 12 to 21 years with motor disorders. The client was also receiving rehabilitation services from speech-language pathologists and physical and occupational therapists on site through a service agreement with the Centre hospitalier universitaire Sainte-Justine. Individuals with special needs, such as those with CP, can attend specialized schools until the age of 21 in the province of Québec. Audiological evaluation reported normal hearing, and receptive and expressive language abilities were both judged functional for daily life activities. Speech-language pathology evaluation of this client revealed moderate spastic dysarthria and velopharyngeal incompetence with mild-to-moderate hypernasality, imprecise articulation, and breathy and mildly hoarse voice. Inappropriate pauses within sentences, slower rates of speech, production of inaudible word segments, and communication breakdowns in some contexts and/or with some conversational partners were common. Although educational reports indicated that the client had learning disabilities, cognitive abilities were functional for daily life activities.

This client had previously received traditional speech treatments and was responsive to treatment, but the results were limited, and no generalization was observed outside of treatment.

The client had consistent school attendance, showed strong involvement in studies and rehabilitation services, and had a strong motivation to improve communication abilities. Further, this client was shown to be stimulable for increased vocal loudness and improved articulation prior to treatment when asked to use a loud voice in the stimulability tasks of LSVT LOUD (i.e., a sustained vowel /a/ phonation task, a maximum high and low phonation task, and a functional sentence repetition task). All of these suggested that the client was a good candidate for LSVT LOUD. In addition, the client was approaching graduation, which meant a discontinuity in rehabilitation services, and the treating speech-language pathologist was motivated to provide an intensive, end-of-treatment approach for this client.

The therapeutic objectives for this client were to (a) increase vocal loudness, (b) improve speech intelligibility in daily life, and (c) reduce velopharyngeal incompetency through the potential distributed effect of LSVT LOUD across the speech production systems (Boliek & Fox, 2017; Fox et al., 2006). In all treatment sessions, the client was seated in a manually operated wheelchair (wheels locked) and was wearing his lumbar corset designed to slow the progression of scoliosis.

Treatment

Assessment of Vocal Medical Status Prior to Treatment

Although the verification of potential vocal fold pathology through otorhinolaryngologic examination (videolaryngostroboscopy) is standard research and clinical practice prior to beginning LSVT LOUD in adult patients such as those with Parkinson disease (e.g., Ramig et al., 2018; Ramig, Sapir, Countryman, et al., 2001), this procedure is inconsistent in the research literature on the application of LSVT LOUD in patients with CP. Two studies mentioned that an otorhinolaryngologic exam was used to rule out vocal pathology prior to LSVT LOUD (Ertan et al., 2022; Fox & Boliek, 2012), two indicated that the assessment of vocal pathology was gained from medical chart reviews (Boliek & Fox, 2017; Reed et al., 2017), one did not specify how vocal pathology was ruled out (Langlois et al., 2020), and four did not indicate that vocal pathology was assessed or ruled out prior to treatment (Bakhtiari et al., 2017; Boliek & Fox, 2014; Levy et al., 2013; Moya-Galé et al., 2022). Our clinicians verified the absence of vocal fold pathology from medical chart review and discussions with each client's medical team prior to beginning LSVT LOUD treatments.

LSVT LOUD

The LVST LOUD protocol was administered to both clients by their own licensed speech-language pathologist

(contributing authors to this report) certified in LSVT LOUD. As specified in the LSVT LOUD protocol, each client received 16 individual 1-hour long therapy sessions, four times per week over a period of 4 weeks. The first half of each session consisted of three tasks: (a) repetitions of maximum duration of a sustained vowel, (b) repetitions of maximal frequency range, and (c) repetitions of 10 functional phrases/sentences. This was followed by speech hierarchy exercises that changed daily and progressed to more challenging goals both in length and complexity and that were individualized for each client. Throughout all the exercises, the focus was on maintaining a loud, good quality voice (i.e., normal, healthy vocal loudness). Clients also practised their voice/speech exercises at home once a day on treatment days and twice a day on nontreatment days. Further they were encouraged to perform a functional carryover exercise every day of the treatment month. The parents of Client 1 (the preschool-age client) reported that their child completed these exercises two or three times a week (on days without treatment sessions), whereas Client 2 (the young adult client) self-reported completing them every day.

The functional phrases and tasks (such as the exercises practised at home) differed between the two clients given their difference in age. Measurement procedures and clinical measures used to determine the impact of LSVT LOUD on communication abilities also differed slightly between the two clients, as the speech-language pathologists used the resources and technologies available to them in their respective clinical environments.

Medication During Treatment

Medical chart review revealed that Client 1 received trihexyphenidyl (Artane) consistently during the course of treatment, but the dose was not specified in this client's medical records. Client 2 received 35 mg of Baclofen each day and this was maintained during the course of treatment.

Technologies Used to Monitor Clinical Progress and Collect Pre- and Posttreatment Acoustic Data

Client 1

The treating speech-language pathologist used the LSVT Companion, a software/hardware system that provides calibrated values of vocal intensity (in dB SPL), duration (in seconds), and frequency (in Hz), to monitor clinical progress during LSVT LOUD treatment (Halpern et al., 2012) and to collect pre- and posttreatment acoustic data. Recording was performed using the standard clinical procedure detailed in the user manual and a constant mouth-to-microphone distance of 30 cm.

Client 2

Because the treating speech-language pathologist did not have access to a LSVT Companion, she used the Voice Analyst application (version 2.21) that was running on an iPad Air (MD785C/A model) to monitor clinical progress and provide feedback during LSVT LOUD treatment and to collect pre- and posttreatment acoustic data. This application provides uncalibrated values of vocal intensity (in uncalibrated dB SPL), duration (in seconds), and frequency (in Hz). The iPad on which the Voice Analyst application was running was supported by an easel during data acquisition to ensure stability, visibility of the screen (to both the client and the speech-language pathologist), and a constant mouth-to-microphone distance of 30 cm within and across all treatment sessions.

Clinical Measures and Analyses

Acoustic Measures

Client 1. Standard LSVT LOUD clinical pre- and posttreatment acoustic measures were taken the day before the first day of treatment and the day after the last day of treatment. The treatment acoustic measures were average vocal intensity (in dB SPL) and maximum duration (in seconds) during six repetitions of the sustained /a/ phonation task, and average vocal intensity (in dB SPL) during a sentence repetition task containing twelve different sentences. These are standard acoustic measures in LSVT LOUD, and they have also been used in research projects to determine the impact of LSVT LOUD on the speech abilities of individuals with CP (Boliek & Fox, 2014; Ertan et al., 2022; Fox & Boliek, 2012; Moya-Galé et al., 2022).

Although increased maximal frequency range was treated, these data did not provide a reliable clinical measure as the clinician was required to continually model this task at the same time as the client produced the task, and thus, the acoustic data were contaminated.

To summarize the clinical acoustic measures and to provide a statistical measure of gains, if any, means and standard deviations were calculated pre- and posttreatment and compared statistically using paired *t* tests (Boliek & Fox, 2014). *P* values below .05 were considered statistically significant (Boliek & Fox, 2014, 2017; Fox & Boliek, 2012). All statistical analyses were performed with SPSS (Version 27).

Client 2. Standard LSVT LOUD clinical pre- and posttreatment acoustic measures were taken 11 days preceding the first day of treatment and on the last day of treatment, respectively. The treatment acoustic measures were average vocal intensity (in uncalibrated dB SPL) and

maximum duration (in seconds) during six repetitions of the sustained /a/ phonation task, highest fundamental frequency (F0; in Hz) during six repetitions of the high sustained /a/ phonation task, and lowest F0 (in Hz) during six repetitions of the low sustained /a/ phonation task. The same process as described for Client 1 above was used to assess treatment gains, if any, in these pre- to posttreatment acoustic data. Because this client was in a school setting and thus available to the treating speech-language pathologist for clinical follow up, measures from the sustained phonation task (average vocal intensity and maximum duration) collected under the same conditions as pre- and posttreatment were also recorded at 3- and 20-month follow-up periods. Paired *t* tests were used to compare pretreatment average vocal intensity and maximum duration from the sustained phonation task to data collected at the 3- and 20-month follow-up periods (Boliek & Fox, 2014; Moya-Galé et al., 2022).

Although average vocal intensity during a sentence repetition task was also measured the first and last day of treatment, the clinician recorded only a mean across all the sentences instead of an average vocal intensity for each individual sentence and thus, no statistical comparisons were completed for this task for this client.

Perceptual Measures

Client 1. In addition to the acoustic measures, two clinical perceptual tools, one suggested by LSVT LOUD protocol, and one often used in our standard clinical practice, documented LSVT LOUD treatment impact from the caregiver perspective. First, a French version of the perceptual rating form from the LSVT LOUD treatment materials was completed by the child's mother pre- and posttreatment. This form uses visual analogue scales to evaluate 10 key aspects of voice, speech, and communication. Specifically, and as described in Fox and Boliek (2012), the child's mother is asked to place a mark on a horizontal line whose endpoints are defined as the extreme limits of the voice/speech parameter of interest (e.g., *always loud enough* to *never loud enough*). The rating of each of these parameters is extracted from the visual analogue scale by measuring the distance of the mark from the right limit and by calculating the proportion of this distance to the total distance between the two endpoints, and by converting this proportion to a percentage. Each percentage indicates the mother's judgments of her child's voice, speech, or communication with a higher percentage indicating a positive perceptual judgment. As in Fox and Boliek (2012), the pre- to posttreatment difference in percent ratings for each variable was used as an indication of treatment impact for each of the voice/speech parameters of interest.

The child's mother also completed the French version of the Focus on the Outcomes of Communication Under Six (FOCUS-34) questionnaire (Oddson et al., 2019; Turcotte et al., 2013/2016) pre- and posttreatment. This questionnaire is a valid and reliable parent-report outcome measurement tool that is designed to capture changes in communicative participation over the course of treatment (Oddson et al., 2019; Turcotte et al., 2013/2016). It includes 34 seven-point Likert-scale questions about activities/capacities (e.g., "My child uses new words," "My child uses words to ask for things") and participation/performance (e.g., "My child is included in play activities by other children," "My child can communicate effectively with other children"). Responses to these questions are summed to obtain a total score. Each total represents the client's communicative participation status, with a higher score representing better communicative participation. The pre- to posttreatment FOCUS-34 total score difference was calculated and compared to the following published criteria: below 6 = absence of likelihood of meaningful clinical change, between 7 and 10 = potential meaningful clinical change, and above 11 = significant clinical change (Oddson et al., 2019).

Client 2. The client's mother and class teacher (who taught the client several subjects during the week) completed a French version of the perceptual rating form from the LSVT LOUD treatment materials pre- and posttreatment. Details of this form were provided in the description of perceptual measures for Client 1. The same analyses as described previously for Client 1 were used to determine the impact of LSVT LOUD on speech, voice, and communication characteristics.

Perceptual estimates of the adequacy of the velopharyngeal function and its articulatory impact were also performed pre- and posttreatment by the treating clinician using the Universal Parameters Ratings for Reporting Speech Outcomes in Cleft Palate (Henningsson et al., 2008; John et al., 2006). This rating tool that we regularly use in our clinical practice has been developed to standardize the perceptual evaluation of speech characteristics of children with cleft palate and is also used for the assessment of resonance disorders (American Speech-Language-Hearing Association, n.d.). It includes the ratings of five universal speech parameters (hypernasality, hyponasality, nasal air emissions and/or nasal turbulence, consonant production errors, voice disorders) and two global speech parameters (speech understandability and speech acceptability). The hypernasality, speech understandability and speech acceptability parameters are rated on a scale from 0 to 3 (0 = *within normal limits*, 1 = *mild*, 2 = *moderate*, 3 = *severe*). The hyponasality, nasal

air emission and/or nasal turbulence, consonant production errors and voice disorder parameters are rated as 0 (*within normal limits*) or 1 (*present*). The nasal air emission and/or nasal turbulence and consonant production errors parameters also include descriptors of frequency or type of errors. The perceptual evaluation was performed during a sentence repetition task containing 18 sentences (14 with words with oral sounds only and 4 with coarticulation of oral and nasal sounds). The characteristics of the sentences followed the guidelines of speech sample contexts and principles listed in Henningsson et al. (2008). A plastic tube with one end placed at the entrance of the client's nostril and the other near the clinician's ear was used to estimate hypernasality and/or nasal emissions during the sentence repetitions. This "listening tube," as described by Kummer (2011), is used clinically to detect inappropriate acoustic energy escaping through the nasal cavity during the production of oral sounds.

Clinical Findings

Acoustic Measures

Client 1

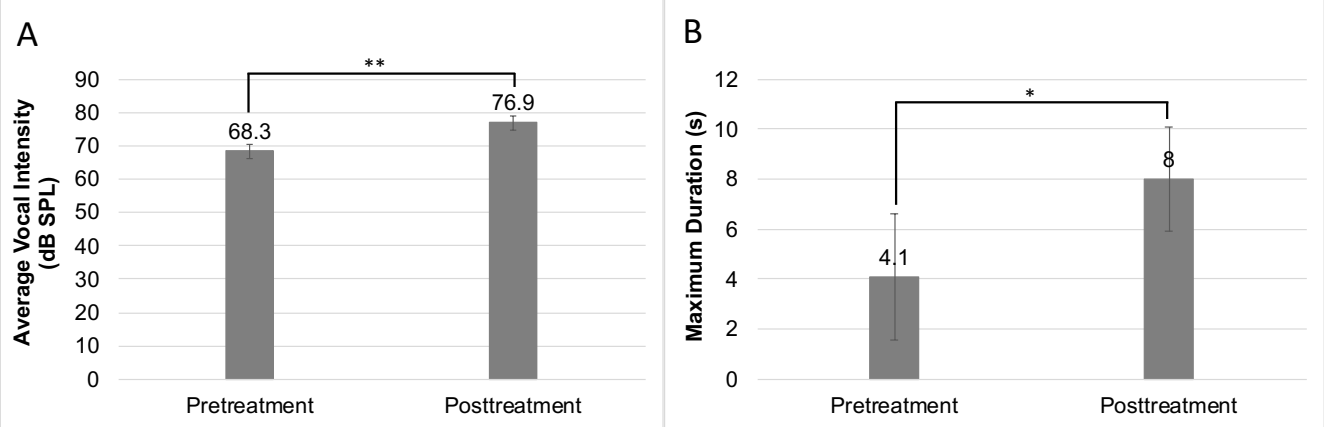
Presented in **Figure 1** are the pre- and posttreatment means and standard deviations of average vocal intensity and maximum duration from the six repetitions of the sustained vowel phonation task. Average vocal intensity increased from 68.3 dB SPL (*SD* = 2.2 dB SPL) pretreatment to 76.9 dB SPL (*SD* = 2.0 dB SPL) posttreatment and maximum duration increased from 4.1 s (*SD* = 2.5 s) pretreatment to 8.0 s (*SD* = 2.1 s) posttreatment. Paired *t* tests revealed that these increases were statistically significant (average vocal intensity: $t(5) = -8.189$, $p < .001$; maximum duration: $t(5) = -3.845$, $p = .012$).

Presented in **Figure 2** are the pre- and posttreatment means and standard deviations of average vocal intensity from the repetitions of the twelve sentences of the sentence repetition task. These values also increased significantly from 65.4 dB SPL (*SD* = 1.8 dB SPL) pretreatment to 73.0 dB SPL (*SD* = 2.1 dB SPL) posttreatment ($t(11) = -9.297$, $p < .001$).

Client 2

Presented in **Figure 3** are the means and standard deviations of average vocal intensity and maximum duration from the six repetitions of the sustained phonation task at pre-and posttreatment and at the 3- and 20-month follow-up periods. Also shown are the means and standard deviations of the highest and lowest F0 from the six repetitions of the high and low phonation tasks at pre- and posttreatment. As seen in **Figure 3**, average vocal intensity was 67.9 dB SPL (*SD* = 1.6 dB SPL) pretreatment, 74.3 dB SPL (*SD* = 1.4 dB SPL) posttreatment, 74.8 dB SPL (*SD* = 0.8 dB SPL) at the 3-month follow-up period, and 78.3 dB SPL (*SD* = 0.8 dB SPL) at the 20-month follow-up period.

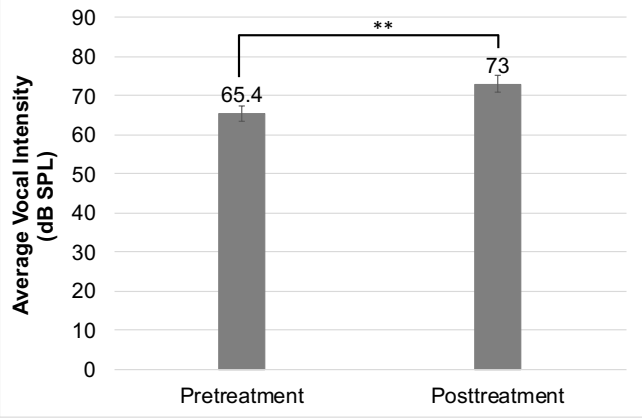
Figure 1



Client 1's pre- and posttreatment means and standard deviations of (A) average vocal intensity and (B) maximum duration from the six repetitions of the sustained phonation task

* $p < .05$. ** $p < .001$.

Figure 2

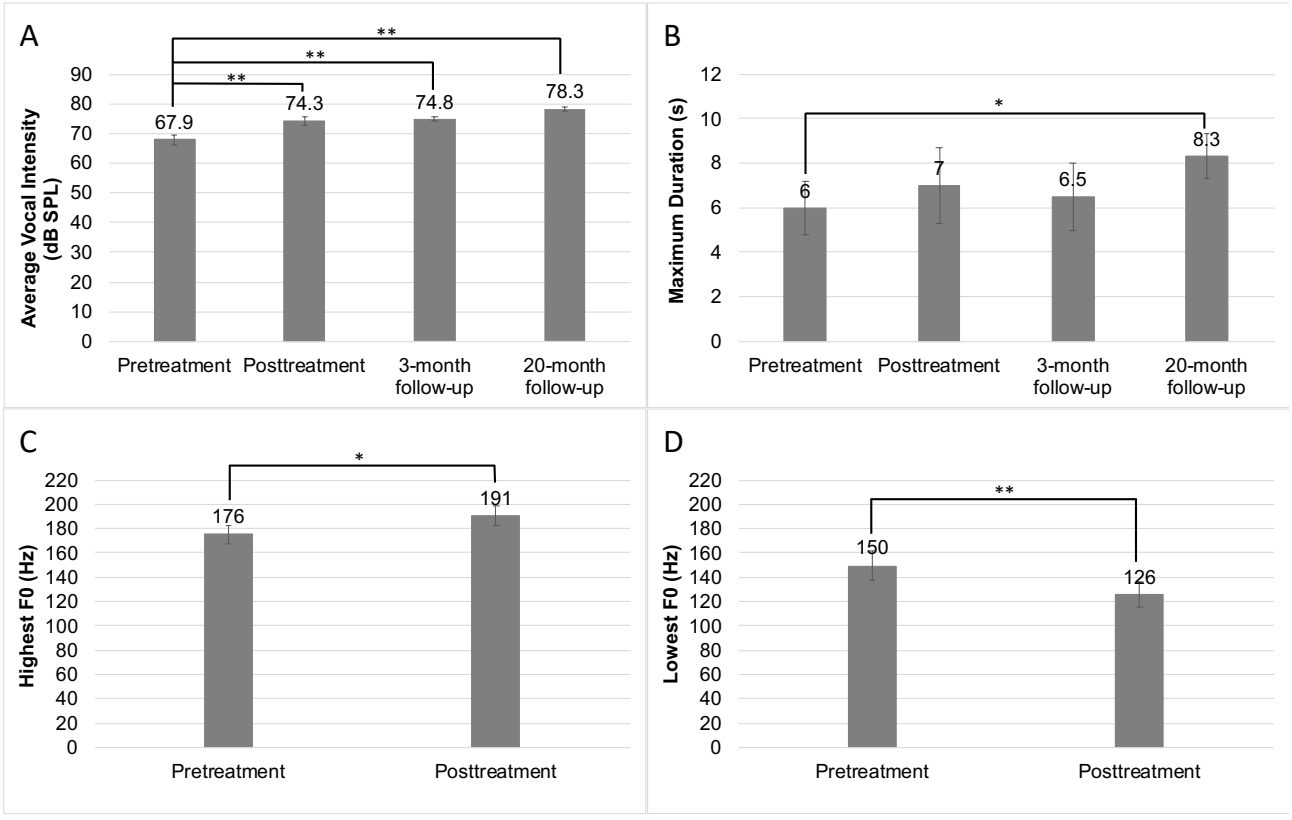


Client 1's pre- and posttreatment means and standard deviations of average vocal intensity (dB SPL) from the repetitions of the twelve sentences in the sentence repetition task

** $p < .001$.

Paired *t* tests were used to compare average vocal intensity pretreatment to posttreatment and pretreatment to the 3-month and 20-month follow-up periods. Significant increases in average vocal intensity were observed pre- to posttreatment ($t(5) = -11.355$, $p < .001$) and pretreatment to 3-month ($t(5) = -8.990$, $p < .001$) and 20-month ($t(5) = -13.795$, $p < .001$) follow-up periods. Maximum duration of sustained phonation was 6.0 s ($SD = 1.2$ s) pretreatment, 7.0 s ($SD = 1.7$ s) posttreatment, 6.5 s ($SD = 1.9$ s) at the 3-month follow-up period and 8.3 s ($SD = 1.0$ s) at the 20-month follow-up period. The only significant difference in these phonation times was between pretreatment and the 20-month follow-up period ($t(5) = -4.108$, $p = .009$). Significant differences were found between pre- (176 Hz, $SD = 8$ Hz) and post- (191 Hz, $SD = 8$ Hz) treatment highest F0 ($t(5) = -2.948$, $p = .032$) and between pre- (150 Hz, $SD = 13$ Hz) and post- (126 Hz, $SD = 10$ Hz) treatment lowest F0 ($t(5) = 6.986$, $p < .001$). Neither highest or lowest F0 was measured at the 3- or 20-month follow-up periods.

Figure 3

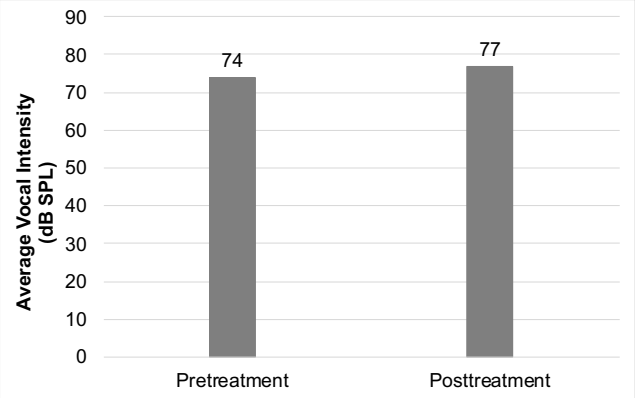


Client 2's pretreatment, posttreatment, 3-month follow-up, and 20-month follow-up means and standard deviations of (A) average vocal intensity and (B) maximum duration from the six repetitions of the sustained phonation task. Also shown are the pre- and posttreatment means and standard deviations of (C) highest and (D) lowest F0 from the six repetitions of the high and low phonation tasks, respectively

Note. F0 = fundamental frequency.
* $p < .05$. ** $p < .001$.

Presented in **Figure 4** are the pre- and posttreatment means of average vocal intensity from the sentence repetition task. As mentioned above, only means were available for this task and thus, no statistical analyses were performed.

Figure 4



Client 2's means of average vocal intensity during the sentence repetition task pre- and posttreatment

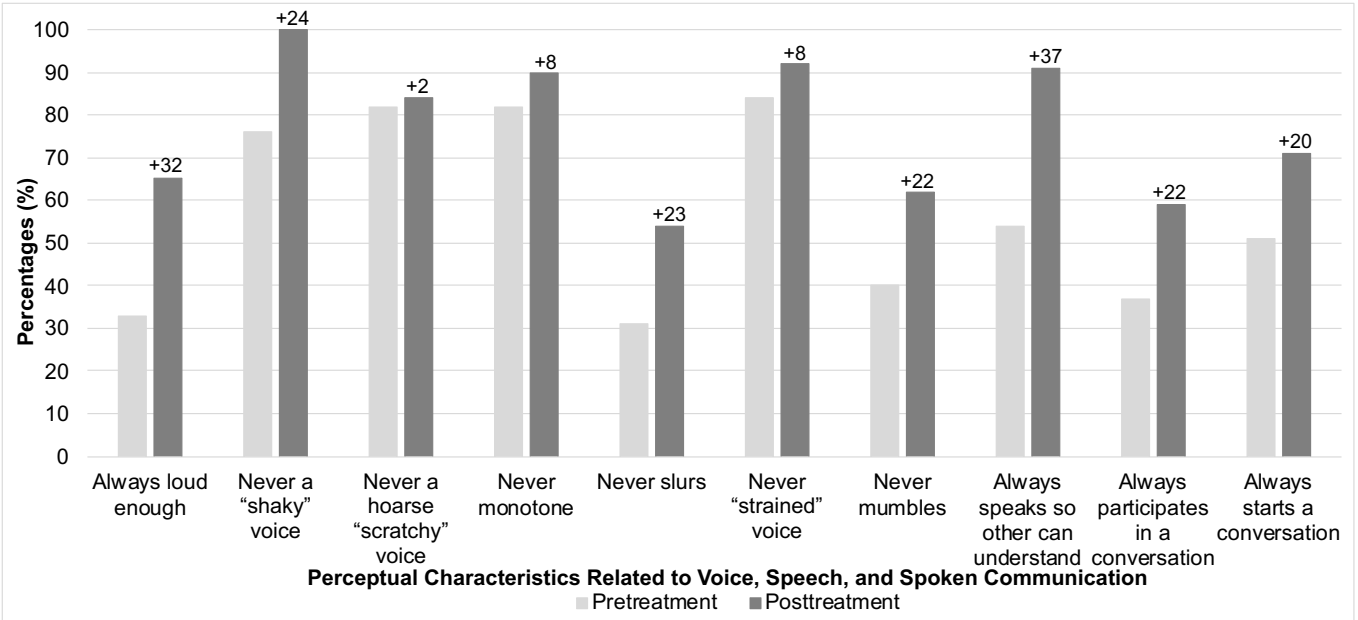
Perceptual Measures

Client 1

LSVT LOUD Perceptual Rating Form. Presented in **Figure 5** are the pre- and posttreatment ratings by Client 1's mother of the 10 variables of the LSVT LOUD perceptual rating form. As can be seen, the greatest improvements in percent change pre- to posttreatment were seen in "always speaks so others can understand" (37%), "always loud enough" (32%), "never a 'shaky' voice" (24%), "never slurs" (23%), "never mumbles" (22%), "always participates in a conversation" (22%), and "always starts a conversation" (20%).

FOCUS-34 Questionnaire. The total score of the FOCUS-34 questionnaire by Client 1's mother increased from 87 pretreatment to 115 posttreatment, resulting in a pre- to posttreatment difference score of 28. When compared to the criteria of Oddson et al. (2019), this pre- to posttreatment difference score of 28 suggests a significant clinical change in Client 1's communicative participation abilities following treatment.

Figure 5



Client 1's pre- and posttreatment perceptual ratings by mother on 10 characteristics of voice, speech, and communication

Note. The percentage of change (+ indicates improvement) pre- to posttreatment is indicated above the posttreatment bar.

Client 2

LSVT LOUD Perceptual Rating Form. Presented in **Figure 6** are the pre- and posttreatment ratings by Client 2's mother and teacher of the 10 variables of the perceptual rating form. For the mother, the greatest improvements in percent change pre- to posttreatment were seen in "always starts a conversation" (49%), "always loud enough" (48%), "always participates in a conversation" (43%) and "never slurs" (32%). For the teacher, the greatest improvements were seen in "always loud enough" (31%), "never monotone" (21%), "never slurs" (19%) and "always starts a conversation" (18%). Differences in percent change pre- to posttreatment were observed between the mother (M) and teacher (T) on three voice/speech variables: "never a hoarse, scratchy voice" (M: 18%; T: 2%), "never mumbles" (M: 17%; T: 2%), and "always participates in a conversation" (M: 43%; T: 3%). "Never a strained voice" was rated worse posttreatment by the teacher (–36%).

Universal Parameters Ratings. Presented in **Figure 7** are the pre- and posttreatment ratings by the clinician of the Universal Parameters Ratings. Improvements were observed for the hypernasality and speech acceptability parameters with both going from a *severe* rating (3) pretreatment to a *moderate* rating (2) posttreatment. Speech understandability also improved from a *moderate* rating (2) pretreatment to a *mild* rating (1) posttreatment. Audible nasal air emission and/or nasal turbulence was *present* pre- and posttreatment (rating of 1), but the frequency of this characteristic improved from *frequent* pretreatment to *intermittent* posttreatment. The parameters voice disorder and consonant production errors remained at the same rating pre- to posttreatment (1). The consonant production errors identified were weak oral pressures and other oral misarticulations. The parameter hyponasality was characterized as *normal* pre- and posttreatment (rating of 0).

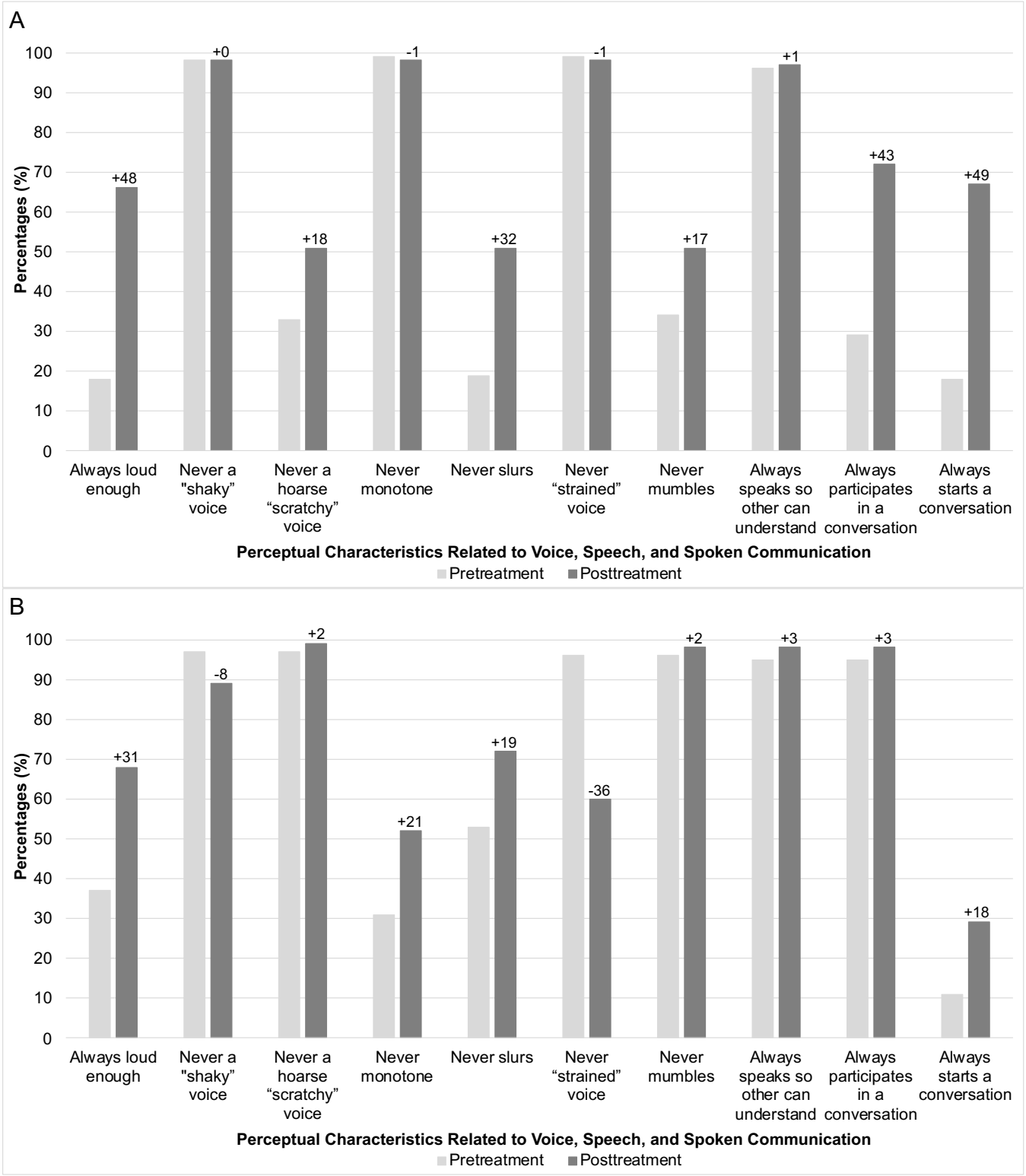
Clinical Conclusions

This is the first report, to our knowledge, of clinical case studies outside of a planned research investigation of the application of LSVT LOUD in the treatment of the communicative impairments associated with CP in two individuals, a preschooler and a young adult. These clinical findings add to the growing body of research literature supporting the application of evidence-based treatments to improve communication in pediatric and adult individuals with CP (e.g., Boliek & Fox, 2014, 2017; Carl et al., 2022; Ertan et al., 2022; Fox & Boliek, 2012; Langlois et al., 2020; Levy et al., 2013, 2021; Moya-Galé et al., 2021, 2022; Pennington et al., 2006, 2010, 2013, 2018, 2019; Reed et al., 2017). The LSVT LOUD protocol was applied and standard acoustical and perceptual measures were used to assess clinical outcomes. Our clinical findings revealed that average vocal intensity increased significantly pre- to posttreatment in the sustained phonation task for both clients, and for Client 2, for whom data were available, from pretreatment to 3- and 20-month follow-up periods. These clinical findings are generally similar to those of previous research investigations of increased posttreatment average vocal intensity for the sustained phonation task in individuals with CP (Boliek & Fox, 2017; Ertan et al., 2022; Reed et al., 2017) and maintenance of treatment impact at 3- (Boliek & Fox, 2017; Reed et al., 2017) and 4-month follow-up (Moya-Galé et al., 2022). Data from adults with Parkinson's disease also suggest that maintenance following LSVT LOUD can be documented over a longer period of time, more than 12 months after treatment (Nakayama et al., 2020; Ramig, Sapir, Countryman, et al., 2001).

In Client 1 (for whom data were available), average vocal intensity also increased significantly pre- to posttreatment for the sentence repetition task, and these clinical findings are also consistent with those of previous research studies of children with CP (Boliek & Fox, 2017; Langlois et al., 2020; Reed et al., 2017). Highest and lowest F0 for the high and low phonation tasks increased significantly pre- to posttreatment for Client 2 (for whom data were available) and these clinical data are consistent with the increased F0 range in adults (Ertan et al. 2022; Moya-Galé et al., 2022) and children (Fox & Boliek, 2012) after LSVT LOUD. No significant difference pre- to posttreatment in F0 range was observed in children with CP in the Boliek and Fox (2017) study.

Maximum duration of the sustained vowel phonation task increased significantly pre- to posttreatment for Client 1, but not for Client 2, despite a significant difference between the pretreatment and the 20-month follow-up data for this client. These differences between Clients 1 and 2 in changes in maximum duration of sustained phonation consequent to treatment may not be surprising given the inconsistency observed in the research literature of the impact of LSVT LOUD on this acoustic variable in individuals with CP (i.e., Boliek & Fox, 2017; Ertan et al., 2022; Fox & Boliek, 2012; Moya-Galé et al., 2022; Reed et al., 2017). As suggested previously (Boliek & Fox, 2014), it is possible that our clients might have benefited from receiving LSVT LOUD over a longer period of time to improve maximum duration of sustained phonation. The significant difference at the 20-month follow-up period and not posttreatment and at the 3-month follow-up period in Client 2 may be related to the continuation of practice and application of the strategies developed during treatment, as suggested by Boliek and Fox (2017).

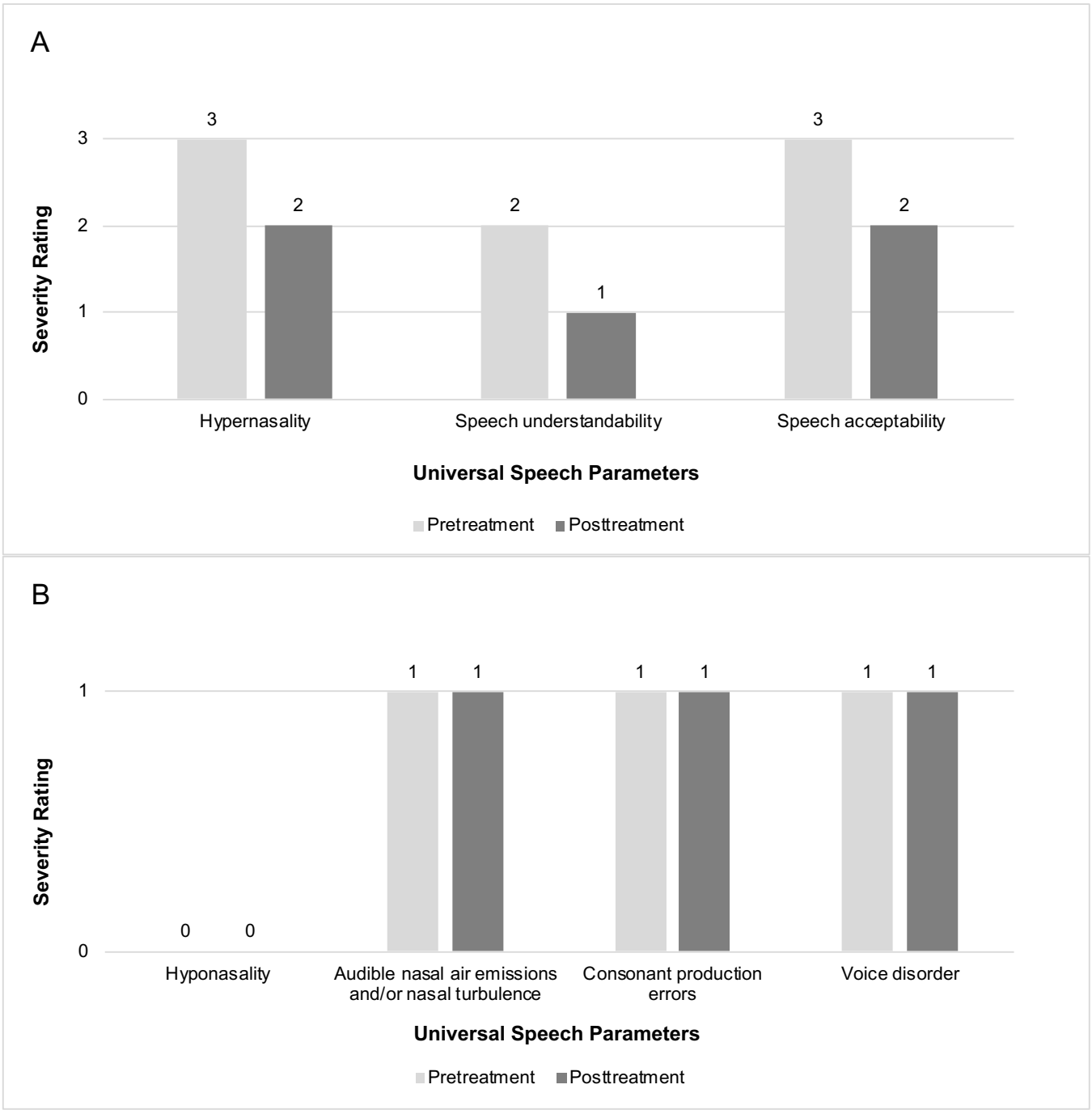
Figure 6



Client 2's pre- and posttreatment perceptual ratings by mother (A) and teacher (B) on 10 characteristics of voice, speech, and communication

Note. The percentage of change (+ indicates improvement; – indicates worsening) pre- to posttreatment is indicated above the posttreatment bar.

Figure 7



Client 2's pre- and posttreatment ratings of (A) one universal speech parameter (hypernasality) and two global speech parameters (speech understandability and speech acceptability) having a rating scale from 0 to 3, and (B) four universal speech parameters (hyponasality, nasal air emission and/or nasal turbulence, consonant production errors, voice disorder) having a score of 0 or 1

Note. Panel A: 0 = *within normal limits/none*, 1 = *mild*, 2 = *moderate*, 3 = *severe*. Panel B: 0 = *within normal limits/none*, 1 = *present*.

The FOCUS-34 from the mother of Client 1 indicated significative improvements in the quality of, and confidence in, communication pre- to posttreatment. The perceptual ratings of the clients' caregivers (and teacher) are perhaps a more powerful indication of clinical outcomes as they represent the complexities of communication beyond isolated vocal intensity, duration, and frequency measures. Taken together with previous research findings (Boliek & Fox, 2017; Ertan et al., 2022; Fox & Boliek, 2012), we are highly optimistic about the potential of LSVT LOUD to drive functional communicative outcomes in at least some of our clients with CP. We suggest that this might be of great interest to clinicians working with individuals with CP given that their ultimate therapeutic goal is to have an impact on real-life communication abilities and to enhance participation and integration in everyday lives (Centre de réadaptation Marie-Enfant du Centre hospitalier universitaire Sainte-Justine, 2015c; McLeod & Threats, 2008).

For Client 2, the young adult with CP, the teacher's ratings were consistently lower than those of the client's mother. One possible explanation is that the teacher has been exposed to many students with various profiles and severities of speech impairments, and perhaps the initial characteristics of the client's speech were judged less severe and thus improvements would be potentially less apparent posttreatment. The teacher also indicated that vocal strain actually increased posttreatment. This seems unlikely given that both clients were encouraged to use only a healthy, good quality voice, and Boliek and Fox (2017) reported improvements in acoustic measurement of voice quality following LSVT LOUD. Increased vocal strain was not observed by the treating clinician or mother outside of the treatment sessions. It might be hypothesized that the increase in vocal loudness made whatever vocal strain may have been present even more salient to the teacher. One could also argue that the mother's greater familiarity with the client's voice and speech may have contributed to differences in ratings between mother and teacher.

Improvements in velopharyngeal function and speech adequacy after LSVT LOUD were also observed in Client 2. Hypernasality and nasal air emissions both decreased posttreatment. Boliek and Fox (2014, 2017) attributed improvements in speech articulation and velopharyngeal function after LSVT LOUD to increased orofacial effort and greater velopharyngeal muscle activation and velopharyngeal closure. Perhaps similar mechanisms were at play in the improvements in velopharyngeal function and speech articulation in Client 2 after LSVT LOUD.

In summary, the present clinical results have revealed that LSVT LOUD positively impacted the communication of a preschooler and young adult with CP outside of a planned research study. Of course, this is a very small snapshot of only two clients, but we believe that these clients are highly representative of those we work with on a daily basis, so we are optimistic that we might have similar treatment gains with our future clients with CP. Although these clinical findings are highly encouraging and consistent with previous research investigations, they were not conducted under research conditions, and we present them with the full understanding that they lack research experimental controls and measures of reliability. They are, however, highly reflective of our real-world clinical contexts.

One of the primary goals of treatment research is the eventual translation of research knowledge into everyday clinical practice. Our clinicians took the initiative to bring the research findings of the impact of LSVT LOUD in individuals with CP (and other disorders) out of the lab and into their own clinical worlds. Our hope is that the current clinical report encourages other clinicians to consider the application of this, and other evidence-based protocols, in the treatment of the often-devastating communicative impairments associated with CP. Our current clinical experience convinced us that our clients with CP have a much greater potential than we previously realized to go beyond what we thought were their clinical boundaries to increase their communicative abilities to be heard and understood.

References

American Speech-Language-Hearing Association. (n.d.). *Comprehensive assessment for resonance disorders: Typical components*. https://www.asha.org/practice-portal/clinical-topics/resonance-disorders/comprehensive-assessment-for-resonance-disorders/

American Speech-Language-Hearing Association. (1997). *Functional communication measures*. https://www.edu.gov.mb.ca/k12/specedu/slp/pdf/2.pdf

Bakhtiari, R., Cummine, J., Reed, A., Fox, C. M., Chouinard, B., Cribben, I., & Boliek, C. A. (2017). Changes in brain activity following intensive voice treatment in children with cerebral palsy. *Human Brain Mapping, 38*(9), 4413–4429. https://doi.org/10.1002/hbm.23669

Baldanzi, C., Crispiatico, V., Foresti, S., Groppo, E., Rovaris, M., Cattaneo, D., & Vitali, C. (2022). Effects of intensive voice treatment (the Lee Silverman Voice Treatment [LSVT LOUD]) in subjects with multiple sclerosis: A pilot study. *Journal of Voice, 36*(4), 585.e1–585.e13. https://doi.org/10.1016/j.jvoice.2020.07.025

Boliek, C. A., & Fox, C. M. (2014). 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. *International Journal of Speech-Language Pathology, 16*(4), 372–385. https://doi.org/10.3109/17549507.2014.917438

Boliek, C. A., & Fox, C. M. (2017). Therapeutic effects of intensive voice treatment (LSVT LOUD®) for children with spastic cerebral palsy and dysarthria: A phase I treatment validation study. *International Journal of Speech-Language Pathology, 19*(6), 601–615. https://doi.org/10.1080/17549507.2016.1221451

Boliek, C. A., Halpern, A., Hernandez, K., Fox, C. M., & Ramig, L. (2022). Intensive voice treatment (Lee Silverman voice treatment [LSVT LOUD]) for children with Down syndrome: Phase I outcomes. *Journal of Speech, Language, and Hearing Research, 65*(4), 1228–1262. https://doi.org/10.1044/2021_JSLHR-21-00228

Carl, M., Levy, E. S., & Icht, M. (2022). Speech treatment for Hebrew-speaking adolescents and young adults with developmental dysarthria: A comparison of *m*SIT and Beatalk. *International Journal of Language & Communication Disorders, 57*(3), 660–679. https://doi.org/10.1111/1460-6984.12715

Centre de réadaptation Marie-Enfant du Centre hospitalier universitaire Sainte-Justine. (2015a, March 20). *Cerebral motor deficits*. https://readaptation.chusj.org/en/Specialized-rehabilitation-services/Cerebral-Motor-Deficits

Centre de réadaptation Marie-Enfant du Centre hospitalier universitaire Sainte-Justine. (2015b, March 20). *Motor development disorders program*. https://readaptation.chusj.org/en/Specialized-rehabilitation-services/Motor-Development-Disorders

Centre de réadaptation Marie-Enfant du Centre hospitalier universitaire Sainte-Justine. (2015c, March 20). *Our mission*. https://readaptation.chusj.org/en/Discover-who-we-are/Who-we-are/Our-Mission

Centre de réadaptation Marie-Enfant du Centre hospitalier universitaire Sainte-Justine. (2019, August 9). *School rehabilitation*. https://readaptation.chusj.org/en/Specialized-rehabilitation-services/School-Rehabilitation

Connaghan, K. P., Baylor, C., Romanczyk, M., Rickwood, J., & Bedell, G. (2022). Communication and social interaction experiences of youths with congenital motor speech disorders. *American Journal of Speech-Language Pathology, 31*(6), 2609–2627. https://doi.org/10.1044/2022_AJSLP-22-00034

Countryman, S., Ramig, L. O., & Pawlas, A. A. (1994). Speech and voice deficits in Parkinsonian plus syndromes: Can they be treated? *National Center for Voice and Speech Status and Progress Report, 6,* 99–111.

Ertan, E., Gürvit, H. I., Hanağası, H. H., Bilgiç, B., Tunçer, M. A., & Yılmaz, C. (2022). Intensive voice treatment (the Lee Silverman Voice Treatment [LSVT® LOUD]) for individuals with Wilson's disease and adult cerebral palsy: Two case reports. *Logopedics Phoniatrics Vocology, 47*(4), 262–270. https://doi.org/10.1080/14015439.2021.1951348

Fox, C. M., & Boliek, C. A. (2012). Intensive voice treatment (LSVT LOUD) for children with spastic cerebral palsy and dysarthria. *Journal of Speech, Language, and Hearing Research, 55*(3), 930–945. https://doi.org/10.1044/1092-4388(2011/10-0235)

Fox, C. M., Ramig, L. O., Ciucci, M. R., Sapir, S., McFarland, D. H., & Farley, B. G. (2006). The science and practice of LSVT/LOUD: Neural plasticity-principled approach to treating individuals with Parkinson disease and other neurological disorders. *Seminars in Speech and Language, 27*(4), 283–299. http://doi.org/10.1055/s-2006-955118

Gabis, L. V., Tsubary, N. M., Leon, O., Ashkenasi, A., & Shefer, S. (2015). Assessment of abilities and comorbidities in children with cerebral palsy. *Journal of Child Neurology, 30*(12), 1640–1645. https://doi.org/10.1177/0883073815576792

Galgano, J., Tsan, G., J., Y., & Ramig, L. O. (2021). Making intensive voice treatment (LSVT® LOUD) accessible for a child with autism spectrum disorder (ASD) and mixed dysarthria using a novel, pre-treatment protocol. *JSM Communication Disorders, 4*(1), Article 1013. https://www.jscimedcentral.com/public/assets/articles/communicationdisorders-4-1013.pdf

Halpern, A. E., Ramig, L. O., Matos, C. E. C., Petska-Cable, J. A., Spielman, J. L., Pogoda, J. M., Gilley, P. M., Sapir, S., Bennett, J. K., & McFarland, D. H. (2012). Innovative technology for the assisted delivery of intensive voice treatment (LSVT® LOUD) for Parkinson disease. *American Journal of Speech-Language Pathology, 21*(4), 354–367. https://doi.org/10.1044/1058-0360(2012/11-0125)

Henningsson, G., Kuehn, D. P., Sell, D., Sweeney, T., Trost-Cardamone, J. E., & Whitehill, T. L. (2008). Universal parameters for reporting speech outcomes in individuals with cleft palate. *The Cleft Palate Craniofacial Journal, 45*(1), 1–17. https://doi.org/10.1597/06-086.1

Hustad, K. C. (2007). Effects of speech stimuli and dysarthria severity on intelligibility scores and listener confidence ratings for speakers with cerebral palsy. *Folia Phoniatrica et Logopaedica, 59*(6), 306–317. https://doi.org/10.1159/000108337

Hustad, K. C. (2010). Childhood dysarthria: Cerebral palsy. In K. M. Yorkston, D. R. Beukelman, E. A. Strad, & M. Hakel (Eds.), *Management of motor speech disorders in children and adults* (3rd ed., pp. 359–384). PRO-ED.

Hustad, K. C., Sakash, A., Natzke, P. E. M., Broman, A. T., & Rathouz, P. J. (2019). Longitudinal growth in single word intelligibility among children with cerebral palsy from 24 to 96 months of age: Predicting later outcomes from early speech production. *Journal of Speech, Language, and Hearing Research, 62*(6), 1599–1613. https://doi.org/10.1044/2018_JSLHR-S-18-0319

Hustad, K. C., Schueler, B., Schultz, L., & DuHadway, C. (2012). Intelligibility of 4-year-old children with and without cerebral palsy. *Journal of Speech, Language, and Hearing Research, 55*(4), 1177–1189. https://doi.org/10.1044/1092-4388(2011/11-0083)

John, A., Sell, D., Sweeney, T., Harding-Bell, A., & Williams, A. (2006). The cleft audit protocol for speech—Augmented: A validated and reliable measure for auditing cleft speech. *The Cleft Palate Craniofacial Journal, 43*(3), 272–288. https://doi.org/10.1597/04-141.1

Kummer, A. W. (2011). Perceptual assessment of resonance and velopharyngeal function. *Seminars in Speech and Language, 32*(2), 159–167. http://doi.org/10.1055/s-0031-1277718

Langlois, C., Tucker, B. V., Sawatzky, A. N., Reed, A., & Boliek, C. A. (2020). Effects of an intensive voice treatment on articulatory function and speech intelligibility in children with motor speech disorders: A phase one study. *Journal of Communication Disorders, 86*, Article 106003. https://doi.org/10.1016/j.jcomdis.2020.106003

Levy, E. S., Chang, Y. M., Hwang, K., & McAuliffe, M. J. (2021). Perceptual and acoustic effects of dual-focus speech treatment in children with dysarthria. *Journal of Speech, Language, and Hearing Research, 64*(6S), 2301–2316. https://doi.org/10.1044/2020_JSLHR-20-00301

Levy, E. S., Ramig, L. O., & Camarata, S. M. (2013). The effects of two speech interventions on speech function in pediatric dysarthria. *Journal of Medical Speech-Language Pathology, 20*(4), 82–87. https://doi.org/10.7916/d8-9wz2-n825

Love, R. J. (2001). *Childhood motor speech disability* (2nd ed.). Allyn & Bacon.

Lowit, A., Egan, A., & Hadjivassiliou, M. (2020). Feasibility and acceptability of Lee Silverman Voice Treatment in progressive ataxias. *The Cerebellum, 19*(5), 701–714. http://doi.org/10.1007/s12311-020-01153-3

Mahler, L. A., & Jones, H. N. (2012). Intensive treatment of dysarthria in two adults with Down syndrome. *Developmental Neurorehabilitation, 15*(1), 44–53. https://doi.org/10.3109/17518423.2011.632784

Mahler, L. A., & Ramig, L. O. (2012). Intensive treatment of dysarthria secondary to stroke. *Clinical Linguistics & Phonetics, 26*(8), 681–694. https://doi.org/10.3109/02699206.2012.696173

Mahler, L. A., Ramig, L. O., & Fox, C. (2009). Intensive voice treatment (LSVT-LOUD) for dysarthria secondary to stroke. *Journal of Medical Speech-Language Pathology, 17*(4), 165–182. https://link.gale.com/apps/doc/A212769718/AONE?u=googlescholar&sid=bookmark-AONE&xid=07667805

McLeod, S., & Threats, T. T. (2008). The ICF-CY and children with communication disabilities. *International Journal of Speech-Language Pathology, 10*(1–2), 92–109. https://doi.org/10.1080/17549500701834690

Mei, C., Reilly, S., Bickerton, M., Mensah, F., Turner, S., Kumaranayagam, D., Pennington, L., Reddihough, D., & Morgan, A. T. (2020). Speech in children with cerebral palsy. *Developmental Medicine & Child Neurology, 62*(12), 1374–1382. https://doi.org/10.1111/dmcn.14592

Mei, C., Reilly, S., Reddihough, D., Mensah, F., Green, J., Pennington, L., & Morgan, A. T. (2015). Activities and participation of children with cerebral palsy: Parent perspectives. *Disability and Rehabilitation, 37*(23), 2164–2173. https://doi.org/10.3109/09638288.2014.999164

Mei, C., Reilly, S., Reddihough, D., Mensah, F., & Morgan, A. (2014). Motor speech impairment, activity, and participation in children with cerebral palsy. *International Journal of Speech-Language Pathology, 16*(4), 427–435. https://doi.org/10.3109/17549507.2014.917439

Moya-Galé, G., Galgano, J., Ferrone, C., Chang, Y. M., & Ramig, L. A. (2022). LSVT LOUD® applied to an adult with cerebral palsy: Acoustic findings. *Communication Disorders Quarterly, 43*(2), 119–127. https://doi.org/10.1177/1525740121993802

Moya-Galé, G., Keller, B., Escorial, S., & Levy, E. S. (2021). Speech treatment effects on narrative intelligibility in French-speaking children with dysarthria. *Journal of Speech, Language, and Hearing Research, 64*(6S), 2154–2168. https://doi.org/10.1044/2020_JSLHR-20-00258

Nakayama, K., Yamamoto, T., Oda, C., Sato, M., Murakami, T., & Horiguchi, S. (2020). Effectiveness of Lee Silverman Voice Treatment® LOUD on Japanese-speaking patients with Parkinson's disease. *Rehabilitation Research and Practice, 2020*, Article 6585264. https://doi.org/10.1155/2020/6585264

Nordberg, A., Miniscalco, C., & Lohmander, A. (2014). Consonant production and overall speech characteristics in school-aged children with cerebral palsy and speech impairment. *International Journal of Speech-Language Pathology, 16*(4), 386–395. https://doi.org/10.3109/17549507.2014.917440

Oddson, B., Thomas-Stonell, N., Robertson, B., & Rosenbaum, P. (2019). Validity of a streamlined version of the Focus on the Outcomes of Communication Under Six: Process and outcome. *Child: Care, Health and Development, 45*(4), 600–605. https://doi.org/10.1111/cch.12669

Oskoui, M., Coutinho, F., Dykeman, J., Jetté, N., & Pringsheim, T. (2013). An update on the prevalence of cerebral palsy: A systematic review and meta-analysis. *Developmental Medicine & Child Neurology, 55*(6), 509–519. https://doi.org/10.1111/dmcn.12080

Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., & Galuppi, B. (1997). Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Developmental Medicine & Child Neurology, 39*(4), 214–223. https://doi.org/10.1111/j.1469-8749.1997.tb07414.x

Pennington, L., Lombardo, E., Steen, N., & Miller, N. (2018). Acoustic changes in the speech of children with cerebral palsy following an intensive program of dysarthria therapy. *International Journal of Language & Communication Disorders, 53*(1), 182–195. https://doi.org/10.1111/1460-6984.12336

Pennington, L., & McConachie, H. (2001). Predicting patterns of interaction between children with cerebral palsy and their mothers. *Developmental Medicine & Child Neurology, 43*(2), 83–90. https://pubmed.ncbi.nlm.nih.gov/11221909/

Pennington, L., Miller, N., Robson, S., & Steen, N. (2010). Intensive speech and language therapy for older children with cerebral palsy: A systems approach. *Developmental Medicine & Child Neurology, 52*(4), 337–344. https://doi.org/10.1111/j.1469-8749.2009.03366.x

Pennington, L., Roelant, E., Thompson, V., Robson, S., Steen, N., & Miller, N. (2013). Intensive dysarthria therapy for younger children with cerebral palsy. *Developmental Medicine & Child Neurology, 55*(5), 464–471. https://doi.org/10.1111/dmcn.12098

Pennington, L., Smallman, C., & Farrier, F. (2006). Intensive dysarthria therapy for older children with cerebral palsy: Findings from six cases. *Child Language Teaching and Therapy, 22*(3), 255–273. http://doi.org/10.1191/0265659006ct307xx

Pennington, L., Stamp, E., Smith, J., Kelly, H., Parker, N., Stockwell, K., Aluko, P., Othman, M., Brittain, K., & Vale, L. (2019). Internet delivery of intensive speech and language therapy for children with cerebral palsy: A pilot randomised controlled trial. *BMJ Open, 9*(1), Article e024233. http://doi.org/10.1136/bmjopen-2018-024233

Ramig, L. O., Gray, S., Baker, K., Corbin-Lewis, K., Buder, E., Luschei, E., Coon, H., & Smith, M. (2001). The aging voice: A review, treatment data and familial and genetic perspectives. *Folia Phoniatrica et Logopaedica, 53*(5), 252–265. https://doi.org/10.1159/000052680

Ramig, L. O., Halpern, A., Spielman, J., Fox, C., & Freeman, K. (2018). Speech treatment in Parkinson's disease: Randomized controlled trial (RCT). *Movement Disorders, 33*(11), 1777–1791. https://doi.org/10.1002/mds.27460

Ramig, L. O., Sapir, S., Countryman, S., Pawlas, A. A., O'Brien, C., Hoehn, M., & Thompson, L. L. (2001). Intensive voice treatment (LSVT®) for patients with Parkinson's disease: A 2 year follow-up. *Journal of Neurology, Neurosurgery & Psychiatry, 71*(4), 493–498. http://doi.org/10.1136/jnnp.71.4.493

Ramig, L. O., Sapir, S., Fox, C., & Countryman, S. (2001). 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. *Movement Disorders, 16*(1), 79–83. https://doi.org/10.1002/1531-8257(200101)16:1<79::AID-MDS1013>3.0.CO;2-H

Reed, A., Cummine, J., Bakhtiari, R., Fox, C. M., & Boliek, C. A. (2017). Changes in white matter integrity following intensive voice treatment (LSVT LOUD®) in children with cerebral palsy and motor speech disorders. *Developmental Neuroscience, 39*(6), 460–471. https://doi.org/10.1159/000478724

Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., Bax, M., Damiano, D., Dan, B., & Jacobsson, B. (2007). A report: The definition and classification of cerebral palsy April 2006. *Developmental Medicine & Child Neurology, 49*(S109), 8–14. https://doi.org/10.1111/j.1469-8749.2007.tb12610.x

Sapir, S., Spielman, J., Ramig, L. O., Hinds, S. L., Countryman, S., Fox, C., & Story, B. (2003). Effects of intensive voice treatment (the Lee Silverman Voice Treatment [LSVT]) on ataxic dysarthria. *American Journal of Speech-Language Pathology, 12*(4), 387–399. https://doi.org/10.1044/1058-0360(2003/085)

Schölderle, T., Staiger, A., Lampe, R., Strecker, K., & Ziegler, W. (2016). Dysarthria in adults with cerebral palsy: Clinical presentation and impacts on communication. *Journal of Speech, Language, and Hearing Research, 59*(2), 216–229. https://doi.org/10.1044/2015_JSLHR-S-15-0086

Turcotte, J., Oddson, B., & Desmarais, C. (2016). *Focus on the Outcomes of Communication Under Six–34–Français.* Holland Bloorview Kids Rehabilitation Hospital. (Original work published 2013)

Wenke, R. J., Cornwell, P., & Theodoros, D. G. (2010). Changes to articulation following LSVT® and traditional dysarthria therapy in non-progressive dysarthria. *International Journal of Speech-Language Pathology, 12*(3), 203–220. https://doi.org/10.3109/17549500903568468

Wenke, R. J., Theodoros, D., & Cornwell, P. (2008). The short- and long-term effectiveness of the LSVT® for dysarthria following TBI and stroke. *Brain Injury, 22*(4), 339–352. https://doi.org/10.1080/02699050801960987

Workinger, M. S. (2005). *Cerebral palsy resource guide for speech-language pathologists.* Thomson Delmar Learning.

Workinger, M. S., & Kent, R. D. (1991). Perceptual analysis of the dysarthrias in children with athetoid and spastic cerebral palsy. In C. A. Moore, K. M. Yorkston, & D. R. Beukelman (Eds.), *Dysarthria and apraxia of speech. Perspectives on management* (pp. 109–126). Paul H. Brookes Publishing.

Authors' Note

Correspondence concerning this article should be addressed to Annie Joëlle Fortin, Centre hospitalier universitaire Sainte-Justine, 3175 Chemin de la Côte-Sainte-Catherine, Montréal, QC, Canada, H3T 1C5.
Email: **annie-joelle.fortin.hsj@ssss.gouv.qc.ca**

Acknowledgments

Our thanks to Annie Salois for her assistance with the clinical interpretation of the velopharyngeal function results, Cynthia Fox for her comments on an earlier version of this article, and two anonymous reviewers for their many helpful suggestions for revision.

Disclosures

D. H. McFarland has ownership interest in LSVT Global, Inc. No other conflicts of interest, financial or otherwise, are declared by the authors.