The Effects of Intensive Voice Treatment (LSVT LOUD®) on Speech Motor Control in Children with Down Syndrome

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INTRODUCTION

Purpose

To determine if a voice treatment, LSVT LOUD®, designed to facilitate motor execution (through intensive treatment, endurance and active practice) and motor learning (through sensory feedback, repeated practice trials and intensive training) can improve voice and speech for children with Down Syndrome (DS).

Background

Children with Down Syndrome (DS) experience challenges communicating orally. Whereas, both speech and language are affected by the syndrome, more significant deficits are reported for speech.(1, 2) The voice quality associated with DS has been described as hoarse, low pitched, breathy and monotonous.(3-7) Reduced intelligibility also has been reported.(1, 8, 9) Communication disorders associated with DS are primarily neurogenic.(9) Therefore, it was reasoned that voice or speech therapy techniques consistent with the principles of motor learning and activity-dependent neural plasticity (e.g., LSVT LOUD) may be used to effect beneficial changes in the speech system.

METHODS/ANALYSIS

Design: A *Phase I*, small group, pre-post design was used [10].

Table 1. *Participant Demographics*

Participants									
Participant Number	S21	S22	S23	S24	S25	S26	S27	S28	S29
Age (years; months)	6; 2	8; 0	5; 1	4; 6	7; 5	8; 7	8; 0	7; 8	8; 10
Gender	F	F	F	F	M	F	F	F	F
Diagnosis	DS	T21	T21	DS	DS	DS	T21	MDS	T21

Note: Expressive language ranged from 1-3 words to full sentence productions.

Treatment:

Single target of *healthy vocal loudness*

Table 2. *Minimum Repetitions during Treatment*

Activity	Total Repetitions in One Month of Treatment
Long Ah	504
High Ah	504
Low Ah	504
Functional Phrases	1680
Structured Speaking Activities	440 minutes
Conversational Speech	440 minutes
Increasing Complexity →	

Table 3. Treatment Outcome Measures

Outcome Measures	Measurement Source
Parent Perceptions of Treatment	Parent Rating Scale
Clinician Perceptions of Voice Pre-Post Treatment	Speech-Language Pathologists
Speech Intelligibility	Naïve Listener Transcription (*Goldman-Fristoe Test of Articulation 2)*
Speech Acoustics	Maximum Phonation Durations Phrase Repetition

RESULTS

Parent Perceptions of Treatment

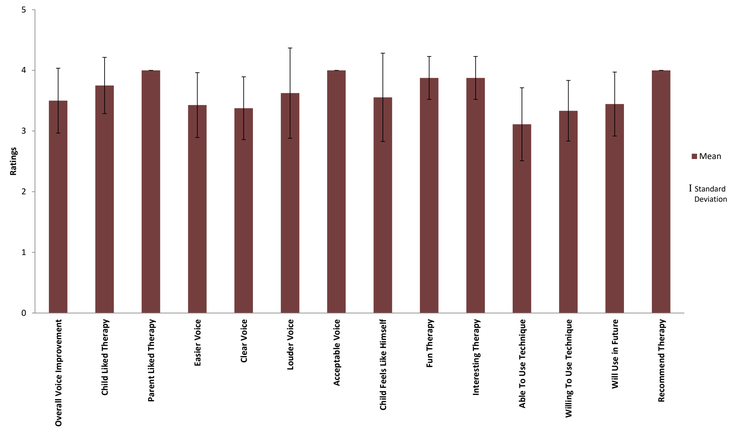

Figure 1. Parent ratings of treatment. A score of 5 is the highest possible positive rating.

Clinician Perceptions of Voice

Table 4. Clinician preference for pre-, post-treatment, or no preference

Variable	Pre-Tx	Post-Tx	No Preference	Significance	χ^2
Overall Loudness	4	**44***	33	0.0001	31.63
Loudness Variability	2	12	**67***	0.0001	90.74
Overall Pitch	10	20	**51***	0.0001	33.85
Pitch Variability	13	3	**65***	0.0001	82.07
Overall Voice Quality	15	**45***	21	0.0001	18.67

Speech Intelligibility

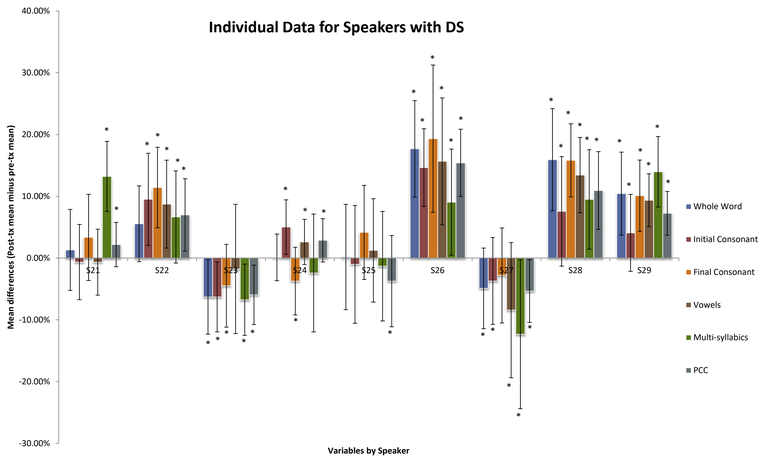

Figure 2. The * indicates that a statistically significant mean difference was found between pre-treatment and post-treatment.

Table 5. Group difference scores from pre- to post-treatment for speakers with Down Syndrome

Variables	Mean differences* (SD)	*t*-value	*p*-value	Cohen's *d*
% Whole Word correct	4.44% (8.62%)	1.55	***0.08***	0.27
% Consonants correct	3.39% (7.47%)	1.36	0.11	0.25
% Initial Consonants correct	3.24% (6.75%)	1.44	0.09	0.19
% Final Consonants correct	5.90% (8.75%)	2.02	***0.03***	0.48*
% Vowels correct	4.46% (7.85%)	1.71	***0.06***	0.32
% Multisyllabics correct	3.39% (9.32%)	1.06	0.16	0.39

Mean differences are calculated by subtracting the pre-treatment means from the post-treatment means. A positive value indicates an increase from pre- to post-treatment. ***Bold italics*** = statistical trend.

RESULTS

Summary of Intelligibility Results:

- **4/9** speakers with DS (S22, S26, S28, and S29) made gains on all of the variables.
- **2** speakers (S23 and S27), did not make gains across all variables.
- **7/9** speakers increased minimally to significantly in overall intelligibility (# whole words correct)

Speech Acoustics

Table 5. Acoustic measures for trained and untrained tasks

Variable	Pre-treatment	Post-treatment	$t_{(8)}$	*P* value
Average dB SPL Sustained Phonation	70.36 (3.33)	81.26 (4.12)	**5.8**	***p* ≤ .001**
Average dB SPL Phrases	64.67 (3.91)	67.36 (4.45)	**2.8**	***p* <.01**
Average Maximum Duration Sustained Phonation (sec)	2.14 (1.9)	3.32 (2.2)	**2.8**	***p* ≤ .01**
Jitter (%)	1.65 (1.3)	1.01 (.85)	**2.4**	***p* < .02**
Shimmer (dB SPL)	6.76 (3.8)	4.42 (3.5)	**2.9**	***p* < .01**
Harmonics-to-Noise Ratio	15.14 (3.9)	18.09 (5.7)	**2.1**	***p* < .03**
Average Fo Sustained Phonation (Hz)	251.17 (19.5)	290.76 (60.3)	**2.4**	***p* < .02**
Fo Range Sustained Phonation (Hz)	268.1 (97.2)	419.3 (163.5)	1.7	*p* <.06

CONCLUSIONS

- All parents indicated satisfaction with the therapy program and would recommend it to other families.
- Expert SLP clinicians preferred post-treatment voices on *overall loudness* and *voice quality* indicating that children with DS were able to train to the target of healthy vocal loudness.
- Following LSVT LOUD, children with DS were generally more intelligible at the single word level. These results are commensurate with previous research showing a relationship between vocal amplitude (loudness) and motor stability leading to articulatory precision. [12-14]
- Results derived from speech acoustics indicated that vocal loudness improved for both trained and untrained (phrases) tasks. Moreover, acoustic measures of jitter, shimmer, and harmonics-to-noise ratio, indicated post-treatment improvements in overall vocal stability.
- These *Phase I* [10] treatment data indicate that LSVT LOUD does impact the speech motor system of children with DS and are consistent with parent ratings of improved functional communication following treatment.

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