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A Boot Camp Approach to Remediating Interdental /s/ in a School-Aged Child

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ABSTRACT

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The relationship between speech articulation therapy dose (frequency, intensity, duration) and treatment outcomes are poorly understood. Identifying optimal therapy doses for specific articulation disorders is essential to providing efficient clinical care. Recent research indicates that intensive speech therapy doses—known as *boot camps*—may promote rapid improvement and generalization for certain speech disorders. Therefore the present investigation examined the effects of a boot camp speech therapy approach to remediate interdental /s/ production in an 8-year-old male. The boot camp included two days of speech therapy involving visual, tactile, and auditory feedback approaches. Therapy was administered 5.5 hours per day across morning and afternoon sessions. Treatment outcomes were evaluated using auditory-perceptual ratings of pre- and post-treatment word pairs. The results indicated that /s/ production improved significantly immediately following the boot camp and improvements were sustained at one week post-treatment ($p < 0.05$). Medial and final /s/ productions improved more so than the initial /s/ productions. These findings suggest that the speech therapy boot camp approach may be effective for certain individuals with speech sound disorders. Future research should explore dose-response relationships among speech articulation therapy dose in other children with speech sound disorders.

Keywords: boot camp therapy, treatment dose, treatment intensity, treatment duration, treatment frequency, interdental /s/, speech sound disorders, articulation case study

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Introduction

Direct speech articulation therapy is the primary treatment for developmental speech sound disorders. Speech therapy is recognized as an essential service to treat functional communication disorders in children. Unfortunately, little is known about the dose-response relationships among the frequency, intensity, and duration of speech therapy and treatment outcomes (Allen, 2013; Baker, 2012a; Warren, Fey, & Yoder, 2007). Treatment delivery has become a critical consideration in managing speech-language pathologist caseloads (To, Law, & Cheung, 2012). Increased productivity requirements demand efficient treatment delivery in public, medical, and private speech therapy settings. Third-party reimbursement necessitates evidence-based best practices including treatment dose guidelines for effective and efficient delivery of therapy services.

Traditional speech articulation therapy for developmental speech sound disorders focuses on phonetic understanding of individual sounds and correcting articulatory patterns, usually through listening and production training (Van Riper, 1996). A traditional approach relies primarily on perceptual and production training, followed by stages of stabilization, transfer, and maintenance (Dagenais, 1995). In general, traditional articulation therapy involves identification of the standard sound, discrimination of the standard sound from its error, variation and correction of sound productions, and sound stabilization in all contexts and speaking situations. New speech sounds are practiced in language segments of increasing length and complexity (i.e., sounds, syllables, words, phrases, sentences, conversation), allowing the individual to learn correct patterns and generalize the sound to all speaking situations (Van Riper, 1996). Traditional service delivery models for speech articulation therapy vary by setting. Often

children receive speech therapy on a once or twice weekly basis, though the precise therapeutic treatment dose is highly variable (Schooling, Venediktov, & Leech, 2010).

Speech therapy treatment dose is an important consideration when evaluating treatment outcomes. Several variables influence treatment dose during the course of speech therapy. These variables include the number and frequency of therapy sessions, session duration, number of teaching episodes or tokens within a session, length and frequency of breaks, and the total treatment time necessary to reach a treatment objective (Baker, 2012b; Warren et al., 2007). Monitoring and controlling each of these variables might be challenging, but careful consideration of these variables is necessary when drawing conclusions about treatment effects (Warren et al., 2007). Treatment dose is often influenced by availability, convenience, or tradition rather than efficiency and effectiveness for individual needs. Instead, clinicians might manipulate treatment dose, intensity and variability of practice, and rest phase duration to evaluate treatments (Laursen & Jenkins, 2002). Each of these treatment dose variables should be considered when evaluating the efficiency and effectiveness of speech articulation therapy.

Although treatment dose is a central consideration when evaluating treatment effects in related fields such as neurobiology, motor learning, exercise physiology, and psychotherapy (e.g., DiPietro, Dziura, Yeckel, & Neufer, 2006; Fatouros et al., 2005; Seynnes et al., 2004; Zafeiridis, Sarivasiliou, Dipla, & Vrabas, 2010), relatively few studies in speech-language pathology have examined dose-response relationships among speech therapy service delivery models and treatment outcomes. Much of this research involves adult populations with voice and speech disorders, perhaps due to the service delivery models often associated with these populations. Perhaps one of the most developed areas of speech therapy dose research involves Lee Silverman Voice Treatment (LSVT) for Parkinson's Disease (Ramig, Countryman,

Thompson, & Horii, 1995). Ramig and colleagues have demonstrated that 16 one-hour sessions of individual speech therapy across four weeks is the optimal dose for most individuals in this population (Sapir, Spielman, Ramig, Story, & Fox, 2007). The frequency and duration of LSVT promotes long-term improvement in voice and speech function, representing an optimal speech therapy treatment dose as compared to other less frequent treatment paradigms (Ramig, Sapir, Countryman, Pawlas, O'Brien, Hoehn, & Thompson, 2001; Sapir et al., 2007). This treatment is now the clinical gold standard for improving speech, voice, and swallowing in this population (Sapir et al., 2007). Perhaps most significantly, individuals sustain improvements over time, thereby reducing lengthy courses of speech therapy and associated healthcare expenses. Comparable findings have been observed using constraint-induced language therapy in adults with aphasia (Pulvermuller, Neininger, Elbert, Mohr, Rockstrok, Koebbel, & Taub, 2001). Similarly, Roy and colleagues have documented that an intensive, single-session therapy dose (1.5 to 2 hours) produces significant immediate improvements in individuals with muscle tension dysphonia (Roy & Leeper, 1993). It is possible that more intensive speech therapy treatment doses might promote more rapid improvement and increased generalization as compared with traditional treatment models in certain clinical populations.

A few studies have examined the effects of non-traditional—generally greater intensity—treatment doses on speech sound production. Van Demark and Hardin (1986) examined the effects of an intensive speech therapy treatment dose (4 hours daily for 26 days) in 13 children with cleft palate. The children made significant improvements in speech articulation during therapy, though not as quickly as was anticipated. A series of studies by Williams (2012) documented greater improvements in children with speech sound disorders who received greater intensity treatment doses, suggesting that specific treatment outcome goals should be used to

establish treatment dose guidelines. Reichow and Wolery (2008) reviewed the effects of early intensive behavioral interventions for children with autism, finding that a long duration of therapy and greater total hours of therapy contributed to higher IQ scores. Thus, a higher treatment dose used in their intensive behavioral interventions contributed to more effective treatment for children with autism. Comparing the effects of an intensive speech therapy treatment dose (40 minutes daily, four days a week, for three weeks) with a more traditional weekly treatment dose for preschool children with language delay, Barratt, Littlejohns, and Thompson (1992) found the greatest improvement in children receiving the high speech treatment dose. In a randomized experimental trial, Allen (2013) observed significantly greater treatment outcomes in children with speech sound disorders who participated in more versus less intense speech therapy when the overall treatment dose was held constant. Collectively these studies indicate that intensive speech therapy treatments may produce more rapid and sustained improvements that traditional therapy doses.

With increased clinical productivity pressures have come innovative treatment paradigms for speech therapy services. One such paradigm is the intensive *boot camp* speech therapy approach (Angadi & Stemple, 2012; Patel, Bless, & Thibeault, 2011; Thibeault, Zelazny, & Cohen, 2009). Most common among clinical voice practices, the boot camp approach typically involves several hours of speech therapy per day across multiple days (Patel et al., 2011). The goal of the boot camp approach is to provide intensive therapy to promote rapid improvement and generalization. Multidimensional approaches in the boot camp method facilitate motor learning and skill acquisition (Carter & Edwards, 2004; Gibbon et al., 1995; Patel, 2011). Recent research indicates that boot camp approaches show promise in accelerating successful treatment outcomes. Boot camp approaches might be particularly advantageous when

individuals must travel significant distances for therapy, or in cases where behavioral compliance is a concern. However, the optimal intensity and duration of the boot camp approach across populations of individuals with speech disorders remains unknown.

One of the most common developmental speech sound errors is misarticulation of the /s/ phoneme. The /s/ phoneme has been identified as one of the most difficult sounds to acquire and produce due to relatively complex motoric patterns (Gibbon & Hardcastle, 1987). During production, the tongue has lateral contact with the palate, allowing for a central narrow groove in which the airstream can flow. This requires precise neuromuscular control of the tongue as well as fine coordination between the tongue and respiratory system to produce necessary airflow. Research has suggested the difficulty of remediating /s/ for many children when solely using traditional therapy methods (Gibbon & Hardcastle, 1987). Therefore, a multidimensional, high intensity speech therapy dose might be more effective in remediating /s/ production. The purpose of the present study was to examine the effects of a multidimensional boot camp approach to remediate an interdental /s/ developmental speech sound disorder in a school-aged child.

Methods

Participant

An 8-year-old male presenting with an interdental /s/ developmental speech sound disorder participated in the study. The participant was a native speaker of American English with no history of hearing loss or language delay. Parental report indicated that articulation errors began following early loss of the upper central incisors at age four. In addition, parental report indicated typical academic development, as well as no cognitive or attention impairments. The participant had not received any formal speech therapy prior to the initiation of the study.

Procedures

During the initial baseline session, speech, hearing, and language data were collected. During this session the following tests and measures were conducted: Goldman Fristoe Test of Articulation-2 (GFTA-2), Clinical Evaluation of Language Fundamentals (CELF-4), oral peripheral exam, and a hearing screening. Administration of the GFTA-2 revealed a standard score of 94 (*M*: 100, *SD*: 85-115) and a percentile score of 15 for the Sounds-in-Words test. The following speech sound errors were noted: s/θ, ð/d, θ/f. Administration of the CELF-4 revealed a standard score of 96 (*M*: 100, *SD*: 85-115) and a percentile score of 39 for the Core Language subtest. In addition, audio recordings of the participant producing a series of words, designed to target specific speech sounds (primarily /s/) in initial, medial, and final word position, were collected.

The first session of speech therapy began one week following collection of baseline data. Therapy involved a boot camp approach to remediation, wherein the participant attended two consecutive days of long-interval therapy. Treatment was held for 5.5 hours each day (11 total hours) with an hour break for lunch following the first three hours. A 10-minute rest break also occurred every 90 minutes.

Therapy methods followed a traditional articulation hierarchy, moving through each level when correct productions were achieved with 90% accuracy as follows: discrimination of target sound, target sound production in isolation, target sound production in syllables (initial, medial, final), words, phrases, sentences, and during spontaneous conversation. Therapy techniques incorporated a multidimensional approach including auditory, tactile (Speech Buddies©, tongue depressor), and visual feedback (therapy mirror, palate model, and dynamic electropalatography [EPG]), thus aiding rapid acquisition and generalization of correct articulatory patterns. Prior to

the collection of data, a dental impression and subsequent stone mold of the participant's upper teeth was made by a licensed dental technician. The stone mold was used to create a custom-fit EPG pseudopalate similar to an orthodontic retainer, designed by SmartPalate International©. The participant was given instructions to wear his practice pseudopalate for 10 minutes each day for each of the three days prior to the start of therapy. During therapy, visual feedback from the EPG device was illuminated on a computer monitor through a series of different colored circles overlaid on a stylized anatomical rendering of a hard palate.

Principles of integral stimulation were incorporated into treatment planning, considering the need for repetitive and intensive practice (Gildersleeve-Neumann, 2007). Principles of motor learning also formed a basis for treatment by maintaining readiness to learn, providing early success, using random practice, and gradually decreasing scaffolding to encourage self-monitoring under different conditions. To increase motivation and attention across the relatively long therapy intervals, two different therapists delivered treatment over the course of both days. A general treatment plan is outlined in Appendix A, although specific treatment procedures were modified and adapted throughout therapy to meet individual participant needs as determined by clinical judgment.

Stimuli and Data Collection

The elicited word stimuli contained the /s/ phoneme in initial, medial, and final word positions with a variety of vowel contexts as well as initial /s/ blends (Table 1 outlines specific probe words). Probe words included the /s/ phoneme in real words, namely /s/ and /s/-blend productions (i.e., /sc/, /sl/, /sm/, /sn/,/sp/, /st/, /sw/). However, the word stimuli also included additional speech sounds (i.e., / ʃ θ z t k l r tʃ/), many of which were similar in place or manner of articulation to the sound being remediated. The elicited word stimuli were not specifically

targeted in therapy and the order of words presented was fully randomized before each recording. The speech samples were recorded in a sound-attenuating booth by an external microphone at a sampling rate of 44.1 kHz with a quantization of 16 bits. Data on the participant's progress (audio recordings of probe words and spontaneous conversation) was collected at the beginning and end of each 2.5-hour session. The progress data were drawn from the same set of words elicited in the baseline session and was recorded in the same manner.

Table 1

List of /s/ Words Used in Data Collection

/s/ Words			
Initial Position	Medial Position	Final Position	Initial /s/ blends
Sad	Passing	Gas	Scoop
Sock	Faucet	Toss	Slow
Soup	Loosen	Loose	Small
Seal	Recess	Piece	Sneeze
			Speak
			Stamp
			Swan

Data Analysis

A group of 10 adult listeners was asked to rate the quality of recorded productions elicited before and after therapy sessions, thus examining pre- and post-treatment data. The listeners were native speakers of American English and reported no history of speech or language disorders. At the time of their participation, all of the listeners exhibited pure-tone air-conduction thresholds of ≤ 25 dB HL at octave frequencies from 250 to 8000 Hz. The listeners were asked to listen to each stimulus item and rate the quality of the sound production based on the perceived pronunciation and ability to be understood. The order of presentation for the stimulus items was fully randomized.

The signal was routed from a computer hard drive to the listeners via Sennheisser HD 650 headphones. The listeners were seated in a single-walled sound booth meeting ANSI S3.1 standards (American National Standards Institute, 1999). The listeners self-selected the intensity level of the presented stimuli, with a starting level of approximately 60 dB HL. The volume range available to the listeners was limited to a safe hearing level. The perceptual ratings took place in one session not longer than one hour in length. The randomization, stimulus presentation, and subsequent recording of the listeners' perceptual judgments were controlled by custom software.

Stimulus items of the same word were presented in pairs of pre- and post-treatment tokens. For example, *sad* was a token word recorded before and after therapy. The pre-treatment recording of *sad* was paired with the post-treatment recording of *sad* with one second of silence between the tokens. This allowed listeners to hear the same pair of words twice, with just the order presented being counterbalanced. In one pair the pre-treatment word was presented first and in a different pair the post-treatment word was presented first. The order of tokens in each pair and the order of pairs presented to the listeners were fully randomized. Listeners were trained to anchor on the first word presented and rate if the target sound (i.e., /s/) in the second word was better or worse than in the first word. Listener judgments of better or worse as well as a confidence interval were obtained by using a computerized sliding scale, as represented in Figure 1 to rate the target sound in each word from 0 to 100 (0 representing highly misarticulated /s/ in words, 100 representing normally articulated /s/ in words). The middle of the scale indicated the target sound in the second word presented was the same as in the first word (i.e., neither better nor worse).

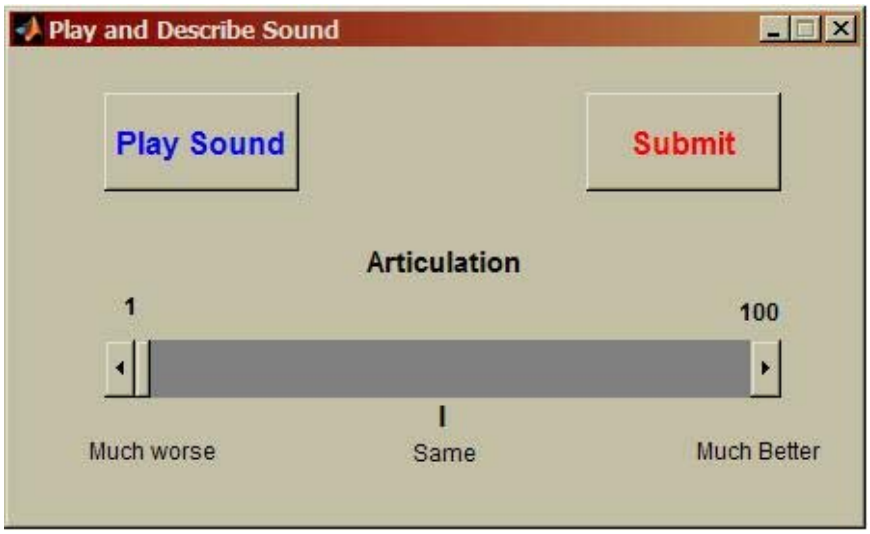

Figure 1. Sliding scale for listener ratings.

Each participant listened to a series of sample tokens not used in the actual testing to practice rating the experimental stimuli. Examples were presented where both pre-treatment and post-treatment tokens were heard first in the paired stimuli. Following the practice set, listeners rated the experimental data according to the quality of /s/ production in words. The written script used to provide instructions for perceptual ratings is found in Appendix C.

Intra-rater Reliability

Twenty percent of the tokens were presented to the listeners twice in order to measure intra-rater reliability. Measures of listener reliability were obtained by comparing a listener's rating between the two presentations of the same stimulus. Comparisons of the two sets of data resulted in a Pearson Correlation of .86 ($p < .0001$), with an absolute mean difference of 8.86 across the listeners (*min* = 5.37, *max* = 11.95, *SD* = 2.16).

Statistical Analysis

This study involved a single-subject multiple baseline design, with repeated measurement of the dependent variables before, during, and after treatment. Descriptive statistics of the dependent variables were reported in terms of mean, range, and standard deviation. A two-way

repeated measures analyses of variance (ANOVA), with the listener ratings as the dependent variable was used to examine possible differences in treatment condition (pre vs. post) and word position (initial, medial, and final). Considering that the rating data ranged between 0 and 100, an arc sine transformation was applied to the data prior to statistical analysis. ANOVA results included a measure of effect size, partial eta squared, or η^2. The value of η^2 can range from 0.0 to 1.0, and can be considered a measure of the proportion of variance explained by a dependent variable when controlling for other factors.

Results

The efficacy of treatment condition (i.e., multidimensional boot camp therapy for a speech sound disorder) was determined by the evaluations of listener rating comparisons who judged the quality (perceived pronunciation and ability to be understood) of pre- and post-treatment /s/ productions. As illustrated in Figure 2, immediately post-treatment and follow-up productions were rated higher (i.e., better articulation) than initial baseline productions for both /s/ and /s/-blend tokens, with the greatest increase occurring immediately post-treatment. Descriptive statistics are provided in Table 2 and Table 3, delineating listener rating means and standard deviations for /s/ and /s/-blend productions as a function of initial baseline, immediately post-treatment, one week follow-up, and word position or blend type.

Average means of /s/ and /s/-blend productions were 88.9% and 92.2% for post-treatment and follow-up productions, respectively, and were rated higher (i.e., better articulation) than initial baseline. In the reverse comparisons, listener ratings found initial baseline /s/ and /s/-blend productions to be worse than post-treatment and follow-up conditions with an average mean of 54.5% and 61% respectively.

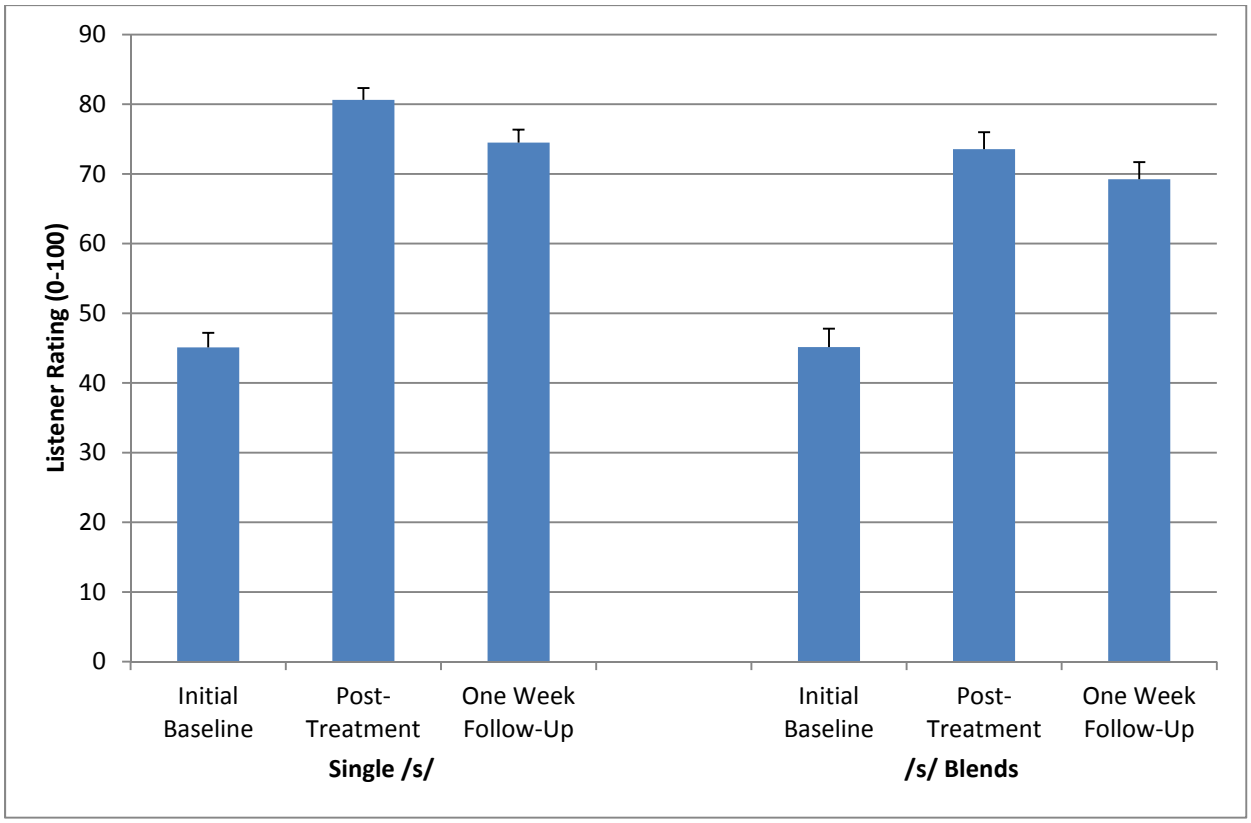

Figure 2. Mean listener ratings comparing initial baseline to post-treatment and one week follow-up productions.

Table 2

Single /s/ Listener Rating Means and Standard Deviations across Treatment Condition and Word Position

Tx Condition	Initial		Medial		Final	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
AB	73.24	20.47	84.16	16.26	85.33	13.70
BA	50.14	21.12	45.48	17.68	34.56	20.96
AC	73.61	21.95	70.11	18.15	78.68	17.60
CA	52.40	23.55	47.27	15.90	41.46	24.87

Note. *AB: Baseline to post-treatment comparison. BA: Post-treatment to baseline comparison. AC: Baseline to one week follow-up comparison. CA: One week follow-up to baseline comparison.

Table 3

/s/-Blend Listener Rating Means and Standard Deviations across Treatment Condition and Word Position

Blend Type	AB		BA		AC		CA	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
/sc/	68.87	19.80	55.56	22.72	58.01	13.01	57.34	16.62
/sl/	78.01	19.54	48.30	25.27	75.11	16.46	44.89	9.80
/sm/	88.46	13.65	10.65	10.18	74.44	31.05	21.49	25.85
/sn/	72.38	18.00	38.70	15.81	70.10	22.33	48.08	5.40
/sp/	80.36	17.34	52.96	17.58	77.46	13.17	35.21	20.51
/st/	74.70	20.57	42.92	17.07	73.63	20.13	50.34	11.69
/sw/	52.09	18.53	75.43	18.91	55.92	15.56	50.38	6.10

Note. *AB: Baseline to post-treatment comparison. BA: Post-treatment to baseline comparison. AC: Baseline to one week follow-up comparison. CA: One week follow-up to baseline comparison.

Initial Baseline Compared to Post-treatment

Single words. A two-way repeated measures ANOVA was used to determine if listener ratings varied between pre- and post-treatment productions of /s/ across the initial, medial, and final word position. The ANOVA indicated a significant main effect of treatment condition (pre vs. post), $F(1, 29) = 58.31$, $p < .0001$, $\eta^2 = .67$. Listener ratings of post-treatment /s/ productions increased from a mean rating of 43.21 ($SD = 21.13$) to 80.62 ($SD = 17.86$). In addition, a significant interaction was found between treatment condition and word position, $F(2, 58) = 10.83$, $p < .0001$, $\eta^2 = .27$. As illustrated in Figure 3, post-treatment /s/ productions increased with much greater improvement in medial and final word positions as compared to initial position.

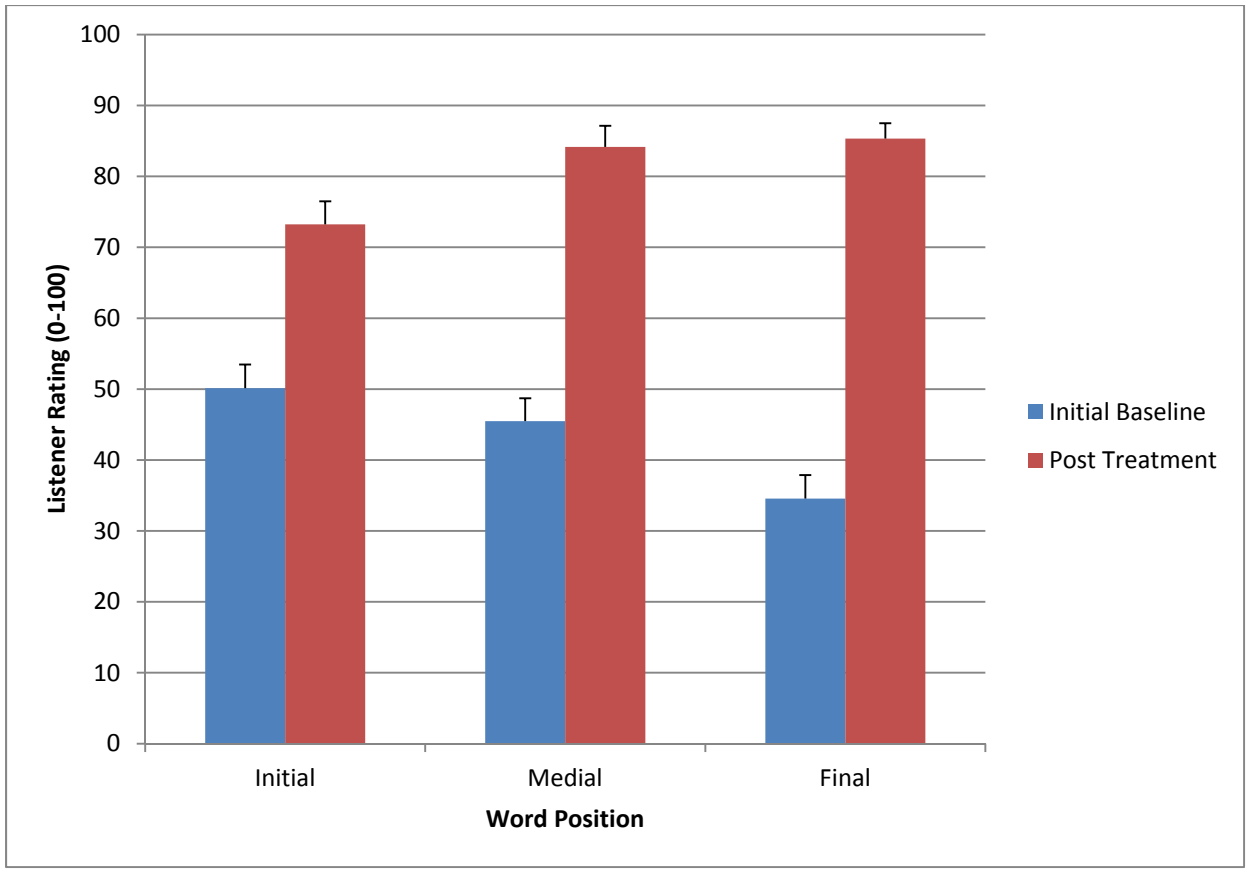

Figure 3. Mean listener ratings comparing initial baseline and post treatment /s/ productions as a function of treatment condition and word position.

Blends. For /s/-blend productions, the statistical analysis indicated a significant main effect of treatment condition (pre vs. post), $F(1, 9) = 31.37$, $p < .0001$, $\eta^2 = .78$. When collapsed across /s/-blend type, the listener ratings increased from an overall mean rating of 46.36 (SD = 25.67) on initial baseline to 73.55 (SD = 20.46) following treatment. In addition, a significant interaction was found between treatment condition and blend type, $F(6, 54) = 10.86$, $p < .0001$, $\eta^2 = .55$. As illustrated in Figure 4, listener comparison ratings found an increase in post-treatment productions as compared with initial baseline for the majority of /s/-blend productions

(i.e., /sc/, /sl/, /sm/, /sn/, /sp/, and /st/) except for the /sw/ which showed a decrease in perceived production quality post-treatment compared to initial baseline.

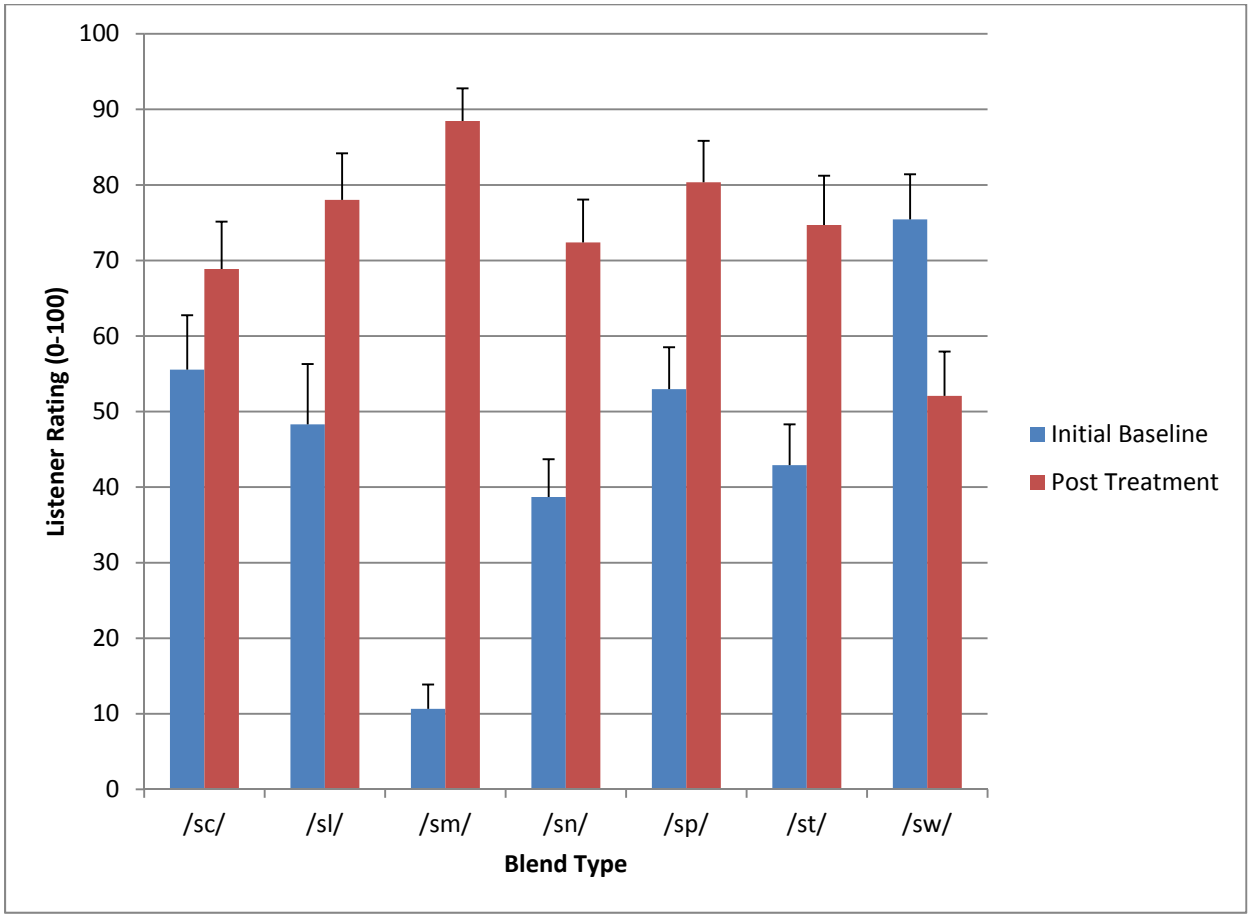

Figure 4. Mean listener ratings comparing initial baseline and post treatment /s/-blend productions as a function of treatment condition and word position.

Initial Baseline Compared to One Week Follow-up

Single words. A 2-way repeated measures ANOVA was used to determine if listener ratings varied between pre- and post-treatment productions of /s/ across the initial, medial, and final word position. The ANOVA indicated a significant main effect of treatment condition (pre vs. post), $F(1, 29) = 23.88$, $p < .0001$, $\eta^2 = .45$. Listener ratings of follow-up /s/ productions increased from a mean rating of 47.02 ($SD = 22.56$) to 74.50 ($SD = 19.57$). In addition, a

significant interaction was found between treatment condition and word position, $F(2, 58) = 9.65$, $p < .0001$, $\eta^2 = .25$. As illustrated in Figure 5, listener comparison ratings of follow-up /s/ productions decreased from post-treatment ratings, but were still higher than initial baseline ratings with much greater improvement in the final word positions as compared to initial and medial positions.

Blends. For /s/-blend productions, the statistical analysis indicated a significant main effect of treatment condition (pre vs. post), $F(1, 9) = 26.92$, $p < .001$, $\eta^2 = .75$. When collapsed across /s/-blend type, the listener ratings increased from an overall mean rating of 43.96 (SD = 18.49) on initial baseline to 69.24 (SD = 20.52) following treatment. In addition, a significant interaction was found between treatment condition and blend type, $F(6, 54) = 3.29$, $p < .008$, $\eta^2 = .27$. As illustrated in Figure 6, listener comparison ratings found an increase in 1 week follow-up productions as compared with initial baseline for the majority of /s/-blend productions (i.e., /sc/, /sl/,/sm/, /sn/, /sp/, and /st/) except for the /sw/ which showed a decrease in perceived production quality post-treatment compared to initial baseline.

Discussion

The present study evaluated the effectiveness of a multidimensional boot camp therapy approach employing visual, auditory, and tactile feedback for treatment of an interdental /s/ speech sound disorder in a school-aged child. Listener ratings showed a significant, consistent increase in the correct articulation of /s/ and /s/-blend productions relative to baseline both immediately following treatment and one week later, except for one token (/sw/). Improvements in articulation of the /s/ phoneme were highest immediately following treatment. Ratings decreased after a follow-up period of one week, but /s/ productions were still significantly better than during initial baseline. Improved /s/ articulation also varied across word position. For

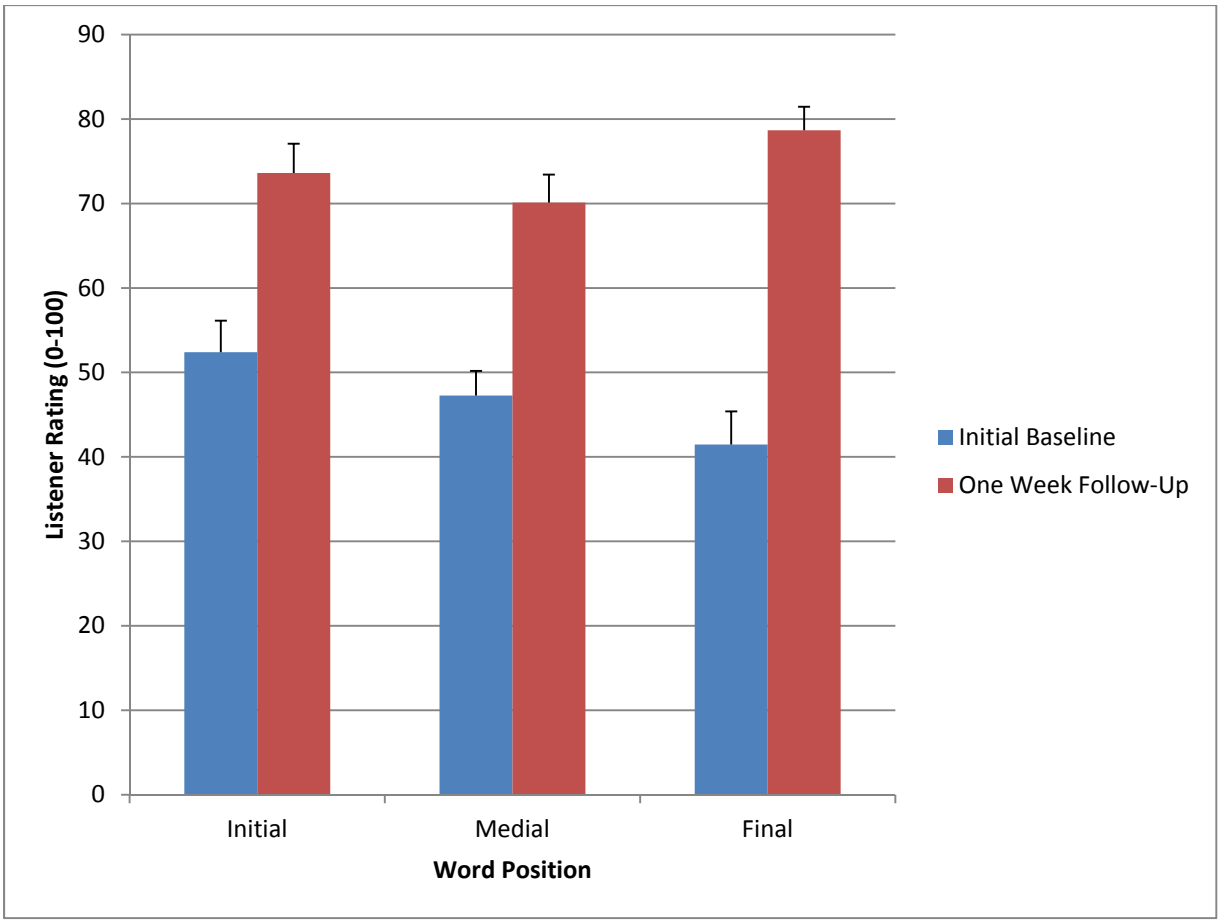

Figure 5. Mean listener ratings comparing initial baseline and one week follow-up /s/ productions as a function of treatment condition and word position.

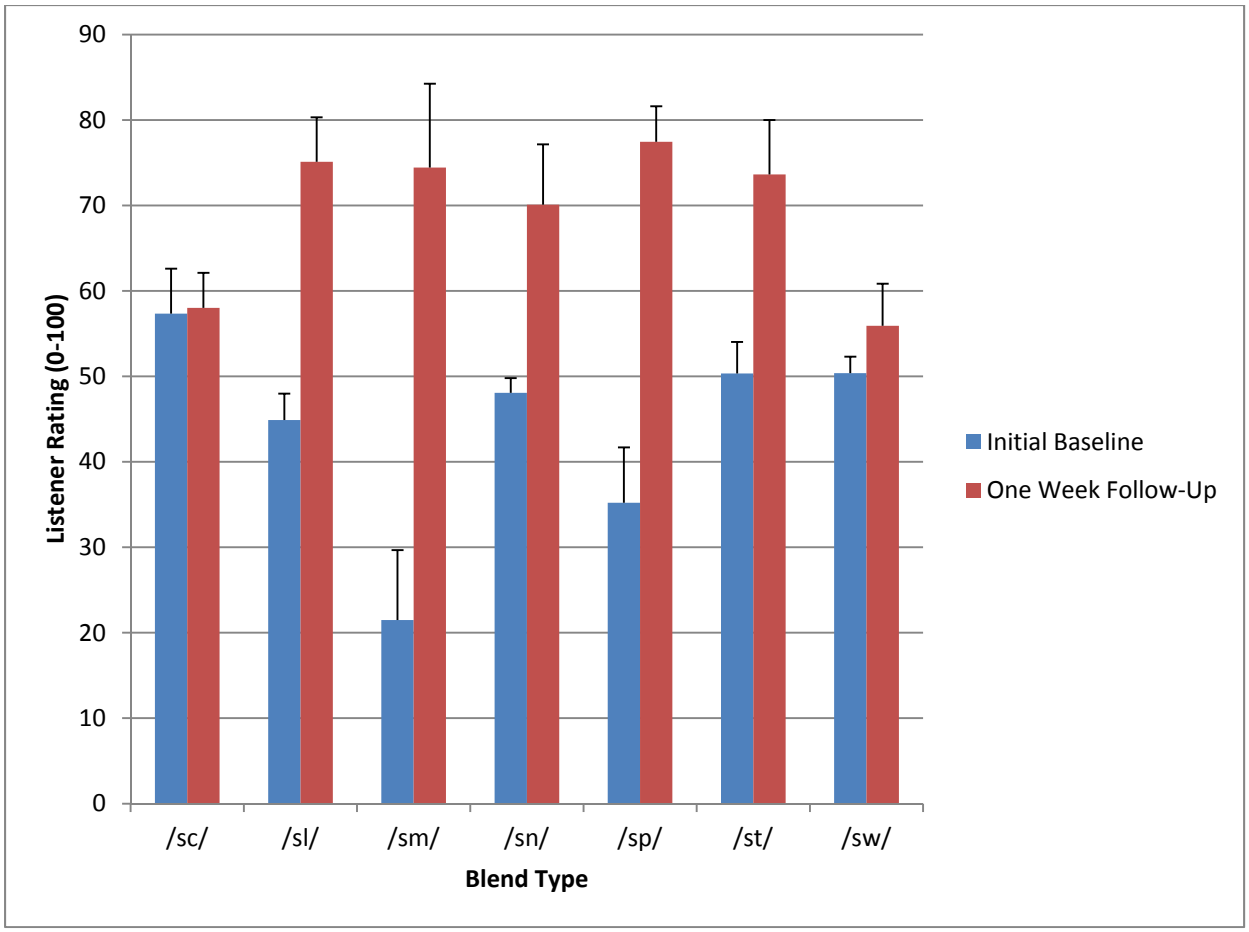

Figure 6. Mean listener ratings comparing initial baseline and one week follow-up /s/-blend productions as a function of treatment condition and word position.

single /s/ words, the medial and final word positions showed the greatest improvement, while articulation quality in the word initial position increased, but not as dramatically. This could have occurred because of specific difficulty with word initial /s/ productions for that particular individual. Or it may be due to a higher accuracy of /s/ productions in the initial word position already established before beginning boot camp therapy, thus limiting the range of improvement possible during the brief treatment period. Despite this variability, the results suggest the effectiveness of a multidimensional, boot camp approach in improving productions of the /s/ phoneme for this particular individual.

Previous research concerning a short-term, intensive therapy approach has indicated success with the boot camp method, although limited research is available, particularly for treatment of a variety of communication disorders. Although analyzing two different communication disorders (i.e., voice and articulation), the results of the present study were similar to that of Roy and Leeper (1993), indicating that clients improved in individual objectives following a boot camp treatment approach. Roy and Leeper (1993) used an intensive therapy method when using manual laryngeal musculoskeletal tension reduction to treat functional voice disorders, concluding that participants demonstrated improved vocal function after just one session. A study by Thibeault et al. (2009), with a dose frequency similar to that of the present study, found that their participant reached all treatment objects within 17 hours of therapy over a 2.5 day period. Despite differences in etiology, presentation, and treatment for voice disorders versus speech sound disorders, the participant of this study also displayed improvement in targeted therapy goals when remediating an interdental /s/ misarticulation after a high treatment dose. In addition, a study conducted by Allen (2013) concluded that treatment of phonological disorders using a multiple oppositions approach was more effective when

conducted with a higher dose frequency of three sessions weekly as compared to one session weekly. Results from Allen's (2013) research suggest the benefit of comparing treatment outcomes to a control group and ultimately indicate similar results as the present study of greater treatment gains following higher treatment dose.

Results from the perceptual analysis revealed an order effect concerning the order of paired tokens. Tokens were paired, and listeners compared pre-treatment tokens to post-treatment and follow-up tokens. When initial baseline tokens were presented as the first word in the pair, listeners rated a relatively high number of post-treatment and follow-up productions to be better than initial baseline productions. However, when the exact same word pairs were presented with post-treatment or follow-up productions heard as the first word in the pair, listeners rated a lower number of post-treatment and follow-up productions as better than initial baseline tokens. Therefore, the order in which the word pairs were presented affected listener ratings. This is likely due to the nature of the task since it was easier to anchor on a worse token first and then hear the improved difference for the second token. However, if the improved production was presented first, it was more difficult to distinguish between the two tokens.

General patterns of the treatment condition for /s/ and /s/-blend productions (except /sw/) indicated greater improvement post-treatment and a slight decline in perceived /s/ quality during a 1 week follow-up. This pattern was to be expected because productions should be highest immediately following intensive treatment and the post-treatment session largely analyzed treatment effect. However, after one week without treatment, improvements from the week before faded, although were still significantly improved from productions during the initial baseline. One of the /s/ blends (i.e., /sw/) did not follow this same pattern of improved articulation post-treatment and follow-up. Instead, listener ratings found that the perceived

quality of the /s/ phoneme in the /sw/ blend declined post-treatment and after a 1 week follow-up period. A possible explanation for this anomaly may be found by examining the following sound (i.e., /w/) in the blend. The semivowel /w/ was the only blend type requiring lip rounding. This may have complicated the utterance, making it more difficult for a quick articulatory transition from /s/ to /w/, thus negatively affecting the perceived pronunciation of the /s/ phoneme.

Implementing a high treatment dose may have facilitated greater treatment success. This may have occurred because of the nature of the intensive treatment, providing variability of practice with multiple techniques, contributing to increased generalization of skills learned (Laursen & Jenkins, 2002; Patel et al., 2011). Providing a high therapy dose within a short and intensive time frame may have better facilitated motor learning patterns, as established by repetition and practice (Asanuma & Pavlides, 1997). Treatment was also individualized according to what was appropriate and functional according to what was successful for the individual, allowing increased time to incorporate specificity in training (Patel et al., 2011). The increased motivation and compliance necessary for high therapy dose may have also contributed to increased treatment success and carryover (Thibeault et al., 2009). Increased success may have also been due in part to the ability of the child and therapist to establish a relationship more quickly without having to re-establish rapport each week (Barratt, Littlejohns, & Thompson, 1992). However, it was not feasible to evaluate and contrast the effects of different dose levels in this single client, and thus the precise contribution of the dose level used cannot be quantified.

Despite the successful treatment of this participant, it is unclear how widely the findings of the present study might be generalized. Many factors contribute to the success of using a high treatment dose, including age, type of communication disorder, personality, motivation, and location. Since conducting intensive therapy has not been widely studied, it is unknown which

types of communication disorders could be successful with this methodology. Due to the intensive nature of providing a high dose of therapy, it may not be a feasible approach when treating very young children. Participants must be old enough to understand treatment rationale to some degree; otherwise, a lack of motivation may inhibit the ability to conduct intensive therapy. They must also be able to withstand the rigorous program physically and mentally (Patel et al., 2011). Patient fatigue and motivation are major factors of success and must be more carefully monitored throughout treatment. Behavior management problems would also lend to poor candidates for this approach. In addition, both participants and clinicians must have large increments of time available to dedicate to therapy sessions. A high therapy dose may be particularly useful for individuals who have limited access to speech therapy services such as people that reside in rural areas, those who need to remediate speech problems within a short period of time for vocational purposes, or those who have failed traditional articulation therapy (Angadi & Stemple, 2012; Patel et al., 2011; Thibeault et al., 2009). Conducting short-term intensive therapy could reduce the financial expense of frequent travel to a speech-language pathologist while still maintaining the effectiveness of speech therapy.

The present study employed multimodalities during articulation therapy, including auditory, tactile, and visual feedback methods. However, not all methods seemed equally as successful, and a couple of techniques were stopped altogether due to clinical impressions indicating regression of articulatory precision. When the participant attempted to use EPG as a mode of visual feedback, the quality of /s/ productions were reduced, in that correct articulatory placement was lost. Therefore, that mode was discontinued for the remainder of therapy. EPG may not have been effective for this particular client because correct articulatory placement was already mostly established prior to introduction of the EPG pseudopalate. The palatometer

largely focuses on visual feedback to display tongue-to-palate contact, and if correct placement can be easily achieved by traditional methods, the pseudopalate may be too distracting or confusing. Speech Buddies©, a set of tools used to teach correct tongue positioning, were attempted during therapy but were also discontinued. Again, for this particular child, correct tongue position was more easily established with traditional methods, and this particular method of tactile feedback seemed to unnecessarily complicate that process. It is also possible that the client's dentition may have not been appropriate for the Speech Buddies© due to protrusion of the tongue against the maxillary central incisors. For this individual, traditional therapy methods using auditory and tactile cues appeared to be more effective than other techniques such as EPG and Speech Buddies©.

Toward the end of treatment sessions, it was noted that the participant began to over-generalize correct /s/ productions to the /θ/ phoneme, causing /θ/ sounds to be impacted in a negative way. By the end of the second day of the high articulation therapy dose, the participant had spent many hours focusing on correct production of one specific phoneme (/s/). Although /s/ productions improved, perhaps the extended period of time participating in such direct and intense therapy started to negatively influence other sounds, particularly /θ/. Since he had previously been fronting his /s/ productions, it is logical that he would over-generalize the /s/ phoneme to /θ/. Therefore, session length may be one of the most important factors when planning a high treatment dose and clinicians should be cautious of over-generalization.

Although results were positive and indicated success of boot camp therapy for treating an interdental /s/ misarticulation, several limitations of this study should be considered when conducting similar research in the future. One of the primary limitations of this study was the methodology of single case design. The results of this case study may not generalize to other

children. A larger group study would provide further information about effectiveness of the treatment method and randomized clinical trials would provide evidence for treatment efficacy. Second, the effectiveness of the approach could also be unique to this child or to the /s/ phoneme in particular. It would be beneficial for further research to study the effects of boot camp treatment on different sound disorders. Third, due to limited clinical research about treatment dose, few guidelines exist for optimal dose intensity and dose frequency. Deeper insights about session length and frequency are needed so that optimal treatment dose can be determined. For example, it might be better to conduct therapy for two 1.5-hour sessions each day for 3 days rather than two 2.5-hour sessions each day for 2 days. Determining optimal frequency and duration of resting periods would allow for maximum attention and minimal fatigue (Warren et al., 2007). Also, a high treatment dose alone will not facilitate generalization of skills or techniques if training is not coordinated with the individual's target behaviors. Fourth, it would be helpful to draw direct comparisons between boot camp treatment and traditional articulation therapy in order to quantify the difference between improvements post-treatment. It is possible that the degree of improved articulation following boot camp therapy may not differ much from the degree of improvement following a week of traditional articulation therapy. If so, the benefits may not be great enough to justify the intensive demands on the clinician and client. Fifth, the results from this study were not analyzed long-term, and it is uncertain if improved articulation from the boot camp therapy was maintained over the next few months. Finally, boot camp research in the voice disorders literature highlights the importance of using multiple clinicians during treatment. In the present study, two separate clinicians provided therapy, but the load was unequally distributed with one clinician providing the majority of the treatment. It

may be advantageous to distribute the length of therapy time more equally across clinicians or to have three or four clinicians conduct therapy in order to encourage generalization.

Changes in specific points of methodology could also improve future research designs regarding boot camp articulation therapy. Due to a missing vowel context (i.e., /i/) in the medial position, perceptual results could not be analyzed according to vowel type. Ensuring that the same vowel contexts are used in initial, medial, and final positions would allow results to be analyzed according to word position of the target phoneme. In addition, it might be helpful to use a visually larger rating scale for listener ratings during the perceptual listening task. The computerized rating scale used in this study ranged from 0 to 100 and having a larger scale when rating could increase the accuracy of each rating. With a smaller scale, slight differences between ratings are magnified. A larger scale would help balance the difference between ratings that may have only differed because of a slight hand twitch or bump of the mouse.

Despite the limitations of this study, the insights gained here will further understanding about the importance of appropriate treatment intensity when treating a variety of communication disorders. Establishing specific guidelines about optimal treatment intensity will improve clinical practice for treatment of speech disorders, and this study piloted such research for using a high therapy dose when treating speech sound disorders, particularly when remediating interdental /s/. Depending on the severity of the speech sound disorder, a high therapy dose may not fully remediate the misarticulation, but could serve as a jump-start that would stimulate larger treatment gains within a shorter time period. However, due to limited research in this area, a more comprehensive understanding of optimal treatment dose for remediating speech sound disorders is needed. It is anticipated that the positive results from this

study will stimulate further research about short-term, high dose intensive therapy when treating speech sound disorders.

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Appendix A: Treatment Plan

DAY 1: (5.5 hours)

Hours	Treatment Outline
9:00-9:10	Data collection
9:10-9:30	Discriminate correct vs. incorrect /s/ productions • GOAL: identify the different between correct and incorrect /s/ productions • *Auditory bombardment*: Record utterances. Listen to correct vs. incorrect /s/ productions.
9:30-9:45	Discuss correct /s/ shape • GOAL: to understand basic tongue position for correct /s/ shape • Demonstrate placement with a static model: "butterfly" shape, narrow stream of air in the center • *Tactile*: Use a straw to facilitate tongue contact of the lateral margins with a narrow groove
9:45-10:15	Traditional therapy • Facilitative contexts: from /t/ to /s/ • Practice "lazy /t/" • Use mirrors as needed • Introduce at the word level (Worksheet with plural words e.g., hats, cats)
10:15-10:30	Introduction to the palatometer • Calibrate visual display • Make sound targets • Discuss articulatory placement, contact patterns, and sounds • Demonstrate correct contact patterns • Emphasize forward air flow
10:30-10:40	Data collection
10:40-10:50	Break
10:50-11:10	Traditional therapy • GOAL: Produce correct /s/ in isolation • /s/ initial word position (worksheets) • *Traditional*: modeling, demonstrating, cuing, reinforcing.
11:10-11:30	Practice with palatometer • Review placement/Gold Standard • Silent hold • Add voicing and airstream once placement is accurate • Clinician model; practice together, JT practices with feedback • JT practices alone 3 minutes • *Auditory*: Record utterances and review productions from waveform.
11:30-11:50	Traditional therapy • /s/ initial position • Game: Artic. bowling
11:50-12:00	Data collection

LUNCH BREAK

Hours	Treatment Outline
1:00-1:10	Data collection
1:10-1:30	Review skills learned in the morning • GOAL: review discrimination, /s/ in isolation, initial, and medial word positions • *Auditory*: discriminate between correct and incorrect /s/ productions (Red light/Green light) • *Tactile*: feel correct placement • Practice facilitative contexts, i.e., "lazy /t/"
1:30-1:50	Speech Buddies • GOAL: correct tongue placement • *Tactile*: facilitate correct tongue placement • Alternate with practice of /s/ sounds and then /s/ words
1:50-2:15	Practice with palatometer • Correct /s/ placement in isolation, initial, and medial word positions • Have JT teach clinician how to produce a good /s/ • Vary from looking at visual display and not looking to establish correct placement • Gold Standard • /s/ in word initial position • Introduce /s/ in medial position
2:15-2:30	Auditory feedback • Discriminate between correct/incorrect /s/ productions in words
2:30-2:40	Data collection
2:40-2:50	Break
2:50-3:10	Practice without palatometer • Focus on /s/ medial positions (worksheets) • Game: Kerplunk • Some initial /s/
3:10-3:30	Practice with palatometer • Review correct /s/ positions • Silent hold • Review /s/ in initial and medial positions • Introduce /s/ in final word positions
3:30-3:50	Traditional articulation therapy • /s/ in final position (Worksheets) • Game: Memory • Review all skills learned: correct placement in isolation and all word positions
3:50-4:00	Data collection

DAY 2: (5.5 hours)

Hours	Treatment Outline
9:00-9:10	Data collection
9:10-9:30	Palatometer review • Warm-up exercises • Practice /s/ in isolation, and in all positions of words • Gold Standard
9:30-9:45	Auditory bombardment • Review and practice discriminating correct /s/ productions
9:45-10:00	Tactile feedback • Use Speech Buddies to facilitate correct placement again • Straw to represent the narrow stream of air down the center
10:10-10:30	Traditional therapy • Practice facilitative contexts("lazy /t/") • Practice /s/ in all word positions • Intersperse with non-target words • Begin working on /s/ at phrase level • Game: Artic. bowling
10:30-10:40	Data collection
10:40-10:50	Break
10:50-11:20	Practice with palatometer • /s/ at phrase level • Practice with Gold Standard • 3 minutes of individual practice • *Auditory*: Record utterances and review productions from waveform. • Practice /s/ in contrast: "old" vs. "new" way
11:20-11:40	Traditional Therapy • Game: McDonalds French fries: categorize as initial, medial, final • Focus on forward airstream and correct placement
11:40-11:50	Palatometer review • Practice different rates: Slow, regular, slow. Regular, slow, regular. • Practice /s/ at phrase level • Introduce sentence level
11:50-12:00	Data collection

LUNCH BREAK

Hours	Treatment Outline
1:00-1:10	Data collection
1:10-1:30	Palatometer • Practice /s/ productions with smartpalate: alternating between where he sees it and where he doesn't

	• Review /s/ in all word positions • Practice /s/ in phrases • Begin /s/ in sentences
1:30-1:50	Traditional therapy • Read a book: "Swimmy" by Leo Lionni • Practice /s/ in phrases and sentences
1:50-2:15	Practice with palatometer • /s/ in sentences • Practice with Gold Standard
2:15-2:30	Auditory feedback • Discriminate between correct/incorrect /s/ productions in phrases/sentences • Use waveform on palatometer
2:30-2:40	Data collection
2:40-2:50	Break
2:40-3:00	Traditional therapy • Describing pictures (manipulated for increased /s/ productions) • Focus on /s/ in sentences • Move toward /s/ in conversation
3:00-3:20	Practice with palatometer • /s/ in conversation • *Auditory feedback*: /s/ in conversation: record with palatometer and review productions
3:20-3:40	Traditional articulation therapy • /s/ in conversation • Artic. basketball
3:40-3:50	Review of all skills learned • Practice auditory discrimination • Review correct placement, manner, and voicing • Review correct /s/ in all word positions, phrases, sentences, and spontaneous speech
3:50-4:00	Data collection

Appendix B: Participant Consent Form

Parental Permission for a Child to Be a Research Participant

Introduction
The aim of this study is to examine the effectiveness of using a palatal sensor and tactile aids to remediate a developmental speech disorder. Your child is being invited to participate in this study because he/she is a native speaker of English with a history of a speech disorder. This study is being conducted under the supervision of Shawn Nissen, Ph.D., an associate professor in the Department of Communication Disorders at Brigham Young University.

Procedures
In this study your child will receive speech therapy using visual feedback from a palatal sensor (similar to an orthodontic retainer), as well as more tradition methods of treatment, such as verbal or tactile feedback. An example of tactile feedback might by touching the palate or tongue with a tactile aid (similar to a plastic straw). Your child will be asked to have a dental impression created by a licensed dental professional. A list of possible dental professionals will be provided, but you are welcome to have an impression created by another dentist or technician of your choice. This study will involve a hearing screening, the sensor fitting, weekly speech therapy sessions (30-40 minutes). The therapy sessions will be conducted by graduate students enrolled in the Communication Disorders Master's program under the supervision of the licensed speech language pathologist working at your child's school. Samples of your child's speech will be collected at the beginning and end of each therapy session, which will then be rated by listeners for intelligibility and pronunciation.

Risks/Discomforts
There are minimal risks associated with participation in this study. The palate sensors and tactile aids used in this study have been used for a number of years in the speech pathology community without any reports of adverse events. The tactile aids have smooth and rounded surfaces, but there may be some minor discomfort to the child when touching the areas of the palate behind the upper teeth. The palate sensor is similar to an orthodontic retainer and may cause some minor discomfort to the gums or teeth during use. The participant may encounter some minor discomfort when the dental impression (which is used to create the sensor) is being created. The finished sensor is too large to be accidently swallowed; in addition it is attached to the data collection unit. Your child's speech may sound different with the sensor in place and it may take a period of time for them to become accustom to speaking with the sensor in their mouth.

Benefits
There are no direct or guaranteed benefits for participants of this study.

Confidentiality
All information provided will remain confidential and will only be reported with no identifying information. All data, including digital recordings of your child's responses will be kept on a password protected computer in a locked laboratory and only those directly involved with the research will have access to them.

Compensation
Your child will not be compensated for participation in this study.

Participation
Participation in this research study is voluntary. Your child has the right to refuse to participate or withdraw at any time without penalty.

Questions about the Research
If you have questions about this study, contact Shawn Nissen, Ph.D., at (801) 422-5056 or shawn_nissen@byu.edu.

Questions about your Rights as Research Participants
If you have questions regarding your rights as a research participant, you may contact the BYU IRB Administrator, A-285 ASB, Brigham Young University, Provo, UT, 84602 or at (801) 422-1461.

I have read and fully understand the consent form. Any questions have been answered to my satisfaction. I give permission for my child to participate in this research.

Signed: _____ Date: _____
(signature of participant's parent or legal guardian)

Child's Name: _____

Appendix C: Perceptual Rating Instruction Script

General Introduction

This test will consist of two sections. In the first section you will be listening for the /s/ sound. We are going to have you listen to a series of words and rate them according to how well the speaker articulated the /s/ sound in each word. Sometime the /s/ will be at the beginning of the word, sometimes it will be in the middle, and sometimes it will be at the end. You will hear two words presented each time with 1 second in-between the words. The two words presented together will be the same word. You will be comparing the two words, focusing on the /s/ sound, and make a rating according to whether the /s/ in the second word is better r worse than the /s/ in the first word. Remember to always anchor on the first word and compare the second word to the first word. The left of the slider (show slider) would indicate the /s/ in the second word is much worse than in the first word. The right of the slider would indicate the /s/ in the second word is much better than the first word. The middle of the slider would indicate the /s/ productions in both words are the same. During the test, you will play the word by clicking here (show *play sound* button). Wait until you hear both words before making your rating. Then move the slider and rate how well the /s/ in the second word is articulated compared to the /s/ in the first word. Do not be afraid to use the range of the scale (go really high or really low). If you need to hear the words again, it is alright to play the sound more than once. When you have selected your rating of the sound, click *submit*. This will then allow you to click on the *play* button to listen to another set of words.

Training Introduction

We are going to begin with a training to help you become familiarized with the program. In some of the examples the /s/ in the second word will be worse than in the first word. In some

examples the /s/ in the second word will be better. Remember that you are always comparing the second word to the first word. Rate according to if the second word is better or worse than the first word. These examples were selected to show you poorly and more normally articulated examples. Practice running through the program to become familiar with the program and listening for the /s /sounds. There will be 8 sets of words presented for the training.

Actual test

Now we will run the actual test. Please mark as accurately as possible. Remember, you can mark anywhere along the scale to record articulation for the words. Listen for the /s/ sound and rate whether the second sound is better or worse than the first. You can listen to the words more than once if needed. Please take your time and attempt to make accurate judgments.

Training Introduction

We are going to do another quick training. This time you will hear words that contain either a voiced or voiceless /θ/ or /ð/ (theta and thorn). The /θ/ sound may be at the beginning, middle, or end of the words. Listen for the quality of the /θ/ articulation. Again, you will always compare the second word to the first word presented and rate if it is better or worse than the /θ/ in the first word.

Actual test

Now we will run the actual test. Please mark as accurately as possible. Remember, you can mark anywhere along the scale to record articulation for the words. Listen for the /θ/ sound (voiced or voiceless) and rate whether the second sound is better or worse than in the first word. You can listen to the words more than once if needed.

Appendix D: Annotated Bibliography

Allen, M. M. (2013). Intervention efficacy and intensity for children with speech sound disorders. *Journal of Speech, Language, and Hearing Research*, *2012*, 856-865. doi:10.1044/1092-4388

Objective: This article evaluated the effectiveness of the multiple oppositions approach when treating phonological disorders in young children and examined optimal dose frequency. *Methods*: Fifty-four preschool children participated in the study. Each child was randomly assigned to receive treatment with the multiple oppositions approach once each week for twenty-four weeks, three times a week for eight weeks, or receive a conditional storybook intervention. Treatment outcomes were measured by examining the percent of consonants correct. *Results*: Preschool children who received the multiple oppositions treatment approach three times a week for eight weeks had statistically significantly higher percentages of consonants correct than those who received the lower treatment dose. *Conclusions*: The multiple oppositions approach was effective in treating young children with speech sound disorders and was most effective when treated with a higher dose frequency. *Relevance to current work*: This study indicated that in this instance, a higher dose of therapy was more effective than a lower treatment dose. It is possible that a higher treatment dose may be more effective for other speech sound disorders as well.

Angadi, V., & Stemple, J. (2012). New frontiers and emerging technologies in comprehensive voice care. *Perspectives on Voice and Voice Disorders*, *22*, 72-79. doi: 10.1044/vvd22.2.-72

Objective: This publication summarized the history and evolution of voice therapy, outlining future areas of focus. The authors evaluated a *new frontier* in voice therapy called boot camp therapy, which is an intensive treatment approach that takes place over a short period of time. Other techniques such as LaxVox therapy, telepractice in voice therapy, virtual reality, and video self-monitoring were also discussed. *Conclusions*: New technologies and emerging treatment techniques may have the potential to greatly enhance the treatment of voice disorders. Boot camp therapy may be used to treat muscle tension dysphonia, dysphonia secondary to vocal fold scarring, paradoxical vocal fold motion, and functional aphonia. Advantages of boot camp therapy include rigorous practice, the ability to use multiple treatment approaches, and opportunity to transfer to different situations. However, participants require high levels of motivation and compliance. Speech-language pathologists must individually consider appropriateness of such therapy. *Relevance to current work*: Reports of successful treatment using an intensive short-term approach in the voice disorders literature suggests the value of evaluating treatment intensity in other areas of speech and language therapy.

Asanuma, H., & Pavlides, C. (1997). Neurobiological basis of motor learning in mammals. *Neuroreport*, *8*(4), 1-6.

Objective: This study evaluated the link between long-tem potentiation (LTP) and cognitive memory during motor learning. *Conclusions*: It was determined that the sensory cortex was not specifically necessary when acquiring new motor skills once a skill is acquired. The authors proposed that motor learning involves the formation of loop circuits between the motor cortex and the periphery. Refinement of muscle contractions occurs by producing LTP through practice. *Relevance to current work*: It was suggested that intensive practice increases LTP and enhances learning and memory of specific muscle movements. Therefore, increased practice leads to increased motor skill.

Baker, E. (2012a). Optimal intervention intensity. *International Journal of Speech-Language Pathology*, *14*(5), 401-409. doi: 10.3109/17549507.2012.700323

Objective: Due to limited research concerning optimal duration and intensity of treatment methods, this article sought to raise awareness of the lack of information about optimal treatment intensity, describe what is known about intervention intensity, and suggest further considerations for researchers and clinicians. *Conclusions*: The author suggested a framework for measurement of client acts and therapeutic inputs during therapy sessions in order to determine optimal intensity levels. The influence of client-, condition-, clinician-, and service-related variables must be considered when examining treatment intensity. Establishing optimal intensity levels of treatment will lead to best practice, although practicality must also be considered. *Relevance to current work*: There is a need for research about treatment dose and intensity. An understanding of optimal treatment dosage would improve current methods of practice and ensure efficient use of time and resources.

Baker, E. (2012b). Optimal intervention intensity in speech-language pathology: Discoveries, challenges, and uncharted territories. *International Journal of Speech-Language Pathology*, *14*(5), 478-485. doi**:** 10.3109/17549507.2012.717967

Objective: This article summarized research questions and literature about optimal intervention intensity. *Conclusions*: An increased period of intense intervention has been shown to achieve better outcomes although the relationship between treatment intensity and the outcome is more ambiguous. The ideal intensity level for treatment can be established by identifying intervention methods, better understanding how motor learning and neuroplasticity facilitate learning, and considering individual differences. Researchers should also examine the effects of specific intensity strategies (including dose, dose form, dose frequency, session duration, and total intervention duration) on treatment outcomes and suggest solutions for practical application. *Relevance to current work*: Further research is needed about optimal treatment intensity for specific subjects under a variety of conditions in order to determine specific guidelines for treatment intensity that yield the greatest treatment outcomes.

Barratt, J., Littlejohns, P., & Thompson, J. (1992). Trial of intensive compared with weekly speech therapy in preschool children. *Archives of Disease in Childhood, 67*, 106–108.

Objective: This study compared the effects of a traditional weekly speech therapy approach with an intensive therapy dose. The authors wanted to determine if treatment intensity affected speech-language therapy outcomes and if so, what those outcome were. *Methods*: Preschool children aged 2-5 years participated in a randomized clinical trial, receiving language therapy in differing treatment doses. Children receiving the traditional approach attended speech therapy for one forty-minute session a week over a six month period, while the intensive intervention occurred during four forty-minute sessions per week for three weeks. *Results*: Children with language disorders had higher verbal expression scores following the higher treatment dose when compared with children who received the low treatment dose, as determined by Reynell scale scores. *Conclusions*: The more intense treatment approach yielded better therapy results than the traditional approach for preschool children with language disorders. *Relevance to current work*: Improved results following a high therapy dose for children with language disorders suggests that a high dose treatment pattern may be more effective for other areas of speech-language therapy as well.

Blomgren, M., Roy, N., Callister, T., Merrill, R. M. (2005) Intensive stuttering modification therapy: a multidimensional assessment of treatment outcomes. *Journal of Speech, Language, and Hearing Research*, *48*(1), 509-523. doi:10.1044/1092-4388(2005/035)

Objective: This article measured the effects of the Successful Stuttering Management Program (SSMP) in adult participants who stuttered. *Methods*: Nineteen adults who stuttered participated in the study. Participants underwent a 3-week intensive stuttering modification therapy program. Treatment effects were measured by analysis of stuttering frequency and by rating scales such as the Perceptions of Stuttering Inventory (PSI), Beck Depression Inventory, and the State-Trait Anxiety Inventory. *Results*: Of the fourteen measures analyzed, improvements were statistically significant on four of the measures (i.e., scores on the SSI and the Struggle, Avoidance, and Expectancy subscales of the PSI). Improvements were maintained 6 weeks post-treatment on only a few measures. *Conclusions*: Some modest improvements in stuttering were observed post-treatment, but they were not maintained for an extended time period. Although the results were questionable, sustained improvements were observed in self-perceived avoidance and expectancy of stuttering and for some anxiety measures. *Relevance to current work*: The results of the intensive therapy program were inconclusive, but it is unclear if that was due to treatment intensity or therapy method. Regardless, additional studies investigating treatment intensity could contribute valuable clinical knowledge to clinician's understanding of treatment efficacy.

Carter, P. & Edwards, S. (2004). EPG therapy for children with longstanding speech disorders: Predictions and outcomes. *Clinical Linguistics & Phonetics*, *18*(*6-8*), 359-372.

Objective: This study evaluated the effectiveness of electropalatography (EPG) in articulation therapy and considered the ability to predict therapy outcomes, particularly with EPG. *Methods*: Ten children with various speech pathologies participated in the study. The researchers identified possible factors predicting successful improvements with EPG. During a ten-week therapy period, each child participated in therapy using

EPG and baseline and follow-up data were collected. *Results*: The results indicated a significant difference in scores. Each subject showed improvement by demonstrating fewer errors, based on a percentile ranking and by the Probe Scoring System (PSS). The predictions to determine which children would be most successful were inconsistent with actual results. *Conclusions*: EPG therapy was found effective, suggesting that children selected were good candidates for EPG therapy. However, speech therapists were unable to successfully predict which children would be successful in therapy. *Relevance to current work*: EPG can be an effective clinical tool and may be useful as part of a multimodal treatment approach when remediating speech sound disorders.

Dagenais, P. A. (1995). Electropalatography in the treatment of articulation/phonological disorders. *Journal of Communication Disorders*, *28*(4), 303-329. doi:10.1016/00219924-(95)00059-1

Objective: This article summarized the use of EPG in the treatment of speech sound disorders, stating the differences between traditional articulation therapy and therapy with EPG. *Conclusions*: Conclusions drawn from an evaluation of the literature about EPG treatment for speech sound disorders indicated EPG can be an effective alternate method of treatment and can provide insights in assessing a speech problem. EPG was successful largely because of the ability to provide objective data. In traditional therapy, clients must auditorily recognize articulatory misproductions but since EPG is a physiologically-based, visual approach, the client can see correct articulatory placement. *Relevance to current work*: EPG has been a successful method for treating speech sound disorders and can provide objective data and visual feedback that can supplement traditional articulation treatment procedures.

DiPietro, L., Dziura, J., Yeckel, C. W., & Neufer, P. D. (2006). Exercise and improved insulin sensitivity in older women: Evidence of the enduring benefits of higher intensity training. *Journal of Applied Physiology*, *100*(1), 142-149. doi: 10.1152/japplphysiol.00474.2005

Objective: This article investigated the effects of higher intensity exercise training to improve insulin sensitivity in older women. *Methods*: Participants were all females (between the ages of 63 and 83 years) who were inactive, but not obese. The participants were randomly assigned to a group of high-intensity, moderate-intensity, and low-intensity aerobic training. Exercise volume remained constant across all three groups, but the intensity varied greatly. Each participant was measured for total body fat and lean mass as well as the rate of insulin-stimulated glucose utilization. *Results*: Results of the study were found to be significant only with the group that did high-intensity training. The high-intensity treatment group also had significant improvements in insulin-stimulated suppression of adipose tissue. *Conclusions*: The treatment group involved in high-intensity exercise achieved improved results and participating in a higher-intensity program, even if the total volume of exercise remained the same would contribute to benefits to insulin action. *Relevance to current work*: A higher-intensity training program achieved improved insulin sensitivity in older women and suggested that a treatment's or program's level of intensity can greatly affect the outcome and should thus be considered as a research factor.

Fatouros, I. G., Kambas, A., Katrabasas, I., Nikolaidis, K., Chatzinikolaou, A., Leontsini, D., & Taxildaris, K. (2005). Strength training and detraining effects on muscular strength, anaerobic power, and mobility of inactive older men are intensity dependent. *British Journal of Sports Medicine*, *39*(10), 776-780. doi: 10.1136/bjsm.2005.019117

Objective: This study analyzed training intensity by observing the effect of strength training on musculoskeletal fitness in males following a long period without any training. *Methods*: Participants were comprised of fifty-two healthy, but inactive older men (mean age of 71 years). The participants were divided into two groups. One group received low intensity training and the other group received high intensity training over a 24-week period followed by a 48-week detraining period. *Results*: Both groups of participants demonstrated improvement post-training, but the high intensity group exhibited significantly greater gains in strength, anaerobic power, and mobility. *Conclusions*: The effects of a high intensity training program contributed to greater gains in muscular strength and mobility as compared to a low intensity program for older men that had previously been inactive. The high intensity program also may have better retained increased training effects over longer periods of time. *Relevance to current work*: Increased intensity of training was the primary reason for increased results following the designated program. Treatment intensity may also be an important factor in other programs, such as speech therapy.

Gibbon, F., & Hardcastle, W. (1987). Articulatory description and treatment of "lateral /s/" using electropalatography: A case study. *British Journal of Disorders of Communication*, *22*(3), 203-217.

Objective: Gibbon and Hardcastle performed a case study using electropalatography (EPG) to treat a lateral /s/ misarticulation in order to evaluate the effectiveness of EPG, which provided visual information instead of auditory feedback. *Methods*: One 12-year-old boy participated in the study. He had severe ear infections as an infant, was delayed in acquiring developmental speech milestones, and presented with a lateral /s/. He received speech therapy for 1 year and was subsequently discharged, although the lateral /s/ persisted. Therapy was provided for 1 hour each week over the course of 4 weeks. Treatment methods focused on using EPG to provide tactile and visual feedback when establishing tongue placement. *Results*: EPG patterns of tongue-to-palate contact were compared. The participant was able to achieve a normal /s/ pattern during conversational speech over a short period of time of just four treatment sessions. The typical /s/ pattern was maintained 6 months post-treatment. *Conclusions*: EPG can be an effective treatment method for treating a mistarticulated /s/. EPG provided detailed information regarding tongue configurations, displayed real-time visual information about tongue movement during therapy, and allowed for both qualitative and quantitative measures to be obtained. Thus, EPG may be a valuable tool to use in therapy. *Relevance to current work*: Using a visual feedback modality, such as EPG, may accelerate the length of treatment necessary to remediate speech sound disorders.

Gibbon, F., Hardcastle, B., & Dent, H. (1995). A study of obstruent sounds in school-age children with speech disorders using electropalatography. *European Journal of Disorders of Communication*, *30*(2), 213-225.

Objective: Electropalatography (EPG) was used to determine characteristics and describe patterns of the voiceless obstruents /s, t, ʃ, tʃ / as produced by children with disordered articulation. M*ethods*: Ten children, between 7 and 16 years of age with functional speech sound disorders, participated in the study. Each child presented with different articulatory distortions, including palatal, lateralized, and dental. Children were sorted into three groups (i.e., palatal, lateralized, and dental) depending on tongue placement and based on perceptual judgments. EPG and acoustic data were recorded to visual contact patterns for distorted sounds. *Results*: After analyzing contact patterns displayed using EPG, children whose speech patterns sounded distorted also displayed idiosyncratic tongue-to-palate contact for those sounds. *Conclusions*: Differences in the placement of the articulators could be seen visually using EPG, but could not be deciphered from auditory feedback alone. There was often no pattern across all sibilant and affricate target sounds for individual children. Children demonstrated a variety of tongue-to-palate contact patterns even when listeners perceived sounds to be alike. *Relevance to current work*: Different individuals may have unique production patterns for disordered speech sounds. EPG can aid in characterizing speech patterns, thus directing treatment processes for speech sound disorders.

Gildersleeve-Neumann, C. (2007, November 6). Treatment for childhood apraxia of speech: A description of integral stimulation and motor learning. *The ASHA Leader*.

Objective: Principles of integral stimulation and motor learning were applied to treatment of childhood apraxia of speech (CAS). This article described those principles and their use in enhancing treatment for CAS. Integral stimulation for children incorporated aspects of motor learning such as variability in readiness for motor learning, considering conditions of practice, providing appropriate feedback, and considering the effect of speech rate. *Conclusions*: Gildersleeve-Neumann stated the importance of analyzing principles of motor learning and using principles of integral stimulation in order to make treatment effective for children with apraxia of speech. *Relevance to current work*: Principles of motor learning influence other types of communication disorders and could enhance treatment of speech disorders as well.

Laursen, P. B., & Jenkins, D. G. (2002). The scientific basis for high-intensity interval training: Optimising training programmes and maximising performance in highly trained endurance athletes. *Sports Medicine*, *32*(1), 53-73. doi: 0112-1642/02/0001-0053

Objective: Laursen and Jenkins analyzed the effects of high-intensity interval training (HIT) for trained endurance athletes. *Conclusions:* Although endurance improved, upon examination of muscle enzyme activity, no reported changes in enzyme activity were observed. An additional increase in training volume did not seem to improve the athlete's performance, but for already-trained athletes, a high-intensity interval training program was more effective in improving endurance performance.

Supramaximal sprinting may be as effective as the HIT program for improving endurance. *Relevance to current work*: Although in a different discipline, this article examined the effects of treatment intensity to improve performance, described methods of manipulating treatment intensity, and suggested treatment intensity is an important variable to consider in improving treatment results.

Patel, R. R. Bless, D. M., & Thiebault S. L. (2011). Boot camp: A novel intensive approach to voice therapy. *Journal of Voice*, *35*(*5*), 562-569.

Objective: This article described vocal boot camp, a short-term, intensive therapy approach for patients with voice disorders, and provided evidence to support such a treatment from neurobiology, exercise physiology, motor learning, and psychotherapy literature. Patel et al. summarized the typical framework of intensive short-term voice therapy. Intensive voice therapy typically occurred over 1-4 successive days with about 5 hours of therapy each day and several different clinicians provided treatment. *Conclusions*: The authors suggested that a high-intensity training procedure better followed the pattern of daily living than traditional therapy. Rigorous practice was crucial, thus providing greater opportunities for specificity and individuality in order to generalize skills learned in therapy. Intensive voice therapy reportedly yielded many advantages, although a high degree of commitment was required for each participant. *Relevance to current work*: A high-intensity treatment methodology was shown to be an effective alternative to traditional therapy for voice disorders and higher intensity treatments could also be effective in other areas of speech therapy.

Pulvermuller, F., Neininger, B., Elbert, T., Mohr, B., Rockstroh, B., Koebbel, P., & Taub, E. (2001). Constraint-induced therapy of chronic aphasia after stroke. *Stroke*, *32*(7), 1621-1626. doi: 10.1161/01.STR.32.7.1621

Objective: This study compared results of a traditional approach to aphasia therapy versus a constraint-induced (CI) technique. CI aphasia therapy involved intensive practice over a short period of time. *Methods*: 17 patients, randomly assigned to receive traditional therapy or CI aphasia therapy, participated in the study. Each person was identified with language impairment as a result of a stroke in the left middle cerebral artery. Participants received the same amount of treatment over a longer period of about 4 weeks for traditional therapy or a shorter period of 10 days of massed-practice for CI therapy. *Results*: Patients who participated in the intensive, short-term CI aphasia therapy made significant improvements on standardized tests and also reported higher self-ratings about communicative effectiveness. Participants in the control group did not reach these same gains. *Conclusions*: For this group of patients, the concentrated CI aphasia therapy, which focused on the person's communicative needs, was more effective than traditional treatment methods in improving the language skills of people with chronic aphasia. *Relevance to current work*: A more intensive, shorter-term treatment method was better at achieving communication goals for people with chronic aphasia after a stroke.

Ramig, L. O., Countryman, S., Thompson, L. L., & Horii, Y. (1995). Comparison of two forms of intensive speech treatment for Parkinson disease. *Journal of Speech, Language, and Hearing Research*, *38*(6), 1232-1251.

Objective: Two forms of intensive speech treatment (i.e., respiration treatment and Lee Silverman Voice Treatment [LSVT]) were provided for patients with Parkinson's disease (PD) and the effects of the treatments were compared to see which achieved the greatest communicative gains. *Methods*: 45 patients participated in this study. All of the participants had 16 sessions of intensive speech treatment, with 4 sessions a week for 1 month. Intensity and maximum duration of sustained vowel phonation were measured before and after treatment. Other measurements included intensity, habitual fundamental frequency, fundamental frequency variability, utterance and pause duration, and self-ratings. *Results*: All of the participants, except one, who participated in the LSVT treatment improved post-treatment. Treatment gains were much larger for the group of LSVT participants than the group who received respiration therapy. *Conclusions*: LSVT focused on increasing vocal fold adduction and respiration and intensive treatment using this method was more effective in improving vocal intensity than respiration therapy. *Relevance to current work*: Intensive treatment methods have been proven to be effective when treating patients with Parkinson's disease. However, intensive treatment alone does not always produce improvements. The type of treatment is still an important consideration.

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, and Psychiatry*, *71*, 493-498.

Objective: In order to determine long-term effects of Lee Silverman Voice Treatment (LSVT) for patients with Parkinson's disease, researchers analyzed treatment effects and maintenance two years post-treatment. *Methods*: There were thirty-three patients with Parkinson's disease who participated in this study. Patients were randomly assigned to receive either LSVT or respiratory therapy. Vocal effort was measured by analyzing vocal loudness and inflection in fundamental frequency during a sustained vowel phonation, reading passage, and monologue. Measurements were taken before treatment, after treatment, and two years post-treatment. *Results*: Participants who participated in LSVT had significantly higher sound pressure levels and greater inflection in voice fundamental frequency. These gains were maintained two years after therapy. *Conclusions*: LSVT is an effective approach for increasing vocal loudness and improving vocal function and the positive results are often maintained, even after a couple of years. *Relevance to current work*: LSVT is a high therapy dose approach to treating patients with Parkinson's disease. The success of the program may be due in part to the intensive nature of therapy.

Raymer, A. (2009, February 10). Constraint-induced language therapy: A systematic review. *The ASHA Leader*.

Objective: Raymer conducted a systematic review of constraint-induced language therapy (CILT) as a therapy technique for treating individuals with aphasia. CILT involved a high-intensity training procedure where clients participated in language activities only using verbal communication with no other communication modalities such as drawing or writing. *Conclusions*: Overall, results across studies were positive, indicating that CILT may be an effective treatment method for increasing the communicative effectiveness of client with aphasia. The benefits of the program may be due largely to the high intensity level of treatment. *Relevance to current work*: Treatment intensity may be a major factor of success for aphasia therapy and the intensity of treatment should be considered when investigating various therapy approaches.

Reichow, B., & Wolery, M. (2009). Comprehensive synthesis of early intensive behavioral interventions for young children with autism based on the UCLA young autism project model. *Journal of Autism and Developmental Disorders, 39*, 23–41.

Objective: Reichow and Wolery evaluated an intensive behavioral intervention (EIBI) for children with autism by synthesizing previous research articles and determining the characteristics and effects of EIBI. *Methods*: Fourteen studies were examined by analyzing patient and intervention characteristics. Therapy for this approach was typically provided for at least 20-25 hours per week. *Results*: A multi-level analysis examining experimental methods, participant characteristics, and intervention characteristics. *Conclusions*: Results were inconclusive, but suggested that EIBI therapy, with long durations and greater total therapy hours, was an effective treatment approach for children with autism. *Relevance to current work*: A high therapy dose may be an effective treatment for other populations other than just children with autism. Treatment intensity should be a topic of research when evaluating treatment efficacy.

Roy, N. & Leeper, H. A. (1993). Effects of the manual laryngeal musculoskeletal tension reduction technique as a treatment for functional voice disorders: Perceptual and acoustic measures. *Journal of Voice*, *7*(*3*), 242-249.

Objective: Researchers investigated the effectiveness of using manual laryngeal musculoskeletal tension reduction technique to treat patients with functional dysphonia in one intensive therapy session. *Methods*: This study had 17 participants, 1 male and 16 female, between 20 and 70 years of age. Each person presented with functional dysphonia as dictated by no visible structural problem and normal vocal fold mobility during phonation. All participants completed assessment and treatment procedures in one session lasting up to 3 hours. *Results*: Perceptual and acoustic measures were evaluated for connected speech and sustained vowels. Perceptual measures were more often rated toward normal for post-treatment tokens and acoustic measures of jitter, shimmer, and signal-to-noise ratio (SNR) confirmed significant improvements post-therapy. *Conclusions*: For this population group, the manual laryngeal musculoskeletal tension reduction technique was effective in improving vocal quality after one high-intensity treatment session. *Relevance to current work*: Therapy for this study occurred in a single session, often because participants traveled great distances for the treatment. Travel

expenses and length of stay may be a factor when deciding to do an intensive treatment protocol.

Sapir, S., Spielman, J. L., Ramig, L. O., Story, B. H., & Fox, C. (2007). Effects of intensive voice treatment (the Lee Silverman Voice Treatment [LSVT]) on vowel articulation in dysarthric individuals with idiopathic Parkinson disease: Acoustic and perceptual findings. *Journal of Speech, Language, and Hearing Research*, *50*(4), 899-912.

Objective: Researchers measured the effectiveness of Lee Silverman Voice Treatment (LSVT) to increase vocal loudness when targeting respiration, phonation, and articulation in patients with Parkinson's disease (PD). *Methods*: Fourteen participants with PD received LSVT and were compared to a group of 15 PD patients who did not receive LSVT and to a group of 14 healthy individuals. Two groups with idiopathic PD and one control group of neurologically healthy participants had a videolaryngoscopic examination prior to the study and all groups participated in LSVT. Vowel formants were measured and certified speech-language pathologists completed a perceptual rating of vowels. *Results*: Participants with PD who completed LSVT showed significant changes in the direction of normal values and demonstrated improved vocal and articulatory functions. Control groups did not indicate any change. *Conclusions*: A lack of change in the control groups indicated that changes in the PD with LSVT were specifically related to treatment. Thus, LSVT was shown to be an effective treatment method in improving articulatory function for people with PD. *Relevance to current work*: LSVT is an intensive treatment style and has been empirically supported in the literature, indicating a more intensive method of therapy can have greater therapeutic effects for people with PD.

Schooling, T., Venediktov, R., & Leech, H. (2010, October). Evidence-based systematic review: Effects of service delivery on the speech and language skills of children from birth to 5 years of age. *National Center for Evidence-Based Practice in Communication Disorders, American Speech-Language-Hearing Association*, Rockville, MD.

Objective: This article provided an evidence-based review of service delivery models for speech and language intervention for young children with communication disorders. Researchers examined the effects of frequency, intensity, and duration of service; direct and indirect service; individual and group treatment; and treatment setting. *Conclusions*: After a comprehensive review, the authors concluded that the framework of treatment does have a significant effect on treatment outcomes, although further research is needed. Upon examining treatment dose, six of seven clinically significant studies favored a more intensive treatment method. *Relevance to current work*: This articled reviewed studies dealing with treatment dose and concluded that treatment dose does affect treatment outcomes. Specifically, the authors suggested that a high therapy dose may make therapy more effective.

Seynnes, O., Fiatarone Singh, M. A., Hue, O., Pras, P., Legros, P., & Bernard, P. L. (2004). Physiological and functional responses to low-moderate versus high-intensity progressive

resistance training in frail elders. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *59*(5), 503-509.

Objective: Treatment effects of a low/moderate- and high-intensity training program when strengthen knee extensor muscles in elderly patients were examined. *Methods*: 22 participants who were at least 70 years old (mean age of 81.5 years) and could walk without assistance for distances of 20 meters or greater participated in the study. Each person was randomly assigned to complete high-intensity strength training, low-moderate intensity strength training, or a placebo-control training program. Exercises were preformed 3 times a week for 10 weeks. Knee extensor strength and endurance, stair-climbing power, chair-rising time, and six-minute walking distance were recorded for each participant. *Results*: Participants who completed the high-intensity training revealed significantly different results as compared to results from those that completed the low-intensity training. *Conclusions*: Increased knee extensor strength and endurance were directly related to the intensity of the treatment. A high-intensity, weight-based training program for elderly patients was reported to be safe but also improved physiologic and functional knee strength. *Relevance to current work*: A high-intensity training program was shown to be more effective in muscle training and exercise. Various disciples have declared therapy intensity or dosage to be an important factor in the success of treatment.

Thibeault, S. L., Zelazny, S. K., & Cohen, S. (2009, May 26). Voice boot camp: Intensive treatment success. *The ASHA Leader*, *14*, 26-27.

Objective: Traditional treatment intensity typically occurs in weekly or biweekly sessions. However, examining alternate treatment methods such as a high dose therapy approach may prove more effective for certain patients. This article discussed a boot camp approach to therapy where vocal treatment occurred in a high therapy dose. *Conclusions*: Boot camp therapy can be a more complex approach due to using multiple clinicians, a variety of therapeutic techniques, coordinating with other disciplines, and requirements for a high level of patient motivation. However, a multiple-clinician, intensive approach was effective in increasing patient confidence, improving vocal quality in a short period of time, and providing enhanced knowledge for home practice. *Relevance to current work*: Conducting therapy using a high-intensity style, such as with this boot camp method, could be successful in accomplishing treatment goals over a shorter period of time.

To, C. K. S., Law, T., & Cheung, P. S. P. (2012, October) Treatment intensity in everyday clinical management of speech sound disorders in Hong Kong. *, International Journal of Speech-Language Pathology, 14*(5), 462-466. doi:10.3109/17549507.2012.688867

Objective: This study examined the clinical practice of speech-language pathologists in Hong Kong to investigate treatment intensity and contributing factors in determining treatment intensity when remediating speech sound disorders in children. *Methods*: 102 speech-language pathologists participated in the study and completed an online questionnaire with questions about workload, treatment intensity, and selection of

treatment approach. *Results*: In a public setting, treatment dose for speech sounds disorders was most often two 30- or 35-minute sessions a month, with an average of 20 total sessions. Clinicians in a private setting indicated that treatment dose was most often 2-4 30-60 minute sessions per month, with 5 to 12 total sessions. Treatment frequency had a mild, negative correlation with caseload size. *Conclusions*: Treatment frequency and duration was largely determined by factors such as work setting and caseload rather than evidenced-based practice. Speech-language pathologists did not plan treatment dosage according to therapy approach or client condition, largely due to heavy workloads and a lack of evidenced-based research concerning ideal treatment dose. *Relevance to current work*: This article clearly states the need for further research to determine optimal treatment frequency and duration when treating speech sound disorders in children. Evidence-base research about treatment dose is needed to maximize effectiveness of clinical treatment.

Van Demark, D. R. & Hardin, M. A. (1986). Effectiveness of intensive articulation therapy for children with cleft palate. *Cleft Palate Journal*, *23*(3), 215-224.

Objective: Researchers evaluated the effectiveness of an intensive treatment method in remediating articulation errors in children with cleft palate. *Methods*: Thirteen children with cleft palate attended a six-week intensive treatment program. Each child received four hours of therapy each day for twenty-six days. Articulation was assessed for each participant at the conclusion of intensive therapy and also at a nine-month follow-up. Articulation quality was assessed using nasality ratings, a word articulation test, and a repeated sentence articulation test. *Results*: All children participating in the study demonstrated improved articulation in post-treatment measures. However, ten of the thirteen participants showed no gains from the post-therapy results to the nine-month follow-up results. *Conclusions*: Articulation did improve following the program of a high therapy dose. However, improvements were not as great as predicted and children did not demonstrate significant improvements nine months later. *Relevance to current work*: A high therapy dose for children with cleft palate was effective in improving speech articulation, even if improvements were less than expected. This intensive treatment approach might also be effective when treating speech sound disorders in other populations.

Van Riper, C. & Erickson, R. L. (Eds.). (1996). Speech correction: An introduction to speech pathology and audiology (9th ed.). Boston: Allyn and Bacon.

Objective: This text provided an introduction to main topics of speech and language pathology and audiology including chapters about the development of speech and language, fluency disorders, voice disorders, language disorders, cleft palate, aphasia, and hearing impairment. *Relevance to current work*: Van Riper explained the basic stages of treating speech sound disorders and described a traditional approach to articulation therapy.

Warren, S. F., Fey, M. E., & Yoder, P. J. (2007). Differential treatment intensity research: A missing link to creating optimally effective communication interventions. *Mental*

Retardation and Developmental Disabilities Research Reviews, *13*(1), 70 – 77. doi: 10.1002/mrdd.20139

Objective: Warren, Fey, and Yoder examined the need for research investigating different treatment intensities. They provided a literature review regarding various treatment intensities and proposed specific terms to consider in this area of research. *Conclusions*: Research about treatment intensity could generate increased knowledge and make interventions increasingly effective. Treatment intensity could generally be defined as the duration of treatment and can be measured according to dose (the number of administrated teaching episodes), dose form (the task or activity in which the teaching is delivered), dose frequency (the number of times a dose is provided per day or week), total intervention duration (time period when all treatment for a specific intervention is provided), and cumulative intervention intensity (dose x dose frequency x total intervention duration). Randomized between-group studies comparing treatment group studies are needed to develop efficacious interventions. *Relevance to current work*: Further research about treatment intensity is needed so that the effects of different treatment intensities can be characterized and understood.

Williams, A. L. (2012). Intensity in phonological intervention: Is there a prescribed amount? *International Journal of Speech-Language Pathology*, *14*(5), 456-461. doi: 10.3109/17549507.2012.688866

Objective: This article examined three studies using a multiple oppositions approach for phonological intervention to determine if intensity was an important treatment variable. Intensity of treatment was examined by analyzing the dose, frequency, duration, and cumulative intervention intensity. *Conclusions*: After analyzing three studies collectively, the author concluded that treatment intensity did make a significant difference in greater treatment outcomes. A dose greater than 50 trials per session for at least 30 sessions was found to be most effective in stimulating significant treatment gains. Researchers stated that children presenting with more severe disorders needed increased treatment intensity to facilitate similar gains and the intensity of treatment is often greater at the beginning of a therapy session. *Relevance to current work*: This article included a review of treatment intensity, or dosage, in order to determine the effects of a more intense treatment dose. Further research is needed to establish specific guidelines for optimal treatment intensity resulting in the greatest treatment gains.

Zafeiridis, A., Sarivasiliou, H., Dipla, K., & Vrabas, I. S. (2010). The effects of heavy continuous versus long and short intermittent aerobic exercise protocols on oxygen consumption, heart rate, and lactate responses in adolescents. *European Journal of Applied Physiology*, *110*(1), 17-26. doi: 10.1007/s00421-010-1467-x

Objective: Researchers compared the effect of heavy continuous (HC), short-intermittent (SI), and long-intermittent (LI) treadmill exercise regimes. *Methods*: Nine adolescent males participated in this study and performed a maximal incremental treadmill test. Each participant performed a HC, SI, and LI treadmill exercise. Blood samples were obtained before and after each exercise routine and VO_2 and HR were

measured. *Results*: Results indicated that all participants reached 80% and 85% of VO_2 peak for all exercise protocols, although the total VO_2 consumed was greater in HC and LI programs. *Conclusions*: Long-intermittent exercise was more effective in stimulating the aerobic system than either of the other two exercise programs. Both HC and SI appeared to provide equal results. *Relevance to current work*: The intensity of a program is an important variable when analyzing outcomes of aerobic exercise protocols on the oxygen consumption, heart rate, and lactate responses for adolescents. It is possible that intensity of a treatment program might also be an important variable when considering the effectiveness of speech and language therapy.