Effects Of Oral Myofunctional Therapy On Swallowing and Sibliant Production

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This study investigated the effectiveness of oral myofunctional therapy in eliminating a 16 year-old girl's tongue thrust swallowing pattern and mild sibilant distortion. An ABC design was used where Phase A had eight baseline sessions (no treatment), Phase B had 14 oral myofunctional therapy sessions, and Phase C had four articulation treatment sessions. Dependent measures of swallowing and sibilant production were obtained in each session. A third dependent variable, labial diadochokinetic rate, was also measured each session and served as a control for maturation. Oral myofunctional therapy was shown to be effective in eliminating the tongue thrust swallowing pattern of this subject, but not her sibilant distortion. However, her sibilant distortion reduced after one articulation treatment session and was maintained at negligible levels over the next three treatment sessions. As expected, labial diadochokinetic rate remained stable across the three phases. At the conclusion of Phase C, two bi-weekly home visits revealed that the subject had maintained and generalized her new swallowing pattern. Measures obtained six months after completion of Phase C indicated that the subject had maintained her new swallowing and speech production behaviors. The subject's maximal tongue strength and endurance were below expected normal values at the initiation of the study and increased during the study. Her tongue endurance appeared more sensitive to the effects of oral myofunctional training than tongue strength and, unlike tongue strength, tongue endurance decreased in the six month period following completion of the study.

Numerous investigators have reported that children with deviant swallowing patterns are more likely to have sibilant distortions ("lisps") than those with normal swallowing patterns (see Christensen & Hanson, 1981 for a summary of these studies). For example, Ward, Malone, Jann and Jann (1961), surveyed 24,657 elementary school children and found tongue thrust to be typical in grades one, two, and three. Of the children found to have articulation defects, about 40% also had tongue thrust swallowing patterns. These authors also found that children with a tongue thrusting pattern produced tongue-tip phonemes dentally or interdentally. Subtelny, Mestre, and Subtelny (1964), reported that sibilant distortion was more likely to occur in subjects with both dental malocclusion and tongue thrust swallowing patterns than in subjects with the same dental malocclusion, but no tongue thrust. Fletcher, Casteel, and Bradley (1961), established that 25-35% of tongue thrusters versus 5-10% of non-tongue thrusters exhibited sibilant distortion. While some authors have concluded that oral myofunctional therapy is not effective in correcting tongue thrusting swallow patterns (e.g., Haas, 1977; Schreiber, Maxwell & Guay, 1975), more recent investigations provide support for the efficacy of oral myofunctional therapy in correcting tongue and lip resting postures and tongue thrust swallow patterns and, in some instances, sibilant distortion. Hahn and Hahn (1992) contacted 131 discharged patients up to 10 years post-treatment. They found that, regardless of age, most patients had maintained a correct swallowing pattern for saliva, solids, and liquids, and were nasal breathers. As well, 72% of child and teen groups and 87% of the adult group maintained a correct tongue resting position. Sixty-one percent of the patients rated the results of oral myofunctional therapy as very good, while 30% rated the results as satisfactory. Hanson (1988) commented that 80-90% of patients who receive myofunctional therapy to correct tongue thrust retain the corrected pattern for several years. He listed motivation, interest and cooperation of parents, time available for practice, and maturity of the client as prognostic factors. Bigenzahn, Fischman and Mayrhofer-Krammel (1992) studied 103 patients with orofacial dysfunction affecting

speech. Of these, 71% were reported to have had "noxious" thumbsucking habits with 37% of these corrected before age three years and 14% of these persisting past age six years. Following oral myofunctional therapy, 91% of these patients had improved tongue resting position and 66% had normal articulation.

The purpose of the current study was to evaluate the effectiveness of oral myofunctional therapy in eliminating the tongue thrust swallow pattern and mild interdental and lateral sibilant distortion of a teenage girl, using a single subject design. It was hypothesized that the subject's new tongue position, trained during the oral myofunctional therapy, would generalize to a new tongue placement for sibilant production, resulting in elimination of her sibilant distortion.

METHODS

Subject

The subject (M) was a 16 year-old girl who expressed concern about a mild lisp that worsened when she was fatigued or produced long utterances. She also presented a tongue thrust swallowing behavior. Using Snow's (1991) system of self report, M indicated that when she swallowed, her tongue moved forward toward her teeth. Hanson's (1988) assessment protocol revealed normal structure and function of the lips, upper labial frenurn, dentition, and lingual frenum and a slightly open resting lip posture (about two mm). She reported difficulty breathing through her nose when her mouth was closed. During eating it was observed that M squeezed the bolus between her tongue and maxilla with a forward movement and then pushed the bolus back and occluded her molars during swallowing. She repeated this movement to clear food that remained in the anterior area of her mouth after swallowing. During swallowing, M's tongue protruded beyond the cutting edge of her upper and lower incisors. These observations confirmed the presence of a tongue thrust swallowing pattern. Articulation assessment revealed that she distorted 5% of sibilants in a 200 word sibilant-loaded reading passage. Sibilant distortion was characterized by interdentalization of /s/ and lateral distortion of /sh/.

Potential etiologic factors for her lisp and swallowing pattern included a reported history of small nasal passages (according to her family physician) and prolonged thumb sucking. Small nasal passages may have caused her tongue to assume an anterior position to decrease nasal airway resistance during inspiration. Mason (1993) stated that inadequate nasal air flow could cause a forward tongue carriage and subsequent tongue thrust swallow. To determine if M had a reduced nasal airway cross-sectional area and corresponding increased nasal airway resistance, measures of these variables were obtained subsequent to the conclusion of the study. The procedures and equipment described by Warren (1991) were used to obtain these measures from M. Mean cross-sectional areas and resistances were calculated at simultaneous moments across five reliable samples and appeared to be within normal limits for both inspirations and expirations (Warren, Hairfield, Seaton & Hinton, 1987). During inspiration, M's mean nasal airway cross sectional area was 0.53 cm2, with a calculated nasal airway resistance of 1.85 cm2/$H_2$0/L/s. During expiration, her mean cross-sectional area was 0.56 cm2 with a resistance of 1.63 cm$H_2$0/L/s. M sucked her thumb until she was eight years old. Thumb sucking may have caused her tongue to assume an anterior position in her oral cavity, thereby reducing her ability to reach targets during sibilant production and interfering with her progression to an adult swallowing pattern (Kellum, Gross, Hale, Eiland & Williams, 1994; Luke & Howard, 1983).

M wore a dental retainer with a crib between the ages of 8 and 10 years On the upper dental arch, the appliance had three parts. One part consisted of a band of metal wrapped around the first molar, with a small hole on the inside and outside of each band. The second part was a "crib" that had spikes extending down towards the tongue that was held in place by wires that hooked into the inside holes in the bands in the first part. A third part was a metal wire around the outside of the upper teeth that also hooked into the first part, the purpose being to pull the upper teeth inwards.

On the lower dental arch, there was a band of metal around each first molar. A band of wire that "lined" the inside of the lower teeth hooked into the metal bands on the molars. The purpose was to push the lower teeth out. This appliance reportedly corrected her excessive overjet (with labioversion of the upper and linguaversion of the lower incisors) and eliminated her thumb sucking habit. At age 16 years, M presented with normal dental occlusion. Prognosis for improvement with oral myofunctional treatment appeared favorable for M because she was old enough to understand the mechanisms involved in swallowing and was highly motivated to cooperate in treatment (Hanson, 1988)

Measures

An ABC multiple baseline across treatments single subject design was applied over a total of 26 sessions. Phase A was baseline, Phase B was oral myofunctional therapy, and Phase C was articulation treatment. Initially an ABA design was planned. However, because M continued to exhibit sibilant distortion at the end of Phase B, a new treatment phase (Phase C: Articulation Treatment) was substituted for the second baseline phase (Phase A). Several dependent variables were

behaviors across the three phases. M's performance on the tasks used to obtain these measures in each session was videotaped in a sound-treated booth using a Panasonic AFx8 video recorder.

Swallowing Measures

Frequency of Tongue Thrust Swallowing

Ten consecutive liquid swallows were observed at the end of every session (26 data points in total). These instructions were given to the subject each time: "Swallow 10 times in your usual way. I will have you hold your lips open so that I can see the movement of your tongue." The swallows were observed for forward movement of the tongue between M's upper and lower incisors. M also described the action of her tongue after the 10 swallows. The number of non-tongue thrust (i.e., correct) swallows was then tallied.

After the first oral myofunctional therapy session in Phase B, M used the new swallowing pattern on 10 out of 10 trials. To provide more sensitive measures of change in swallowing function, two additional dependent variables were introduced following the first myofunctional therapy session (Phase B). These were duration and self-ratings of the naturalness or relative ease of swallows performed by M using her new swallowing pattern.

Duration of Swallows

The duration, in seconds, required by M to complete the 10 swallows was used to measure the efficiency of her swallowing behavior in Phases B and C. This duration was timed from the moment the glass touched M's lips for the first swallow to the noise associated with the completion of the 10th swallow.

Ease of Swallowing

M was provided with a visual analog scale (see Figure 1). After completing the 10 swallows, she was instructed to draw a vertical line on the scale at a location that corresponded to her rating of perceived ease versus effort of swallowing. Each session's rating was made independently, i.e., without reference to her previous sessions' ratings. Relative ease of swallowing was quantified by dividing the length (mm) from the vertical line recorded by M to the right end of the line, by the total length of the line. Then the quotient was multiplied by 100 to yield a percentage value. On this scale, 0% indicated very difficult, effortful swallowing while 100% indicated very easy, automatic swallowing behavior. M was asked to make this rating in each of the 13 remaining sessions in Phase B and in all sessions in Phase C.

Related Variables

Tongue Strength and Endurance

The investigators were interested in the relationship between oral myofunctional therapy and M's tongue strength and endurance because oral myofunctional therapy is expected to alter tongue function. The Iowa Oral Performance Instrument (IOPI) (Luschei & Robin, 1991) was used to estimate the subject's tongue strength and endurance. Measures were taken on six occasions during the study, balanced across the three phases. Four trials of tongue strength and endurance were measured on each of these six occasions. The first measures were taken during the first baseline session. The remaining five measures were taken approximately every five sessions, with the final measure taken during the last articulation treatment session in Phase C. To make these measures, M held a sterilized plastic bulb, which was connected to the IOPI, between her tongue and hard palate, as described in the manual. To measure maximal tongue strength, M was instructed to press her tongue as hard as possible against the bulb. The IOPI provides a reading of the maximal pressure achieved, in kPa. The mean of the four trials was taken as the measure of maximal tongue strength. To measure tongue endurance, the IOPI was adjusted to one half of the highest pressure that M achieved on the maximal tongue strength task. The IOPI is equipped with a series of lights, the central one being green, with a yellow light above and below it, and red lights above and below the yellow lights. The green light is illuminated when 50% of the maximal pressure is achieved. As pressure increases or decreases, the yellow lights are illuminated. When

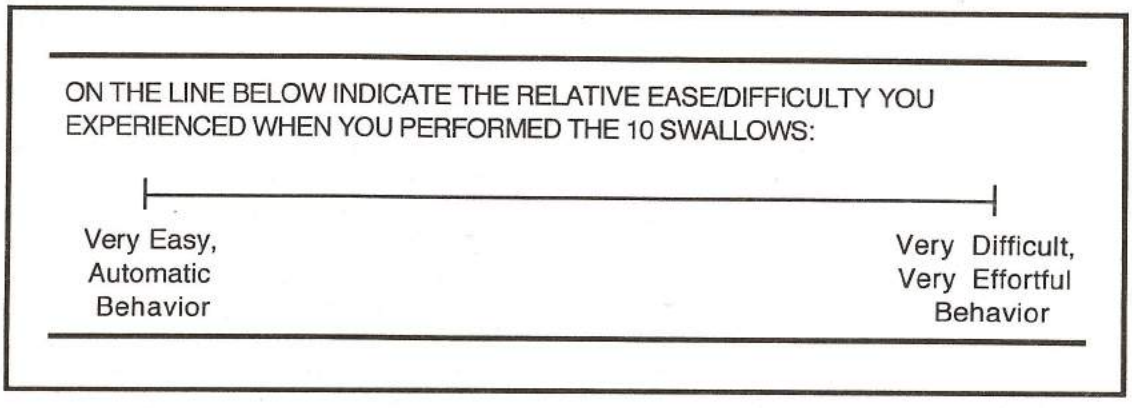


Figure 1. Visual analog scale for self rating of "naturalness" of swallowing.

or decreases, the yellow lights are illuminated. When the pressure increases or decreases substantially, the red lights are illuminated. M was instructed to press against the IOPI bulb until the green light was illuminated and to keep the pressure within the green and yellow light zone for as long as possible. This duration, in seconds, provided a measure of tongue endurance. Mean duration of the four trials was taken as M's measure of tongue endurance for the session.

Speech

Sibilant Distortion

Four reading passages that contained a high proportion of sibilant sounds were used to assess and quantify M's sibilant distortion. These passages were constructed so that the last 200 words of each were balanced for number of sibilants (between 140 and 150) in clusters, singletons, and mono- and multisyllabic words. Each passage had no more than one interdental fricative (/th/ or /th^{v}/). (Interested readers may obtain copies of the passages by contacting the second author.) The four passages were alternated across sessions during the study. The subject was given the following instructions before each administration: "Read the following passage out loud at your usual rate and as clearly as you would normally read it." All the subject's readings were videotaped, using an external Sony ECM 144 lavaliere microphone. From these recordings, M's production of each sibilant was rated as distorted or accurate by the first author and another speech-language pathology graduate student, working independently. Both auditory and visual behaviors were examined to determine presence or absence of sibilant distortion.

Control Variable

Labial Diadochokinetic Rate

Labial diadochokinetic rate was not expected to change as a result of the treatments used in the investigation. However, this measure might be expected to be sensitive to neuromuscular maturation in overall oral-motor function. Measures of labial diadochokinetic rate were obtained to determine if there was evidence that a maturational effect occurred during the course of the study that might account for any changes observed in swallowing and speech behaviors.

Labial diadochokinetic rate was elicited using The Fletcher Time-by Count Test of Diadochokinetic Syllable Rate (Fletcher, 1972). The mean of three trials of labial diadochokinetic rate (in syllables per second), based on 20 repetitions of the syllable "puh" per trial, was used to represent the subject's performance. To elicit these rates, the investigator signaled M to start, counted 20 repetitions, and then signaled M to stop. To measure labial diadochokinetic rate, the audio signal from the videotaped recording of each labial diadochokinetic trial was sent to the input port of an M-Audio Capture and Playback A/D Board (IBM, 1989), installed on a 486 laboratory microcomputer. CSpeech Version 4.0 (Milenkovic & Read, 1992), a waveform analysis software program, was used to measure the duration of the first 20 syllable productions. The sampling rate for digital recording of the audio waveforms was 22 kHz. A digital low pass Butterworth 8 pole filter, with a cut-off frequency of 9 kHz, was used to prevent signal aliasing. To measure duration, the interval between the burst for /p/ in the first and 21st syllables was measured. In 10 instances, where fewer than 21 syllables were produced in a trial, the burst of the 20th, l9th, 18th, or 17th syllable served as the end point. The number of syllables produced between the initial and terminal measurement points was divided by the duration of the interval between these points (measured to the nearest ms), to provide a measure of labial diadochokinetic rate in syllables per second.

Treatments

Phase A (No Treatment)

M's swallowing and speech production were assessed in the first session and her performance on several dependent variables was measured. These dependent variables were also measured during each of the next seven sessions (two sessions on each of three days and one on another day, over the course of two weeks). This gave eight data points for each dependent variable in Phase A.

Phase B (Oral Myofunctional Therapy)

This phase began on the ninth session and consisted of 14 sessions to eliminate M's tongue thrust swallowing pattern and forward tongue rest posture. Treatment included providing M with information about normal swallowing patterns, tongue placement strengthening exercises, and practicing normal swallows. The dependent variables were measured every session during Phase B, providing 14 data points in this phase. Treatment was based on principles outlined by Hanson (1988) with the exception that it was not home-based, due to difficulties related to supervision and control of home practice. However, after the final articulation treatment session in Phase C, the investigator made two home visits, two weeks apart, to observe M's swallowing behaviors.

Garliner's (1981) one and two elastic swallows were used to train proper tongue positioning during swallowing. At M's request, the 5/16 inch orthodontic elastic bands were replaced with thin slices of licorice that approximated the shape and texture of the bands, to eliminate the possibility of swallowing an elastic. A three licorice swallow was attempted but discontinued because the posterior piece consistently slipped to the middle position. Bennett (1985) served as an additional source of procedures to retrain M's tongue posture and

practice exercises was not specified in the treatment sources used. Therefore, the number of repetitions of each exercise in each treatment session was determined arbitrarily by the investigators and subsequently modified, depending on M's performance and response to the procedures. The objectives and exercises (using the corrected swallowing pattern) for each of the 14 oral myofunctional treatment sessions are provided in Appendix A and the swallowing treatment techniques are described in Appendix B.

Phase C (Articulation Treatment)

This phase began on the 23rd session and consisted of four articulation treatment sessions to correct tongue placement for sibilant production. Dependent variables were measured each session, providing four data points in this phase. Correct tongue placements for s /s/, /z/, and /sh/ were taught, using the sweet spot (previously trained in oral myofunctional therapy) as a reference point and mental imagery to reinforce correct tongue position. For the latter, M was instructed to visualize "mentally" where her tongue was contacting her hard palate to gain an internal image of the new placement. Articulation training of sibilants began at the isolated sound level and then moved to increasingly complex utterances along this hierarchy: 1) isolated sounds 2) nonsense syllables with sibilants in initial, medial and final position, 3) words with one, two, three, and four syllables, 4) phrases, 5) sentences, and 6) connected speech. The criterion to move to successive levels in the training hierarchy was production of the target with 90% accuracy, over three blocks of 10 productions. Initially the investigator gave direct feedback to M regarding the accuracy of her target sound production. Later, M was encouraged to self monitor and in later sessions was trained to judge the quality of her own sibilant productions. To accomplish this, a system of self-assessment of sibilant production was used where M and the clinician rated each sound independently and then compared their judgments at regular intervals.

Measurement Reliability

Interjudge reliability of, sibilant distortion was determined by having two trained judges (the first author and another graduate student in speech-language pathology) evaluate M's sibilant productions in each of the 26 video-recorded reading passages. The first author trained the other judge to distinguish distorted (slight or more obvious) from accurate sibilant production, prior to rating M's performance on the reading passages. Following training, each judge independently classified each target sibilant production as distorted or not. A unit-by-unit agreement index was used to estimate interjudge reliability. One target sibilant equaled one unit. First, the number of measured units in agreement (A) was determined. Then the total number of measurements in disagreement (D) was determined. The equation [(A) divided by (A+D)] times 100, gave a unit-by-unit agreement index expressed as a percentage.

Intra-judge reliability of swallowing durations and labial diadochokinetic rate was determined by randomly choosing five sessions for remeasurement of each variable, approximately two months after the original

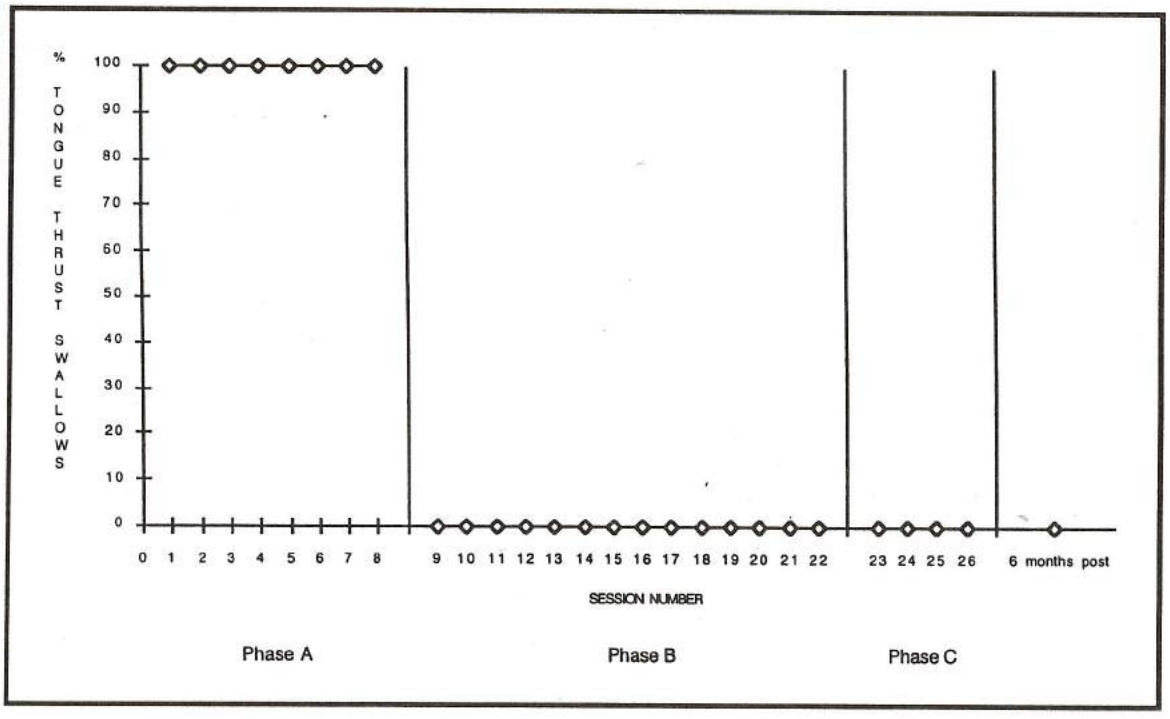


Figure 2. Frequency of tongue thrust swallows.

measurements had been completed. The mean of the differences between the original and second measures of the variables in these five sessions was used to estimate measurement error.

Analysis

Measures of percent tongue thrust swallows, percent sibilant distortion, and labial diadochokinetic rate were plotted for each session in the three phases. A celeration line was plotted for each of these variables in Phases A and B, using the procedure described by Ottenbacher (1986). There was an insufficient number of data points (only four sessions) to plot celeration lines for the variables in Phase C. Visual analysis was used to determine whether these variables changed in level or slope in Phase B or Phase C, compared to Phase A.

M's swallowing durations and ratings of perceived naturalness of normal swallows were plotted and compared for the last 13 sessions in Phase B and all sessions in Phase C, to determine if a slope different from zero was apparent. Tongue strength and endurance measures obtained across the three phases were also plotted and inspected visually to determine if a slope differing from zero was apparent.

The stability of measures of frequency of tongue thrust swallows, duration of swallows, sibilant distortion, and labial diadochokinetic rates was determined in Phase A (baseline) using Tawney and Gast's guideline: "80% to 90% of the data points in a ... phase should fall within a 15% range of the mean level for that phase. If this criterion is met, they contend, most authorities will consider the data stable" (Ottenbacher, 1986, p. 153).

RESULTS

Swallowing Measures

Frequency of Tongue Thrust Swallows

With the initiation of oral myofunctional therapy in Phase B, M readily eliminated her tongue thrust swallowing pattern in the drinking task. As is shown in Figure 2, M demonstrated 100% tongue thrust swallows across the entire baseline phase. After the first oral myofunctional therapy session (Session 9), she had 0% tongue thrust swallows (100% normal swallows). This normal swallowing pattern was maintained for the duration of the study. During Phase C (articulation treatment), when myofunctional therapy was not provided, M continued to use a normal swallowing pattern (Fig. 2).

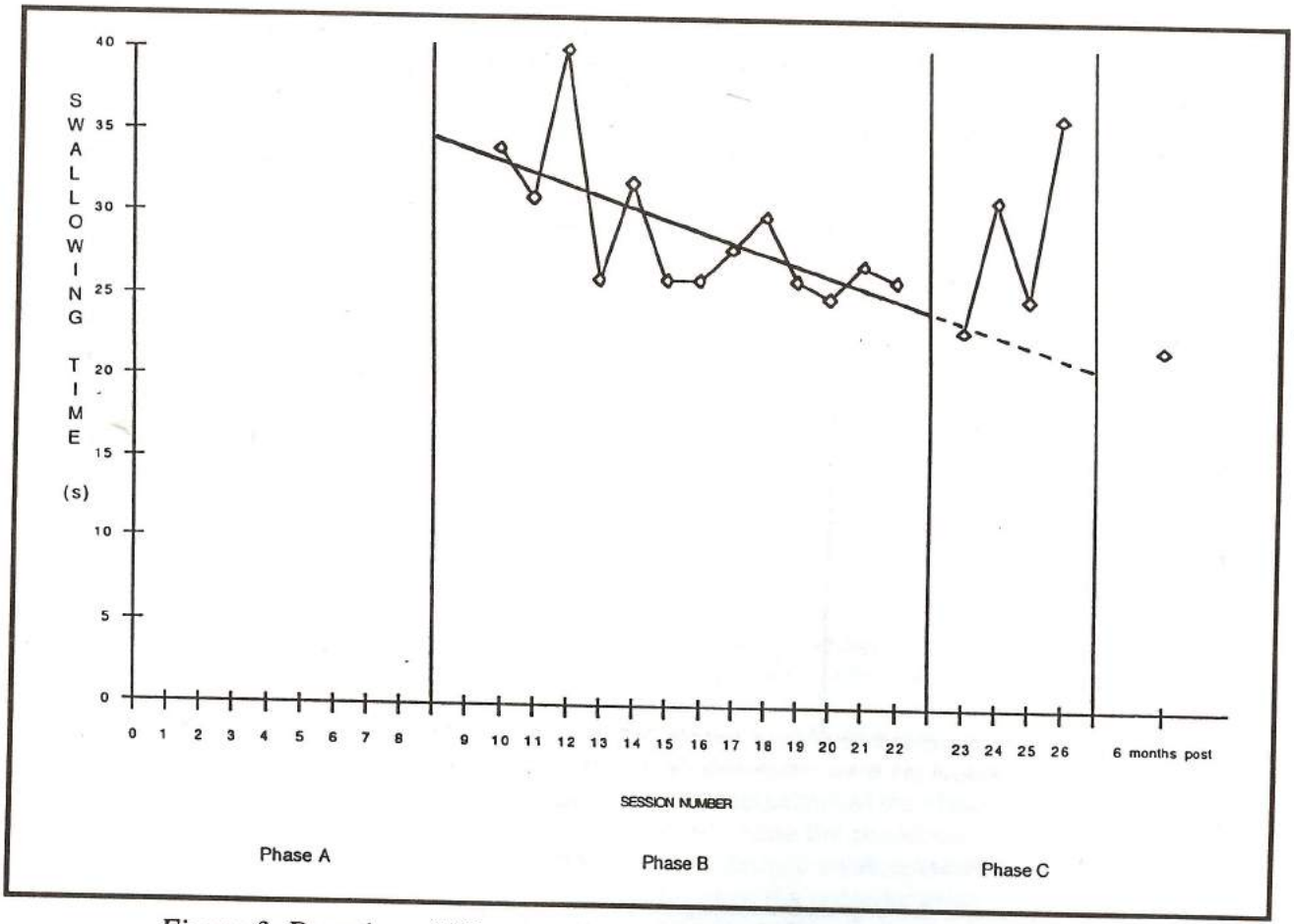


Figure 3. Duration of 10 successive water swallows using the new swallowing pattern. (The dashed line represents an extension of the celeration line plotted in Phase B.)

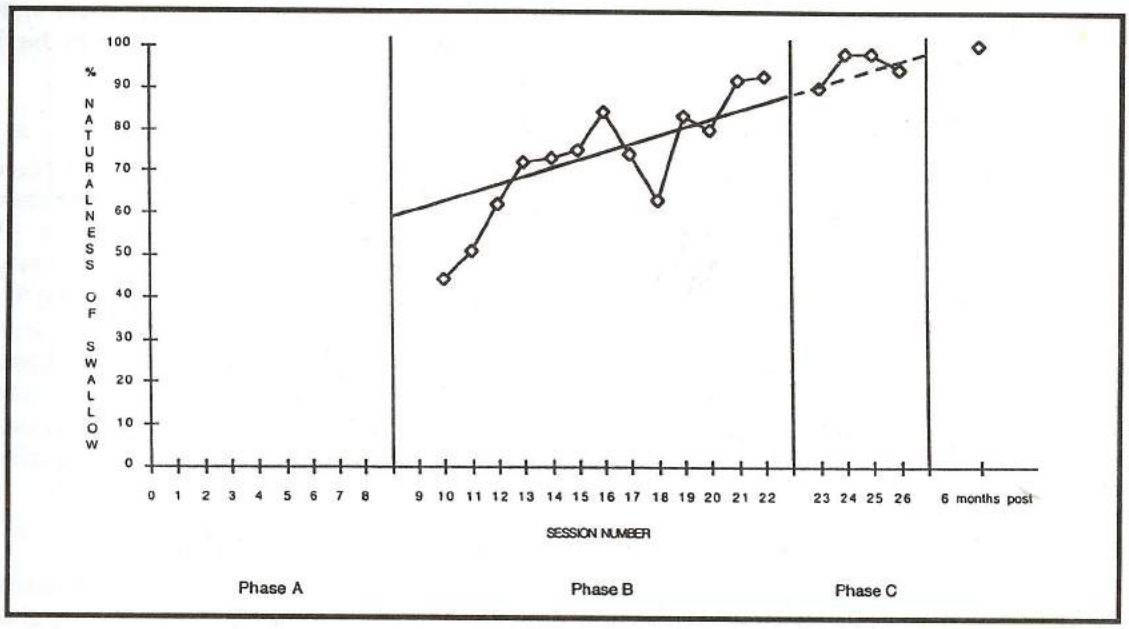


Figure 4. Ratings of relative ease or naturalness of swallows using the new swallowing pattern. (The dashed line represents an extension of the celeration line plotted in Phase B.)

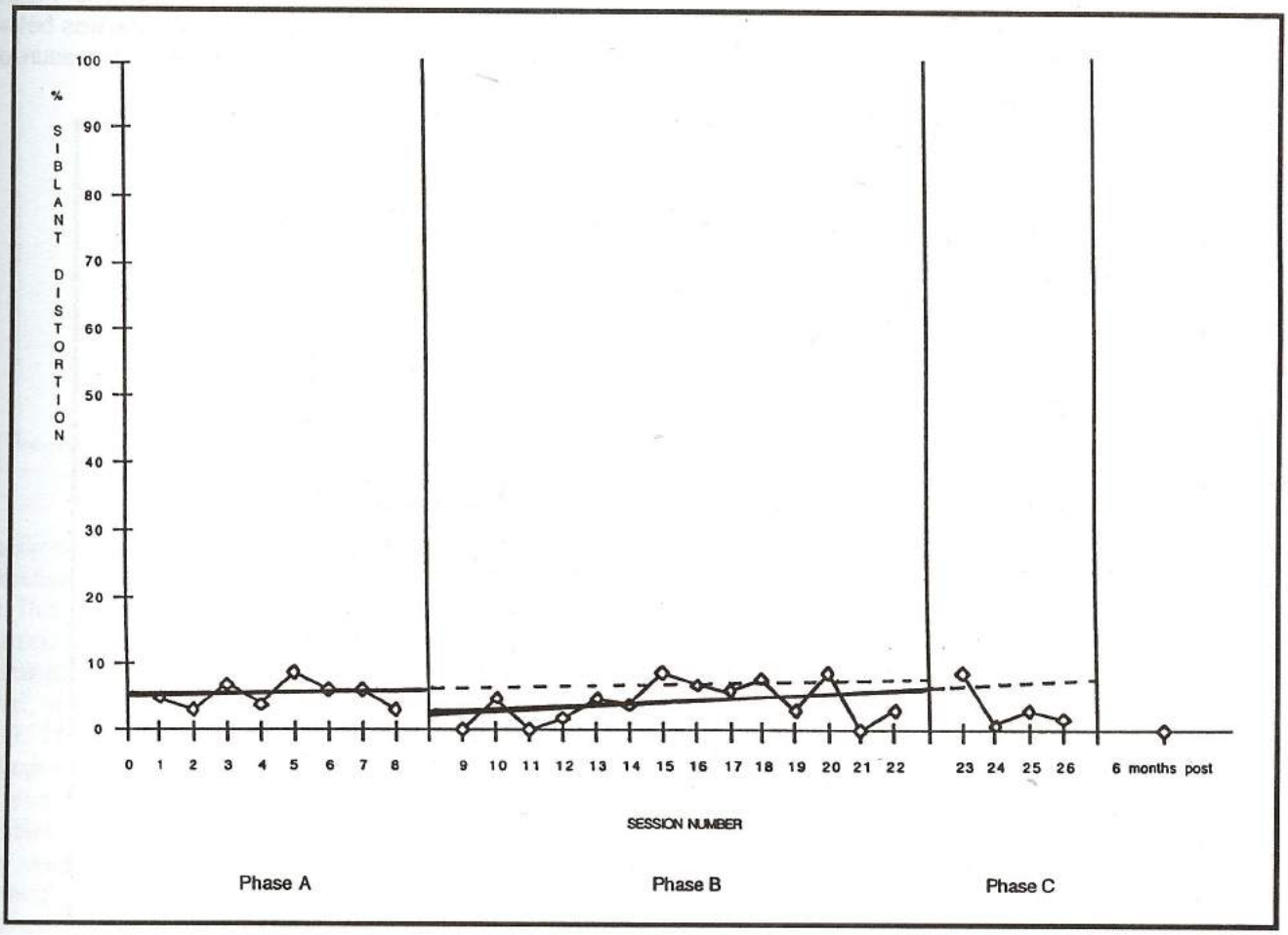


Figure 5. Percentage sibilant distortion. (The dashed lines represent extensions of the celeration line plotted in the previous phase.)

Duration of Swallows

A celeration line (Ottenbacher, 1986) was used to determine the slope of the data points in Phase B. Data points were not available for sections three, six, and nine due to recording equipment malfunction. A decreasing trend in duration of the 10 normal swallows and in the session-to-session variability of these durations was evident (longest = 40 s in Session 11; shortest = 25 s in Session 20), suggesting an increase in M's efficiency of the normal swallow in this phase. The four data points in Phase C exhibit an upward trend, that is, an increase in amount of time taken to perform the 10 swallows (23 s in Session 22 to 36 s in Session 26) and an increase in session-to-session variability compared to Phase B (Fig. 3).

Ease or "Naturalness" of Swallowing Pattern

Figure 4 illustrates M's ratings of naturalness of her new swallowing pattern in Phases B and C. A celeration line determined for the data points plotted in Phase B revealed a trend of increasing ease or naturalness of the 10 swallow task. The extension of this celeration line (shown by the dashed line), compared to the plotted data points, reveals a continuation of this trend in Phase C. In Sessions 24 and 25 (Phase C), M rated her new, normal swallow as 98% natural. This suggests that she had automated her new swallowing pattern by this time in the study.

Sibilant Distortion

M's measured sibilant distortion varied between 1 % and 9% during baseline (Phase A) and between 0 and 9% during oral myofunctional treatment (Phase B). Sibilant distortion measures were not available for Sessions 11 and 21 due to recording equipment malfunction. While the baseline data points met the criterion for stability, inspection of the celeration lines plotted in Phase A and B (see Fig. 5) revealed a slight increasing trend in sibilant distortion. In Phase C, sibilant distortion was 9% in the first session and ranged from 1 % to 3% in the remaining three sessions.

Tongue Strength and Endurance

As is shown in Figures 6 and 7, measures of M's tongue strength and endurance increased across the three phases of the study. In Figure 6, the square symbols represent the expected tongue strength for a female of M's weight (60 kg), based on information provided in the IOPI manual. At the initiation of Phase A, M's mean tongue strength of 34.6 kPa was below expected values for her weight. The second measure of

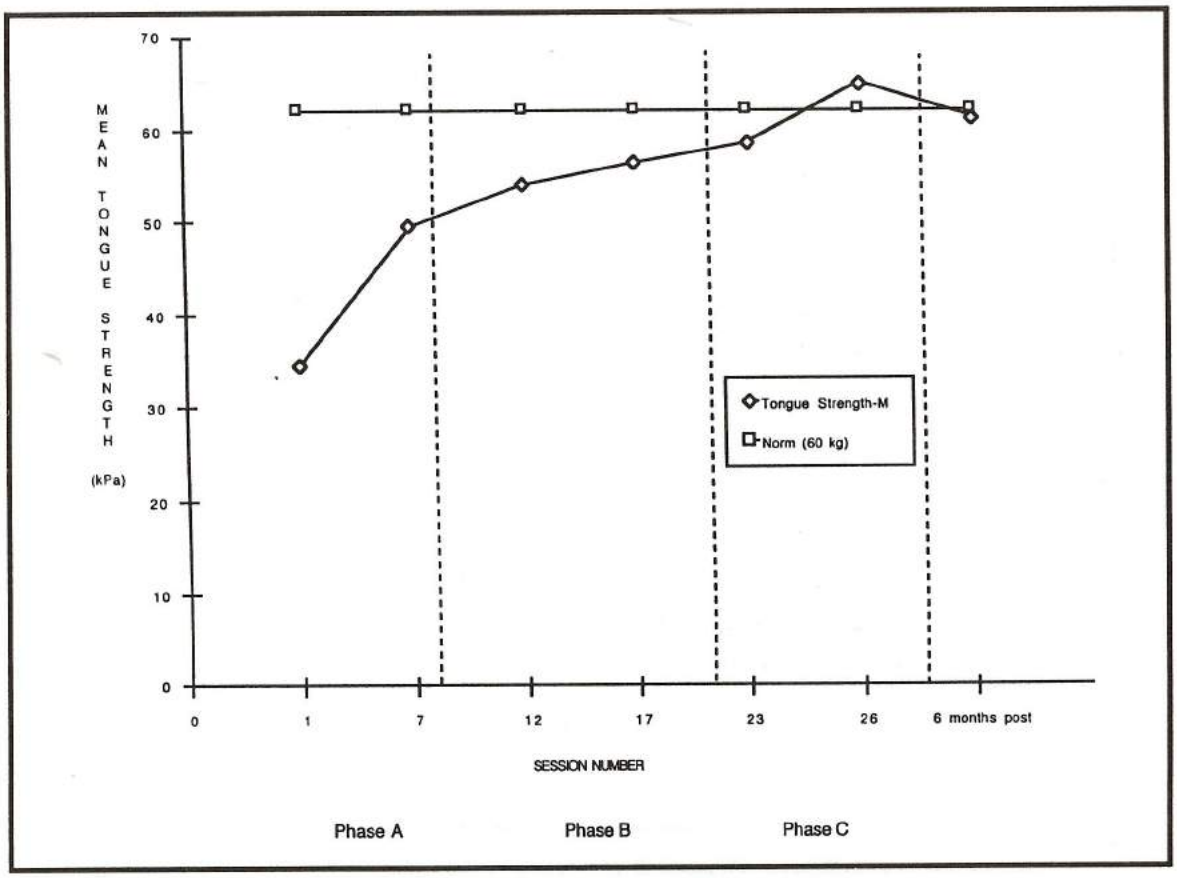


Figure 6. Mean maximal tongue strength measures.

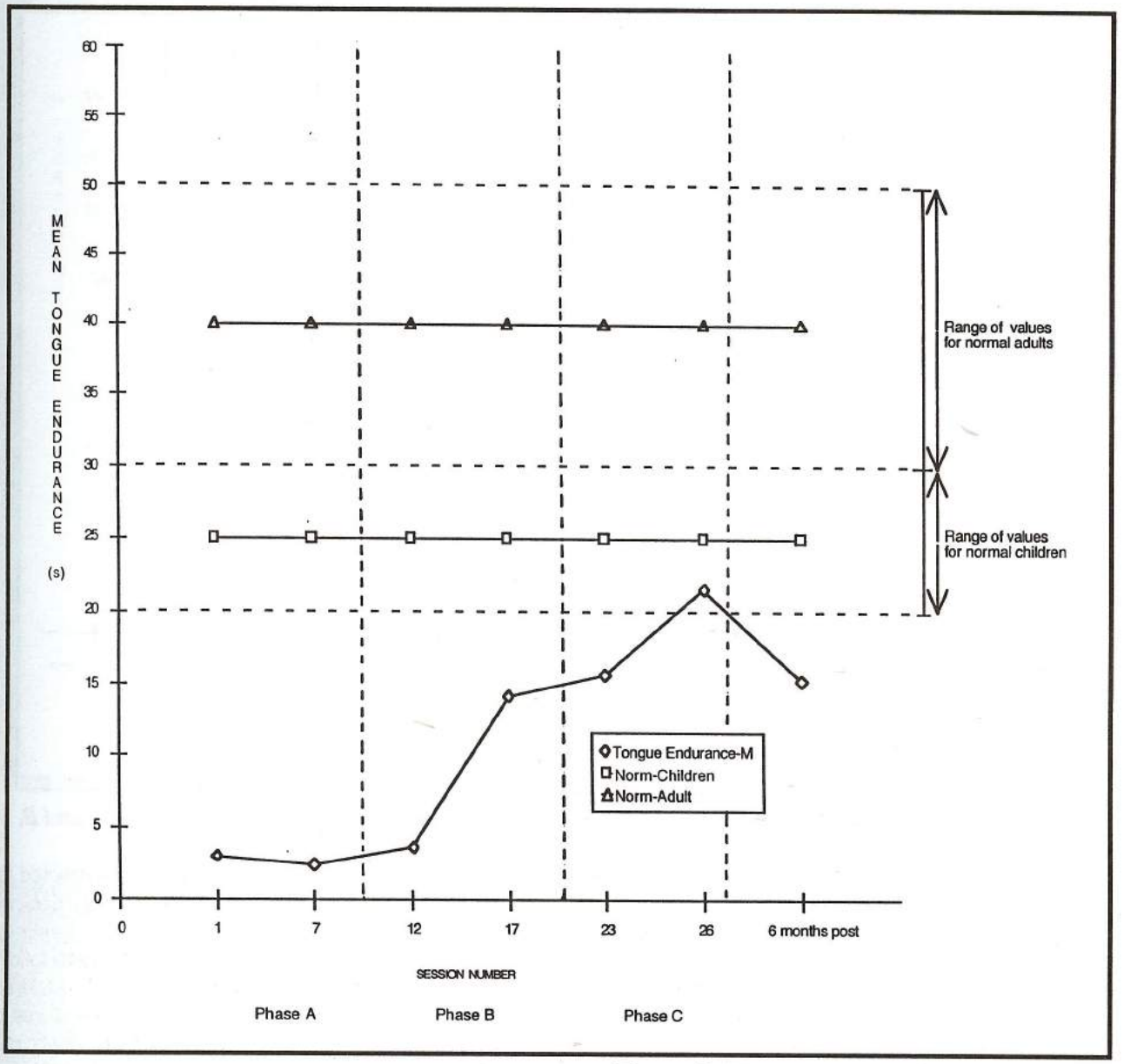


Figure 7. Mean tongue endurance measures.

maximal tongue strength in Phase A was 49.5 kPa, an increase of 15 kPa, but still below expected values for M. This large increase within the baseline phase was surprising, given that no treatment had been administered. This result may reflect increased effort level, or increased familiarity and proficiency with the task. This discrepancy in baseline measures makes interpretation of the increase in measures of tongue strength that was observed in Phases B and C problematic. Of note is that during the final session of the study (Session 26), M obtained a maximal tongue strength of 65 kPa, which was slightly above the normative value for her weight.

Figure 7 reveals that M's tongue endurance increased in Phases B and C to approximate expected values for children (20 - 30 s), but remained below the range of normal for adults (30 - 50 s) at the end of Phase C. Unlike tongue strength, the second tongue endurance measure taken in baseline (2.5 s) was similar to the first (3.1 s), indicating greater stability of M's performance on this latter aspect of tongue function. These results suggest that the exercises performed during oral myofunctional therapy (Phase B) had a positive effect on M's tongue endurance and possibly on her tongue strength.

Labial Diadochokinetic Rate

Mean labial diadochokinetic rates (see Figure 8) remained stable across the three phases as determined by Tawney and Gast's procedure (Ottenbacher, 1986).

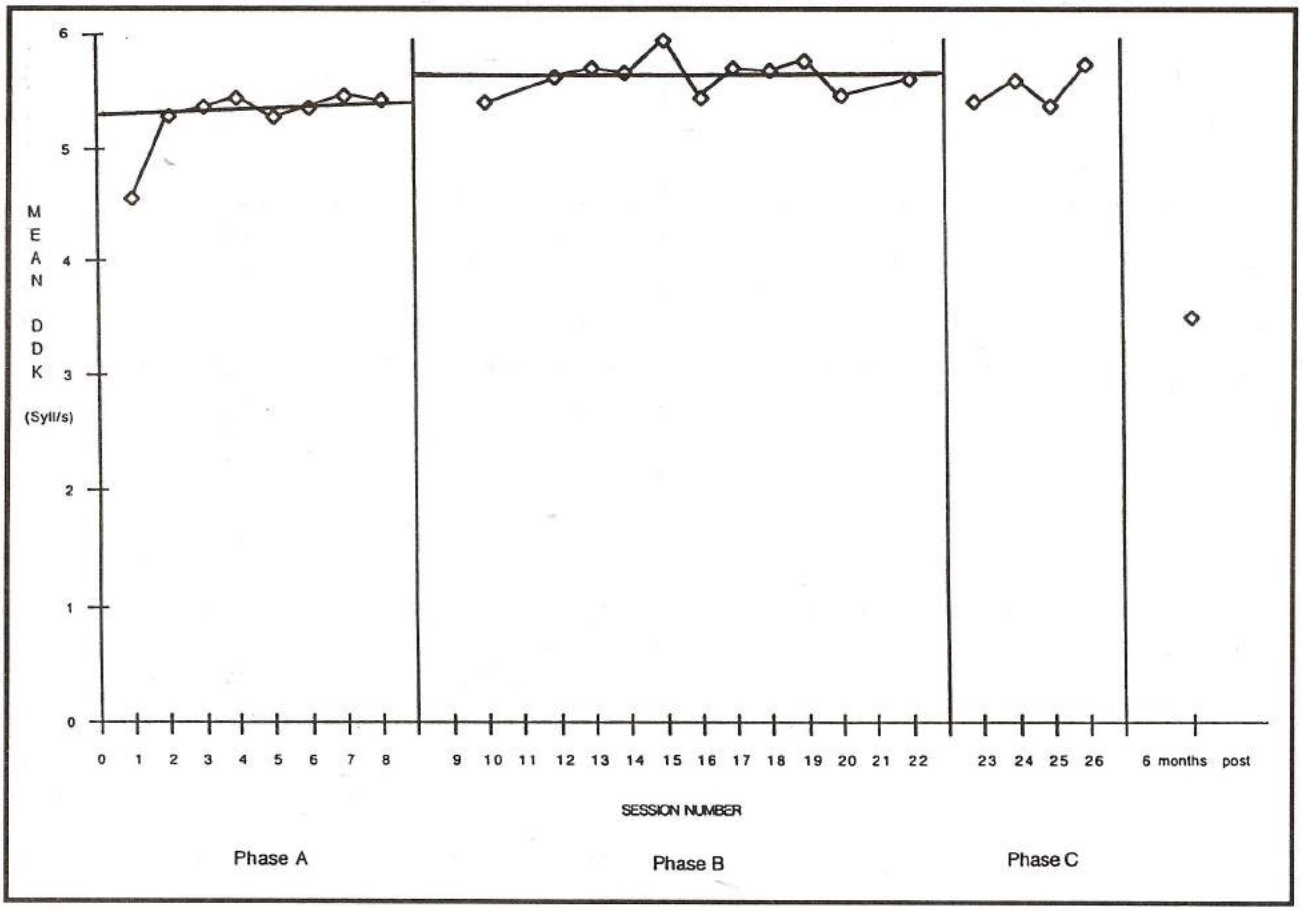


Figure 8. Labial diadochokinetic rate measures with celeration lines shown for Phases A and B.

Data for Sessions 9, 11, and 21 were not available due to recording equipment malfunction. Celeration lines fit to these data In Phases A and B were judged to be similar, with slopes near zero in each phase. Mean diadochokinetic rates were 5.28 syllables/s (Phase A), 5.64 syllables/s (Phase B) and 5.51 syllables/s (Phase C). This suggests that a maturation effect in oral motor neuromuscular behavior did not occur over the course of the study that might account for the changes observed in the treated behaviors.

Follow-Up Evaluations

Home visits were conducted at two and four weeks following completion of Phase C to observe M's swallowing behavior. She used normal swallows while eating dinner and drinking liquids at these visits. A follow-up evaluation was conducted approximately six months after the conclusion of the study to assess M's maintenance of normal swallowing and sibilant production behaviors. Labial diadochokinetic rate and maximal tongue strength and tongue endurance were also measured. M used a normal swallow on all 10 swallowing trials. She performed the 10 swallows in 22 seconds and judged them to be 100% natural. She had 0% sibilant distortion. Her maximal tongue strength (61.25 kPa) was at the normative value expected for her weight. However her tongue endurance had declined from a mean of 21.5 s at the final articulation treatment session in Phase C to 15.25 s at this six month follow-up session. This was below expected values for children, but 12 - 13 s greater than her baseline measures of tongue endurance. M's mean labial diadochokinetic rate was 3.50 syllables/s (standard deviation of .08 syllables/s on 3 trials). This was the lowest of any of these measures obtained during the study. It was hypothesized that fatigue or reduced effort may have accounted for this lower value.

The first author also conducted a short interview with M 18 months following completion of Phase C. M's lips were observed to be together at rest during the interview. When asked about this, she reported that she only keeps her lips parted for breathing when she has significant nasal congestion associated with allergies, and otherwise breathes with her lips together. M also reported that she was very satisfied with her speech and extremely satisfied with her swallowing, which she described as "feeling better" and "requiring less effort" than her old swallowing pattern.

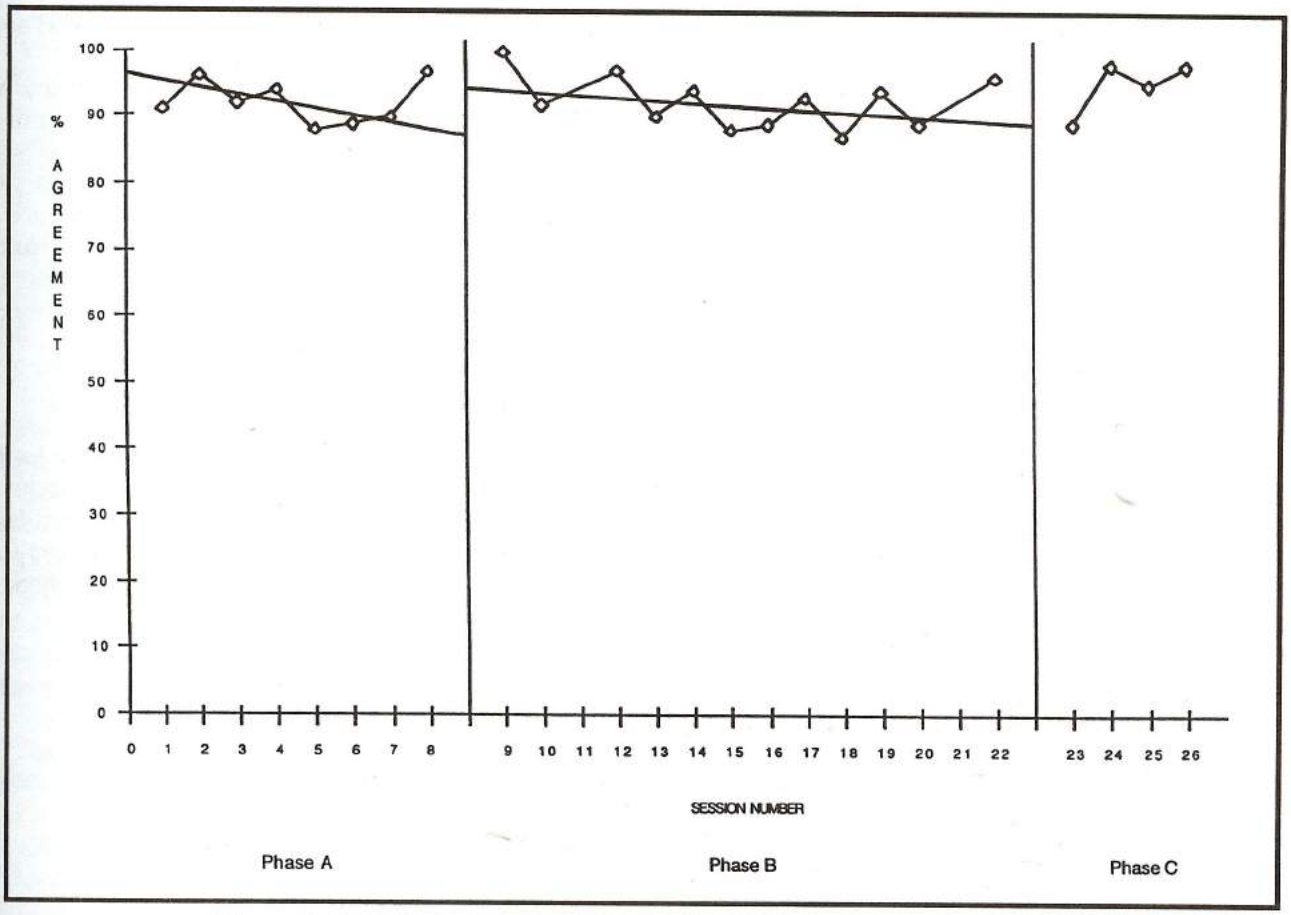


Figure 9. Interjudge agreement of sibilant production classification with celeration lines shown for Phases A and B.

Measurement Reliability

Interjudge agreement for judgments of sibilant distortion is shown in Figure 9. This ranged between 87% and 100%, with a mean of 92.8% across the 26 sessions. This range in interjudge agreement in classifying sibilant production as accurate or distorted is similar to the range of accurate sibilant production measured in the 26 sessions, i.e., 91-100%, or conversely, 0 - 9% sibilant distortion. This finding limits the validity of the results obtained for sibilant production in the study.

The mean difference between the first and second measurements of labial diadochokinetic rate, based on repeated measurement of the trials for 5 sessions, was .045 syllables per second which was deemed to be negligible.

The mean difference between the first and second measurements of swallowing duration, based on remeasurement of the five sessions, was two seconds.

DISCUSSION

Oral myofunctional therapy was shown to be effective in eliminating a tongue thrust swallowing pattern in this 16 year-old subject. The subject used a normal swallow for all 10 trials at the conclusion of the first session of oral myofunctional therapy. This normal swallowing pattern was maintained in the 10 swallowing trials in each session for the duration of the study. Based on observations during two bi-weekly home visits in the first month after the conclusion of Phase C, and an evaluation six months later, the subject had carried over this new pattern to her meals at home and habituated her new swallowing behavior. Inspection of the slope for swallowing duration revealed a decrease during Phase B (oral myofunctional therapy), suggesting that she became more efficient in using her new swallowing pattern in this phase. However, swallow duration increased in Phase C. Swallowing exercises were not performed in the treatment sessions in Phase C so the subject may not have been as "primed" for the 10 swallow task, compared to Phase B where swallowing exercises were performed in the treatment sessions. One potential threat to the validity of this measure to estimate swallowing efficiency is that the subject was not instructed to perform the 10 swallows at as fast a pace as possible. Failure to stipulate this may have increased the variability of her performance. The subject's self-rating of ease or "naturalness" of the new

swallow increased during Phases B and C and was rated as 100% natural in the six month follow-up session. This finding and M's short swallowing duration (22 s) at the six month follow-up session suggest that M had automated a normal swallowing pattern.

Oral myofunctional therapy alone did not eliminate this subject's sibilant distortion. Sibilant distortion showed a slight upward trend during baseline (Phase A) and oral myofunctional therapy (Phase B). With the initiation of Phase C, a decrease in sibilant distortion was evident in the final three sessions. However, interpretation of changes in sibilant production during the study is confounded by the similarity obtained between interjudge agreement scores and sibilant production scores. The relatively mild nature of M's sibilant distortions and the fact that judgments of sibilant production were made from videotape recordings, rather than live, may have decreased the listeners' sibilant classification reliability. Regardless, at the six month follow-up session, M's sibilant distortion was judged by the two listeners to have been eliminated, based on her performance on one of the reading passages. In addition, at 18 months following the study, M stated that she was very satisfied with her speech and perceived that her sibilant production had improved, compared to what it had been prior to treatment. Given that only four articulation treatment sessions had been provided, the oral myofunctional treatment may have facilitated M's skill in combining appropriate lingual articulatory placement with ear training for undistorted sibilant production. This is similar to the findings of Christensen and Hanson (1980) who reported that three of five children who received a period of tongue thrust therapy, prior to articulation therapy, corrected their lisps at the level of conversation following two articulation treatment sessions.

The conclusion that the treatment procedures used were responsible for the changes observed in M's swallowing behavior, as opposed to subject maturation, is supported by the finding that labial diadochokinetic rates remained relatively stable across the study phases. Labial diadochokinetic rate is a measure of oral-motor skill that was not expected to change as a result of the type of treatment provided, but that might be expected to increase with overall maturation in the oral sensorimotor system.

The subject's maximal tongue strength and endurance were below expected normal values at the initiation of the study and increased during the three month period covered by the ABC study design. Her tongue endurance appeared more sensitive to the effects of oral myofunctional training than tongue strength, and, unlike tongue strength, her tongue endurance decreased in the six month period following treatment. This suggests that the subject's use of normal swallowing and speech patterns was not sufficient to maintain the tongue endurance levels that she had attained at the end of Phase C.

In conclusion, oral myofunctional therapy was effective in eliminating the subject's tongue thrust swallowing pattern. Myofunctional therapy alone did not eliminate her sibilant distortion. However, as four articulation treatment sessions were sufficient for the subject to demonstrate satisfactory sibilant production six months following treatment, it is hypothesized that oral myofunctional treatment facilitated her tongue function for accurate sibilant production.

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APPENDIX A: ORAL MYOFUNCTIONAL THERAPY TREATMENT PROCEDURES

Session 1

Objectives: A) The subject learned about tongue thrust. B) The correct placement of the tongue (behind the upper incisors), called the sweet spot, was located. C) The following tongue exercises were completed by the subject. (See Appendix B for a complete description of swallowing treatment techniques used.)

1. 10 Tongue Pushes for 10 seconds each; three seconds rest between repetitions.
2. 10 Tongue Holds for 30 seconds each; 30 seconds rest between repetitions.
3. 10 One Licorice Swallows.

Session 2

Objectives: A) The last session was reviewed, including tongue thrust swallow. B) The subject learned the slurp-swallow. C) The following exercises were completed by the subject.

1. Hold tongue tip on sweet spot for five minutes.
2. 10 Slurp-Swallows.
3. 10 Tongue Pushes for 30 seconds each.
4. 10 Tongue Holds for one minute each with a rest in between of 30 seconds.
5. 10 One Licorice Swallows.
6. 10 Two Licorice Swallows.

Sessions 3 & 4

Objectives: A) The previous session was reviewed, including the slurp-swallow. B) The sip-swallow was learned. C) The following exercises were completed by the subject.

1. Hold tongue tip on sweet spot for 10 minutes.
2. 10 Slurp-Swallows.
3. 10 Sip-Swallows.
4. 20 Open-Closes.
5. 20 Two Licorice Swallows.

Sessions 5 & 6

Objectives: A) The previous session was reviewed. B) Continuous drinking was learned. C) The following exercises were completed by the subject.

1. Hold tongue tip on sweet spot for 15 minutes before session
2. 10 Sip-Swallows.
3. Drink three four-ounce glasses of water using continuous drinking. Drink two more at home.
4. 10 Biting Exercises for 30 seconds each with 30 second intervals in between.

5. 30 Tongue Clicks.
6. 10 Water Trap Swallows.
7. 20 Two Licorice Swallows.

Sessions 7 & 8
Objectives: A) The previous session was reviewed. B) Liquid swallows were practiced. C) Food swallows were initiated. D) The following exercises were completed by the subject.

1. Hold tongue tip on sweet spot for 20 minutes before session.
2. Drink three four-ounce glasses of water using continuous drinking. Drink two more at home.
3. Drink one cup of liquid per day with continuous drinking.
4. 20 Biting Exercises for 30 seconds each with 30 second pause in between.
5. 20 Snack Swallows.
6. Eat one quarter of one meal per day with new swallow.
7. Peanut Butter Licks for three minutes.
8. 30 Two Licorice Swallows.

Sessions 9 - 12
Objectives: A) The previous session was reviewed. B) Liquid swallows were practiced. C) Food swallows were practiced. D) Correct saliva swallows were initiated. E) The following exercises were completed by the subject.

1. Hold tongue tip on sweet spot for 30 minutes at home.
2. Drink three four-ounce glasses of water using continuous drinking.
3. Drink 1.5 cups of liquid per day with continuous drinking.
4. 20 Snack Swallows.
5. Eat one half of one meal per day with new swallow.
6. 20 Water Trap swallows.
7. 30 Two Licorice swallows.

Sessions 13 & 14
Objectives: A) The previous session was reviewed. B) Fast-swallows were practiced. C) The following exercises were completed by the subject.

1. Hold tongue tip on sweet spot for 30 minutes at home.
2. 30 Snack Swallows.
3. Eat two meals per day with new swallow.
4. Drink three four-ounce cups of water with continuous drinking.
5. Drink 2.5 cups of liquid per day with continuous drinking.
6. 30 Two Licorice Swallows.

APPENDLX B: ORAL MYOFUNCTIONAL TREATMENT TECHNIQUES

(Adapted from Bennett, 1985 and Garliner, l981)

One Licorice Swallow: The subject puts a 1/8 inch slice of licorice on the tongue tip and raises her tongue to the alveolar ridge just behind the upper incisors. She clenches her back teeth, opens her lips, and swallows. All swallowing exercises are performed with the lips open to break the reflex action for the tongue to meet the lips.

Two Licorice Swallow: Like the one licorice swallow except the subject holds the licorice pieces on the tip and midpoint of her tongue. She swallows while holding the licorice pieces against her palate.

Three Licorice Swallow: Like the one and two licorice swallow, but the subject holds the licorice pieces on the tip, middle, and back of her tongue. She swallows while holding the licorice against her palate.

The Sweet Spot: Right behind the rugae on the roof of the mouth.

Slurp-Swallows: The subject clenches her back teeth, keeps her tongue on the sweet spot, holds her lips apart in a smile, slurps her tongue up to the roof of her mouth, and swallows.

Sip-Swallow: The subject takes one small drink at a time, swallowing the correct way.

Fast-Swallows: The subject drinks a glass of water without stopping, taking small sips, but drinking fast.

Tongue Push: The subject presses her tongue on the sweet spot for 10 seconds and then relaxes her tongue.

Tongue Hold: The subject holds a licorice piece against her sweet spot for a specified amount of time.

Biting Exercise: The subject places her fingers on each side of her jaw, puts her tongue on the roof of her mouth and bites her back teeth together, feeling her masseter muscles flex.

Open-Close: The subject sucks her tongue up to the roof of her mouth and keeps it there while opening and closing her mouth, for a specified number of times.

Tongue Clicks: The subject holds her tongue tip on her sweet spot, sucks the sides of her tongue up to click, but doesn't touch her teeth with her tongue.

Water Trap: The subject takes a small sip of water and sucks it to the roof of her mouth. She bites her back teeth together, spreads her lips and swallows, trying to keep the water from spilling out.

Peanut Butter Licks: The subject pushes her tongue up against the roof of her mouth and pulls it back, as if she were licking peanut butter of the roof of her mouth.