A Study to Examine the Effectiveness of the Electropalatograph in Elicitation and the Remediation of a Lateral Lisp in an Adult Client

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A STUDY TO EXAMINE THE EFFECTIVENESS OF THE ELECTROPALATOGRAPH IN ELICITATION AND THE REMEDIATION OF A LATERAL LISP IN AN ADULT CLIENT

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HONORS THESIS

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Statement of the Problem

The electropalatograph is an exciting new instrument that is still being researched for clinical use in the remediation of various types of articulation disorders. The electropalatograph gives both client and clinician visual feedback of the client's articulatory productions. Specifically, it allows a client and a clinician to view on a screen exactly where the tongue is placed in relation to the hard and soft palate (McWilliams, 1990).

Technically, the term palatography refers to any effort designed to measure linguopalatal contact without the use of electricity. The term electropalatography refers to any effort designed to measure linguopalatal contact with the help of electricity (Fletcher, 1992). Sometimes the term "palatometer" is used to refer to the electropalatograph.

Modern electropalatography has only been in existence for a short time. It has been about sixty years since Schilling first used electricity to show where the tongue contacts with other articulators in the mouth. Previous to this time, palatography had been limited to coating the hard and soft palate with different substances, phonating a sound, and then viewing what parts of the palate had been touched (Fletcher, 1992).

At the present time, the use of modern electropalatography is limited to only three countries. These countries are Great Britain, Japan, and the United States (McWilliams, 1990).

Most of the electropalatographs that are in use in the United States are being used primarily for research.
Consequently, most of them are found only in university and other research settings. At the present time, there are only a few palatometers in the United States that are being used in a clinical setting (S. Fletcher, personal communication, October 15, 1992).

One of the palatometers that is being used clinically is located at Oakwood Elementary School in Preston, Idaho. Paula Matthews, the speech-language pathologist at the school, is currently using the palatometer to elicit correct tongue placement in some of her clients with articulation disorders. Paula Matthews has used the palatometer primarily for eliciting correct production of the phonemes /r/ and /s/ (P. Matthews, personal communication, summer, 1992).

The electropalatograph could be beneficial to a current student at Utah State University. This student was referred to the USU Speech-Language-Hearing Center at the beginning of fall quarter, 1992 for treatment of a right unilateral lisp. Previous to this referral, she had received treatment in grade school and had experienced some success in elicitation of a correct /s/, but had little success in remediation of the lisp, especially long-term remediation, or generalization. Given the success that Paula Matthews has had with the palatometer in treating some of her clients with lateral /s/ production, it is reasonable to assume that this client may have similar success.

With the development of the palatometer, it would appear that elicitation of a correct /s/ by the clinician and
remediation of a lateral lisp would be easier. Before the invention of the palatometer, a clinician had to depend on auditory and tactile feedback to diagnose lateral lisps and to monitor progress during treatment. This paper will examine the effectiveness of the palatometer in the remediation of lateral lisps. This will be accomplished by comparing treatment involving traditional articulation methods to treatment involving the use of the palatometer.

**Review of Related Literature**

Samuel Fletcher, in his recently released book, "Articulation: A Physiological Approach," presents evidence that speech occurs when the articulators of the speaker (e.g., the tongue, palate, teeth, etc.) are placed in specific, measurable locations in relation to each other. The purpose of the palatometer is to provide visual feedback to a speech-language pathologist as to the specific location of a client's tongue in relation to his/her palate. The palatometer portrays a diagram of the client's palate on a computer screen. Different areas of the diagram light up on the screen when the client makes contact with his/her palate via his/her tongue (Fletcher, 1992).

Normal /s/ production involves several different processes. First of all, the blade of the tongue must be raised up to almost, but not quite, touch the alveolar ridge. The alveolar ridge is a hard, bony protrusion of the hard palate located just behind the upper front teeth. At the same time, the sides of the tongue must also be raised to contact the upper molars. When the
tongue is placed correctly, a small groove at the midline of the tongue is created. Finally, a breath stream that originates in the lungs is guided up through this groove and forced out through the small opening between the alveolar ridge and the blade of the tongue (Secord, 1981).

An articulatory disorder may occur when any of these tongue placements are not made correctly. Specifically, a lateral /s/ sound occurs when air escapes over the sides of the tongue instead of being forced out centrally through the groove at the midline of the tongue. This may occur because the opening between the sides of the tongue and the molars is not completely sealed off.

Specific feedback such as that described above is very important in determining how the articulatory disorder is occurring. It is very difficult for a speech-language pathologist to see where a client's tongue is during the production of a phoneme because the client's articulators are not visible during the production of that sound. The palatometer makes it possible to visualize, as well as hear, how the client is producing a particular sound.

In the palatometric system, a client is custom-fitted with his/her own acrylic plate, or "pseudoplate." The pseudoplate must contain electrodes at any point where the tongue is able to make contact with another articulator. Thus, there are 96 electrodes on the alveolar ridge, hard and soft palate, teeth, gingivae, etc.
During the actual data collection, a surface electrode is placed on the client's wrist and an unharful body charge is introduced. Whenever tongue contact is made with the electrodes, the current from the client's wrist flows to the electrodes and is relayed out through small, fine wires exiting at the corners of the client's mouth. The tongue contacts can be viewed as they are happening or stored and analyzed later. Acoustic output is also stored via a small microphone located about 6 inches from the client's lips.

Graphs of selected moments in time of the client's speech can be analyzed later by noting where the client's tongue contacts were as compared to "critical contact electrode, noncritical contact electrode, and critical noncontact electrode patterns" (Fletcher, 1991, p. 931). A critical contact electrode pattern is an area where tongue contact is necessary for the phoneme in question to be made. A noncritical electrode pattern is an area where tongue contact may be made, but is not necessary to produce the phoneme in question. A critical noncontact electrode pattern is an area where it is necessary for no tongue contact to be made in order that the phoneme in question be made appropriately (Fletcher, 1991).

Many speech-language pathologists must rely on auditory feedback to determine whether a phoneme is distorted. Since people's perceptions are different, what one person would call distorted may not seem distorted to another person. Determining independently whether or not a sound is being produced correctly
will yield different interpretations.

Through the use of spectrography, a clinician can be more objective in determining the presence or absence of an articulatory disorder. A spectrogram permits a clinician to view the changes in frequency, phase, and amplitude of speech over time. Since all the sounds of a language have differing frequencies, their visual representations will also look different when displayed.

These visual representations may be displayed in either the time or frequency domain. In the time domain, the graph plots the change in amplitude over time (Decker, 1990).

In the frequency domain, changes in frequency are the focus of the plot. Amplitude spectra and phase spectra are the two types of spectra that can be viewed in the frequency domain. Of these two, the amplitude spectrum is probably the most common. An amplitude spectrum in the frequency domain shows all the frequencies, along with their respective amplitudes, of any given signal (Decker, 1990).

As mentioned, specific sounds in the English language are formed by different bands of frequencies. The location of these bands of frequencies is unique to each sound. Since the client in question has a lateral lisp, it would be helpful to objectively measure which bands of frequencies make up the /s/ distortion that this client produces. To do this, it is necessary to examine how a properly produced /s/ sound looks on a spectrogram.
The /s/ phoneme is set apart from other consonant sounds in three main ways: 1) place of articulation; 2) manner of articulation; and 3) voicing. Place of articulation refers to the area in the vocal tract where air from the lungs is obstructed in some way. "Manner of articulation refers to the degree of constriction of the vocal tract in the production of a consonant sound" (Secord, 1981, p. 7). Sometimes the air is completely obstructed. Sometimes the air is forced through a small opening, as is the case with the /s/ sound. Sometimes a combination of these two occurs. Voicing refers to whether or not the vocal folds are vibrating in the production of a certain sound. If the vocal folds are vibrating in the production of a certain sound, then that sound is termed a "voiced sound." If the vocal folds do not vibrate, then it is termed a "voiceless sound" (Secord, 1981).

The /s/ sound is a voiceless, alveolar fricative. This means, first of all, that the vocal folds are not utilized. A fricative is a sound in which "the articulators approximate to form a narrow channel in the mouth through which the breath passes. The result is a noisier sound that gives the listener an auditory impression of friction" (Secord, 1981, p. 7). "Alveolar fricative" means that the narrow channel described above is formed by the tongue approximating close to the alveolar ridge.

Voiceless alveolar fricatives have specific bands of frequencies that make up the sound, just as all individual sounds do. Some of the frequencies that make up the /s/ phoneme are
more intense than others. Specifically, the major concentration of sound energy for the /s/ phoneme is located above 4000 Hz. Additionally, since the vocal folds are not used in the production of /s/, the spectrogram does not look pulsed. In other words, there are no breaks in the spectrogram. The "continuous noise energy" is evident on a printout of the spectrogram (Kent & Read, 1992).

Edwards locates the major band of sound energy for an /s/ phoneme between 3500 and 7000 Hz. Because the /s/ phoneme has a "mid-to-high energy concentration," it is perceived as a "hissing" sound (Edwards, 1992). In summary, the descriptions of Edwards and Kent make it clear that a correctly produced /s/ sound will have sound energy of highest intensity in the mid-to-high frequency range, i.e., no lower than 3500 Hz.

**Purposes and Objectives**

**Purpose**

The purpose of this project is to examine the clinical value of the palatometer in the remediation of lateralized /s/ production. This will be accomplished by using the palatometer with an adult client with a lateral lisp. The project is experimental in nature, because of the fact that the palatometer is a relatively new instrument. It is a project-oriented study rather than a research-oriented study. There is very little literature on the clinical value of the palatometer at this point in time. As Dr. Fletcher (1992) states, "one of the great lessons of modern science is that 'common sense,' 'everyday
experience,' and 'pure reason' may open the door to possibilities, but those possibilities are not trustworthy until they are proven" (Fletcher, 1992, preface). A review of the literature indicates that a project that examines the effectiveness of the palatometer in adult clients with a lateral lisp has not yet been undertaken. A project such as this one would add to the literature and help to prove the effectiveness and practicality of the palatometer.

**Objectives**

The four objectives of this project are:

1. To help test the effectiveness of the palatometer in remediating lateral /s/ production by comparing it to traditional approaches to articulation therapy.
2. To provide the student clinician hands-on experience with the Kay Elemetrics DP Sonograph.
3. To provide the student clinician hands-on experience with traditional approaches to assessment and remediation of articulation disorders, specifically lateralized /s/ production.
4. To help the client involved to remediate a life-long lateral lisp.

**Procedures/Methods**

**Subject**

**STATEMENT OF PROBLEM:** The client was referred to the USU clinic by the faculty because of a right unilateral lisp.

**REFERRAL SOURCE:** Communicative Disorders department at Utah State University.
HISTORY: The client reported that her mother had a normal pregnancy and good health throughout the prenatal period. The client is the third of six pregnancies and was carried full term. The client reported that she had good health as a baby. She reported that all developmental milestones, with the exception of the unilateral lisp, were reached at the appropriate age. Toilet training began at age 2 to 2 1/2 and was completed at age 3. The client's mother reported that she babbled at six months, spoke her first word at nine months, and put words together at the age of 2. The client had a mild case of the chicken pox at age 6. She also pulled some ligaments while jumping on a trampoline, but she reported no lasting ill effects from this accident. The client reported that no operations, physical handicaps, or childhood problems have occurred in her life.

The client has four sisters, ages 23, 18, 16, and 13. She also has one brother who is 24 years old. The oldest two siblings are married. The client characterized her home as happy and secure. She indicated that her social interests are attending movies and going to the mall.

The client's family has a history of some health problems. Her father suffers from anemia and hay fever. Her mother and maternal grandfather both have high blood pressure. Her maternal grandfather also has suffered from heart disease in the past. The client has a cousin with diabetes. Finally, she indicated deafness as a problem for one of her sisters, although she did not indicate how severe this problem is or which sister has the
problem.

The client now attends Utah State University and is a senior in the Communicative Disorders program. She did not repeat or skip any grades in school. She is and has always been a very good student. She graduated in the top 10% of her class in San Antonio, Texas. The client indicated that in grade school she was teased a little because of the unilateral lisp. However, she felt that being in college has eased much of the pressure and has helped her.

The speech disorder in question has been in place ever since the client can remember. She reported that the orthodontist and the speech-language pathologist that saw her both thought that her mouth was too small to accommodate her tongue. She received both hearing and speech screenings in grade school. She passed the hearing screenings. She has had no psychological testing done. Her speech-language pathologist in grade school was Mary Jones at Wincrest Elementary School. The client had speech therapy from 1976 to 1983. She reported that Ms. Jones was successful in eliciting a proper /s/ sound, but that remediation was unsuccessful. Generalization of a proper /s/ sound was not a priority during these years. Some days the client was successful during therapy time, but she never generalized. She remembered that most of the therapy that took place focused on imitative tasks. She was also involved in a lot of group therapy.

Project Design

The project will be divided into two major components. The
first component will involve providing the client with speech therapy at the USU Speech-Language-Hearing Center. This speech therapy will incorporate traditional approaches to articulation therapy. The basic design of therapy will involve assessment of the current articulatory problem and then articulation therapy, based on the results of this assessment. Assessment measures will include the collection of the following: 1) a complete case history of the client; 2) an oral peripheral examination to determine the adequacy of existing structures for speech; 3) a hearing screening to determine the adequacy of the client's hearing; 4) an immittance test battery to determine how well the client's middle ear is functioning; 5) results from two articulation tests, the Fisher Logemann Test of Articulation and the Clinical Probes of Articulation Competency; and 6) a conversational articulation sample.

Specifically, the case history will focus on any previous treatment that the client may have received previous to this time. Specific types of methods that were used to elicit a proper /s/ and to generalize the correct production of /s/ to all speaking situations will be probed.

The Fisher Logemann Test of Articulation will be used to screen for the specific sounds that the client has trouble with. Only the sentence subtest will be used for this screening. Once specific sounds that seem to be distorted have been found, only these specific sounds will be probed for the degree of distortion using the Clinical Probes of Articulation Competency.
The Clinical Probes of Articulation Competency (CPAC Probes) are specific articulation tests that probe for correct usage of all the sounds in the English language in different contexts. For example, the CPAC Probes test for correct usage of a sound in isolation, in words, and also in sentences. These differing contexts are increasingly complex. For the purposes of this study, the /s/ sound will be probed only in sentences.

The conversational articulation sample will be a tape recorded sample of how the client's "problem phonemes" sound in a conversational context. The client will be asked to tell about the most exciting day in her life and to tell about her favorite movie of all time.

The second component of the project will involve treatment with the palatometer in Preston, Idaho, under the direction of Paula Matthews. Treatment with the palatometer will begin winter quarter, 1993. Pre- and post-therapy printouts from the palatometer will be provided.

The DSP Sonograph, located in the voice lab of the USU Speech-Language-Hearing Center will be used to objectively measure the frequency ranges containing the most sound energy in the client's production of /s/. These measures will be obtained before therapy at the USU clinic begins. The measures obtained on the Sonograph will be repeated again after treatment at USU ends. The spectrographic measures will also be repeated after treatment with the palatometer has been completed.

In all three instances, the spectrograms will be examined,
in order to determine whether the major regions of sound energy are in the mid-to-high frequency range. Spectrograms of correctly produced /s/ phonemes will also be provided for comparison. In this way, it may be determined objectively whether or not remediation was more effective when the palatometer was included in the treatment program.

Results

The spectrographic representation of the client's production of an /s/ sound before implementing traditional speech therapy approaches is shown in Figure 1 of Appendix A. For contrast, the spectrograms of correctly produced /s/ phonemes are shown in Figures 2 and 3.

As can be seen, the major concentration of noise energy extends down far below the 4000 Hz region (to at least 2000 Hz in most places). This is in opposition to a correctly produced /s/ sound, which has little energy found below 3500 to 4000 Hz. This production is more typical of the /l/ phoneme.

Progress that was attained using traditional approaches to elicitation of a correct /s/ and remediation of the lateral lisp is described below:

At the beginning of fall quarter 1992, the client could produce the /s/ phoneme in initial position of spontaneous words with 17% accuracy. After thirteen therapy sessions using traditional drill and practice articulation approaches, she was able to produce the /s/ phoneme with a central emission of air in initial position of spontaneous two-syllable words with 95%
accuracy. Despite the centralized air stream, the client's production of /s/ still sounded distorted.

At the beginning of fall quarter 1992, the client could produce the /s/ phoneme in medial position of spontaneous words with 0% accuracy. After thirteen therapy sessions using traditional drill and practice articulation approaches, she was able to produce the /s/ phoneme with a central emission of air in medial position of spontaneous two-syllable words with 98% accuracy. Again, her /s/ production still sounded distorted.

At the beginning of fall quarter 1992, the client could produce the /s/ phoneme in final position of spontaneous words with 0% accuracy. After thirteen therapy sessions using traditional drill and practice articulation approaches, she was able to produce the /s/ phoneme with a central emission of air in final position of two-syllable spontaneous words with recurring /s/ with 95% accuracy. Again, despite the centralized stream of air, her production of /s/ still sounded distorted.

The client's progress was then measured objectively, using the DSP Sonograph. This spectrographic representation is shown in Figure 4 of Appendix B. Spectrographic representations of correct /s/ production are provided for comparison in Figures 5 and 6.

After one quarter of speech therapy at the USU Speech-Language-Hearing Center, spectrographic displays of the client's production of /s/ revealed some progress. Most of the sound energy was concentrated around the region of 5500 Hz. However,
there was still a significant amount of energy located at about the 3000 Hz region.

Based upon spectrographic and auditory feedback, it was obvious that the /s/ production that was measured on the sonograph at the end of the quarter was not a correct /s/ production. Nevertheless, the clinician had subjectively presumed the /s/ production to be correct. The clinician had been able to remediate the lateral lisp only to the degree that correct /s/ production had been taught at the beginning of the quarter.

After completion of speech therapy at USU during fall quarter, 1992, the client began seeing Paula Matthew, the speech-language pathologist at Oakwood Elementary in Preston, Idaho. Printouts from the palatometer shown in Figures 7, 8, 9, and 10 in Appendix C represent the progress that the client made during fall quarter, 1992. Figure 7 shows what tongue placement should look like for correct /s/ production. Through observation of Figure 7, it is apparent that for correct production to occur, the groove created by the tongue must be very narrow.

Figure 8 represents the lateralized /s/ that the client traditionally produces. This tongue placement is typical of the client's production of /s/ in conversational speech. It also represents the type of /s/ production that was present before therapy using traditional articulation methods was used.

Figure 9 represents the progress made during fall quarter, 1992, and also shows what tongue placement was like at the
beginning of treatment involving the palatometer. The /s/
production is no longer lateralized, but is obviously too wide of
a groove for proper /s/ production. Central air flow is obvious,
and this type of production sounds correct, as evidenced by the
subjective interpretation made by the clinician at the end of
fall quarter, 1992. Nevertheless, the client's tongue placement
does not yield correct /s/ production, as evidenced by the
objective spectrographic measure shown in Figure 4 of Appendix B.

Figure 10 represents the tongue placement that the client
achieved after only a few therapy sessions using elicitation
procedures with the palatometer. The small groove at midline is
essential for correct /s/ production, and this has been achieved
by the client in this particular production. This /s/ production
has been consistently produced by the client in structured
reading tasks. This production of /s/ has not yet generalized to
unstructured conversational speech (P. Matthews, personal
communication, April 12, 1993).

The spectrogram shown in Figure 11 of Appendix D represents
the client's production of /s/ after twelve therapy sessions
involving the palatometer. Very little sound energy can be found
below the region of 4000 Hz. In fact, sound energy is scarce up
to the region of 5000 Hz. The client's major concentration of
sound energy is in the mid-to-high frequency range, which is
essential for perception of "hissing" quality of a correctly
produced /s/ phoneme (Edwards, 1992). Spectrograms of correct
/s/ production are provided for comparison in Figures 12 and 13
Discussion of Findings

There are three important findings that this research project helped to establish. First, it was found that both traditional methods to articulation therapy as well as therapy with the palatometer are useful in the remediation of lateral lisps in adult clients. Using only traditional methods to articulation therapy was more time consuming. Additionally, traditional methods did not completely meet the desired outcome. Nevertheless, both methods, used separately, did help the client to make progress.

Secondly, it was determined that the role of the palatometer in the remediation of a lateral lisp in this adult client was to elicit a correct pattern of /s/ production. As can be seen from the results, this client did make some progress during speech therapy using traditional articulation approaches. The printouts from the palatometer show marked improvement. Before therapy began, /s/ production was marked by air escaping out laterally. After therapy using traditional approaches, the client was able to produce an /s/ with central air flow, but this central groove was too wide. Thus, the problem with using only traditional methods may have been that the client had not been taught correct tongue placement by the clinician at the beginning of therapy.

Finally, it was found that articulation therapy that includes traditional approaches as well as the palatometer is the most effective type of therapy. After work with the palatometer
began, it became obvious that simply sending the client to Preston to elicit a correct /s/ on the palatometer would not be enough. The palatometer was very useful in eliciting the correct /s/ pattern. The client was able to visualize on a computer screen her incorrect patterns and could see exactly what she needed to do in order to correct her production of /s/. However, during the time between therapy sessions held in Preston, the client had difficulty maintaining the correct pattern of /s/ production and would slip back into old habits. Consequently, it became necessary to continue to work with the client daily, using traditional drill and practice articulation methods, in order for her to retain the correct pattern of /s/ production that was learned on the palatometer. Thus, the role of the palatometer became very specific. It was used to correctly elicit an /s/ and then to continue to monitor the client's production of /s/ throughout the quarter.

Both the palatometer and the use of traditional articulation therapy were necessary for correct /s/ production to continue. No one method replaced the other. Therapy became most effective when the palatometer was paired with continued practice using traditional approaches to articulation therapy.

Three of the four objectives listed in the section marked "Purposes and Objectives" were accomplished in this project. The effectiveness of the palatometer and its role as an effective partner to traditional articulation methods has already been described above. The student clinician learned how to obtain a
spectrogram from a client and how to make a printout of this spectrogram. The student clinician was also introduced to his clinical practicum experience at USU by using traditional articulation procedures to assess and treat lateralized /s/ production. The fourth objective, the remediation of the lateral lisp, was not completely accomplished. The client can now produce a correct, centralized /s/ in structured reading tasks, but has not yet generalized this correct production to all speaking situations at an unstructured conversational level.

Conclusions

The palatometer can be very useful to a speech therapist in helping to remediate a lateral lisp in an adult client. One of the most important procedures of speech therapy is to teach correct production of the phoneme in question from the beginning of therapy. If the client is not taught correct production from the beginning, he/she will practice the phoneme incorrectly during the treatment period. This potentially wastes time and money for the client.

The palatometer can play a major role in teaching correct placement of the tongue during /s/ production. The palatometer can continue to be useful throughout treatment by monitoring the client's tongue placement during treatment sessions. By pairing the advantages of the palatometer with proven traditional articulation procedures, a clinician can be more effective than ever before in the treatment of lateral lisps in adult client.
REFERENCES


Appendix A
Pre-Traditional Therapy Measures

Figure 1
Client's /s/ production

Figure 2
Correct /s/ production
Clinician's production

Figure 3
Correct /s/ production
Edwards, 1992, p. 136
Appendix B
Post-Traditional Therapy Measures

Figure 4
Client's /s/ production in words

Figure 5
Correct /s/ production
Clinician's production

Figure 6
Correct /s/ production
Edwards, 1992, p. 136
Appendix C
Pre- and Post-Therapy Palatometric Printouts

Figure 7
Correct tongue placement

Figure 8
Client's tongue placement
Pre-traditional

Figure 9
Client's tongue placement
Post-traditional treatment
Pre-treatment with palatometer

Figure 10
Client's tongue placement
Post-treatment with palatometer
Appendix D
Post-Treatment Measures With The Palatometer

![Client's /s/ production](image1)

![Correct /s/ production](image2)

![Clinician's production](image3)

Figure 11
Client's /s/ production

Figure 12
Correct /s/ production
Clinician's production

Figure 13
Correct /s/ production

Edwards, 1992, p. 136