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An Electromyographic Study of the Behavior of the Masseter and Temporal Muscles Before, During, and After Orthodontic Treatment: Part Iii. One Week After the Placement of Archwires

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AN ELECTROMYOGRAPHIC STUDY OF THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES BEFORE, DURING, AND AFTER ORTHODONTIC TREATMENT

PART III: One Week After the Placement of Archwires.

by

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LIFE

Richard John Shanahan was born in Waterbury, Connecticut, December 30, 1932. He was graduated from Sacred Heart High School, Waterbury, Connecticut, June 1950. He began his studies at Georgetown University in September of 1950 and received the degree of Doctor of Dental Surgery in June of 1956.

He served with the United States Air Force from July 1956 to July 1958. He began his graduate studies at Loyola University in June, 1958.

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The findings are composed of the photographs of the subject's malocclusion, charts evaluating the muscle behavior, and graphs of duration.

CHAPTER I

INTRODUCTION

A. Introductory remarks and statement of the problem.

The objectives of orthodontic therapy is to improve masticatory function. To do this the teeth must be placed in a position that will be in harmony with the muscular behavior of those muscles which move the mandible. A better understanding of the behavior of these muscles can be gained through electromyographic research.

Electromyographic studies done in the past have shown that changes do occur in muscular behavior in response to orthodontic treatment; Moyers (1949), Jarabak (1954) and (1956), and Zwemer (1955). This research is a part of a longitudinal study designed to show what changes take place in muscular behavior of the temporal and masseter muscles during and after orthodontic treatment. This Experiment, part III of this study, is designed to determine the effect that placing an orthodontic appliance, the second phase of orthodontic therapy, has on the behavior of these muscles. It deals with their muscular behavior one week after the insertion of the first orthodontic appliance.

B. Review of Literature

The validity of longitudinal studies have been reported by Moyers (1949), Geltzer (1955) and Greenfield and Wyke (1956). Moyers stated that "It is

possible to compare parts or heads of the same subject if the readings are taken in a similar and simultaneous manner." Geltzer reported that one could reproduce data on a day to day basis. Greenfield and Wyke stressed the importance of maintaining good head position when undertaking a longitudional electromyographic study.

In order to understand the foundation on which this electromyographic study is based, one must be familiar with myograms recorded from normal individuals.

Moyers (1950) described the function of the muscles of mastication and pointed out the fact that a single muscle does not act alone, but in harmonious cooperation with others. He reported that the temporal muscle exhibited an even state to "tonus" in all parts at physiologic rest, and that during elevation and depression of the mandible there was uniformity of spike potential with regard to size, character and frequency. He also noted that the function of the temporal muscles does not change appreciably with age. Adolescents, however, may present temporary alterations in electromyographic patterns during the period of change from the deciduous to permanent dentition.

Latif (1957) did not find equal "tonus" over all division of the temporal muscles at physiologic rest as Moyers had reported. He found that the anterior fibers of the temporal muscle were less active than the other divisions.

Prusansky (1952) found that the temporal and masseter muscle of the ipsilateral side behaved synchronously when chewing in the buccal segments. He also reported that changes in the occlusions of teeth could change the electromyographic pattern presented by the muscles of mastication.

Mac Dougall and Andrews (1952) observed more or less equal activity over the masseter muscles were most active during protraction and the posterior fibers of the temporal muscle were most active during retraction of the mandible.

Jarabak (1954) studying normal occlusion of the teeth noted that during chewing myograms from the temporal muscles were characterized by rapid onset, early peak amplitude, and rapid decay. These muscles began to contract about the same time, and ceased to contract about the same time. The myograms from the temporal muscles. Here the motor activity showed a gradual increase of amplitude with peak amplitude occuring after that of the temporal muscles.

Perry and Harris (1954) showed that in subjects with normal occlusion the masseter and temporal muscles on both sides reached maximal activity synchronously, and the temporal muscle always displayed electrical activity before the masseter.

Perry (1955) showed that in normal occlusions there exists a great deal of synergy of peak amplitudes in the masseter and temporal muscle on the working side.

Since this study deals solely with patients under active orthodontic treatment, we must refer to the works of those who have shown how occlusion can influence the neuro muscular pattern of activity.

Moyers (1949) noted in subjects with Class II (Angle) malocclusions that the uniformity of spike potential as regard to size, character and frequency was lost. Many of them displayed greater contractions from the posterior fibers of the temporal muscle than from the anterior fibers. He further subdivided these

patients into four groups on the basis of their electromyographic patterns. These subjects were then treated with a bite plate to relocate the mandible in a forward position and thus reduce the Class II molar relation. Myograms taken after treatment showed that in some of the subjects, normal muscle function was established, some showed no great change, while others showed that orthodontic therapy had caused a muscular imbalance, with the posterior fibers of the temporal muscles showing a constant state of contraction.

Greenfield and Wyke (1956) could not isolate normal and malocclusion groups by means of electromyograms.

Jarabak (1954) used an orthodontic splint to show the range of adaptability of the temporal and masseter muscles to altered interocclusal clearance. A subject with excessive interocclusal space (17 m.m.) presented myograms from the temporal muscle on the chewing side that resembled that of a person with normal occlusion. The masseter muscles, however, showed practically electromyographic silence.

After placement of an orthodontic splint to reduce the excessive interocclusal space to 3 m.m., it appeared that the temporal muscles were less active, but the masseter muscles, silent before orthodontic rehabilitation, showed distinct activity.

Perry and Harris (1954) reported that in Class II Division I (Angle) malocclusions the temporal and masseter muscles reached maximal activity asynchronously and that the masseter muscles frequently were first to manifest electrical activity.

Perry (1955) found that malocclusions presented no single motor unit initiating the chewing cycle, and little synergy of contracting units.

Zwemer (1955) reported that the masseter muscles showed the greatest activity in mandibular closure to occlusal contact when a large interocclusal clearance existed. When a normal occlusal space was restored, however, the masseter and temporal muscles were more nearly equal to each other.

Jarabak (1956) studied a Class II (Angle) orthodontic patient who wore intermaxillary elastics to reduce the malocclusion. He noted that there were spontaneous hyperactivity in the posterior fibers of the temporal muscles which continued long after biting and speaking exercises were completed.

He also studied an adult with gross occlusal disharmonies. This patient exhibited spontaneous hyperactivity during rest after biting and speaking. After eliminating the occlusal interferences the characterisitics of hyperactivity disappeared.

It should be recognized that the orthodontic movement of teeth does not directly effect the muscles studied, but that the functional behavior of the muscles can be reflexly altered through effecting periodontal sense receptors.

These receptors have been histologically described by numerous investigators.

Dependorf (1913) found networks of neurofibirls in the periodontal membrane. These fibers ended in fine pointed processes in the cementoblastic region.

Lewinsky and Stewart (1938) observed neurofibrils in the periodontal mem-

brane separating into fine aborizations. Many of these ended in small rounded bodies.

Bernick (1957) described the neurofibrils of the periodontal membrane as terminating in fine aborizations of neural filaments.

Rapp (1958) found large neural trunks located centrally in the apical one third of the periodontal membrane; fine neurofibrils entering from the alveolar bone proper, and scattered throughout the periodontal membrane; organized encapsulated neural terminations scattered throughout the membrane; and neural coils seen along the surface of the cementum.

The neuromuscular mechanism governing jaw movements has been studied by many workers.

Sherrington (1917) found that stimulation of the teeth and gingiva of a decebrate cat caused inhibition of the closing muscles of the jaw and a reflex opening of the mandible. Immediately following the removal of the stimulus there was a rapid closing of the jaw. He attributed this reflex closing to central rebound. Thus, he found that a series of stimulations of the teeth could produce movements quite similar to chewing.

Pfaffman (1936) found that action potentials could be recorded from the maxillary nerve of the cat when one tapped the upper teeth.

Corbin and Harrison (1941) placed electrodes into the mesencephalic root of the trigeminal nerve and recorded action potentials on stimulation of the teeth and gingiva. They believed that these impulses traversing these nerve fibers were probably chiefly inhibitory, preventing damage to the structures

concerned in biting, thereby coordinating and controlling chewing movements.

Szenthagothai (1948) destroyed the mesencephalic root of the trigeminal nerve and found bouton degeneration in the area of the motor nucleus of the trigeminal nerve. He concluded that there must be a monosynaptic reflex arc between the receptors, which have their cell bodies in the mesencephalic root, and the motor nucleus of the trigeminal.

Sicher (1953) states:

> The movements of the lower jaw are automatic movements which occur under considerable force and under some contract of the two rows of teeth. Like other automatic movements, they are characterized by some variability from individual to individual and by great stability in each individual which, however, does not preclude a considerable adaptability.
>
> ....loss of teeth or changes in their position are followed by a rather rapid adaptation of the movements in order to achieve maximum effect with minimum effort.

CHAPTER II

METHODS AND MATERIALS

A. Selection of Subjects

Sixteen patients between 10 and 14 years of age were selected for this study from the Orthodontic Clinic of the Loyola University School of Dentistry. These patients presented with Class I and Class II (Angle) malocclusions which were to be treated with light, resilient wires and light elastic forces.

B. Muscles Studied

The muscles selected for study were the posterior and middle fibers of the right and left temporal muscles and the right and left masseter muscles. These muscles were chosen because of their importance in masticatory function and accessability for the placement of surface electrodes. The middle temporal fibers act as elevators of the mandible. The posterior temporal fibers are concerned with lateral and posterior movements of the mandible. The masseter muscles provide power in elevating the mandible. The muscles of the right side were recorded and studied separately from the muscles of the left side.

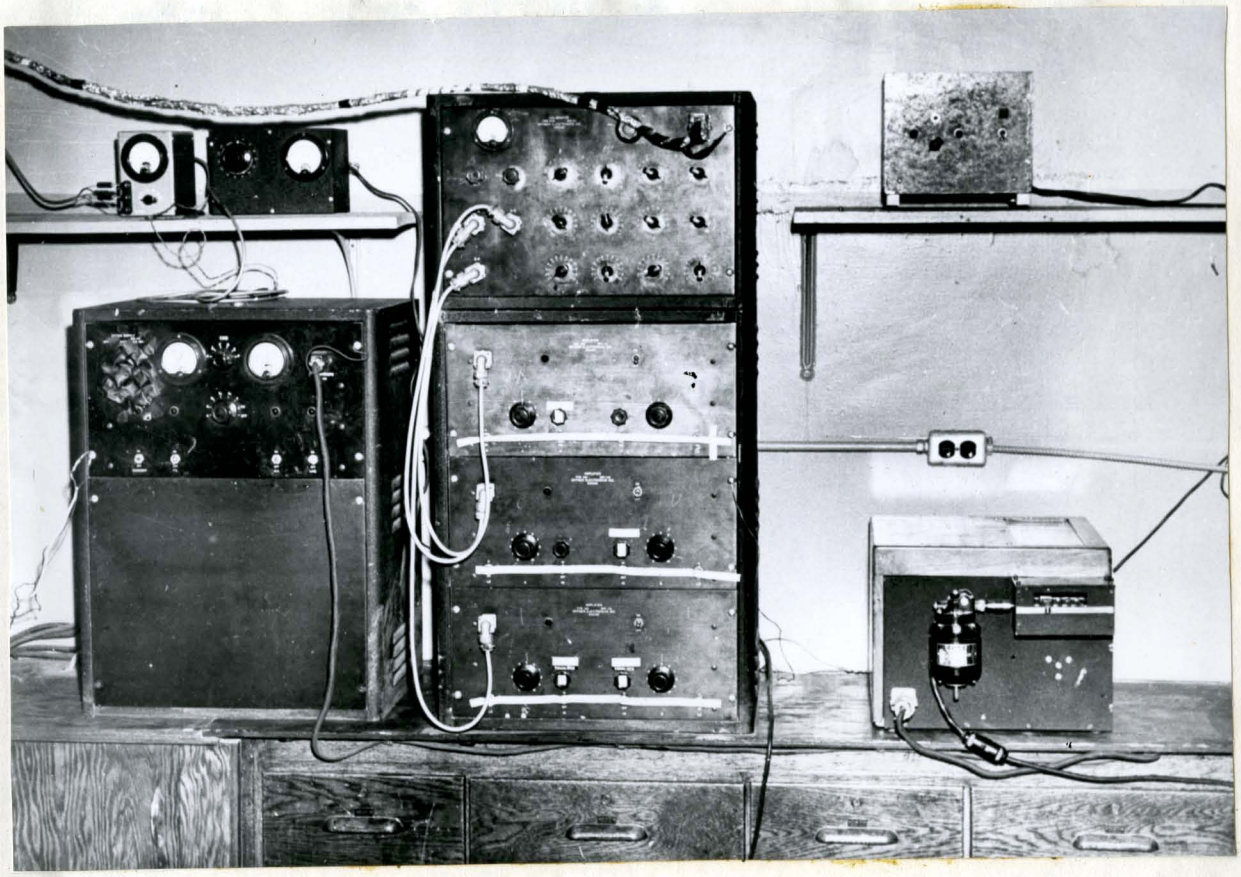


FIGURE 1

ELECTROMYOGRAPHIC EQUIPMENT

C. Electromyographic Equipment

The electromyographic equipment consisted of a six channel Offner Encephalograph Type A modified for electromyography, a crystograph with six pen writers, a time base marker with a separate pen attached to the crystograph, a signal generator and microvolt calibrator, and a Faraday cage with an electrode terminal board mounted therein. The amplifiers were set at a gain of 5; the "Hi" and "Lo" condenser switches were set at "In" and ".05" respectively to surpress the low frequency of the Encephalograph, and bring out the high frequency of the Encephalograph. The paper speed was set at 10 cm. per second and the time base marker indicated intervals of 1/10 of a second. The electromyograph was calibrated from 10 to 250 microvolts before and after each experiment.

D. Sound Equipment

The components of the sound system were a bone conduction microphone (Zenith Hi-Lo, Regent Type), a matching transformer (Shure Model A 86 A), a preamplifier (Heathkit WA-P2), a tape recorder (Wollensak Stereo Model T-1515), an auxiliary amplifier system (two 12 watt amplifiers), and one channel of the electromyograph and the crystograph. (Figure 1). The bone conduction microphone was placed on the subject's forehead and held in position by a spring-type headband. The microphone was connected in series with the matching transformer and the preamplifier.

FIGURE 2

SOUND EQUIPMENT

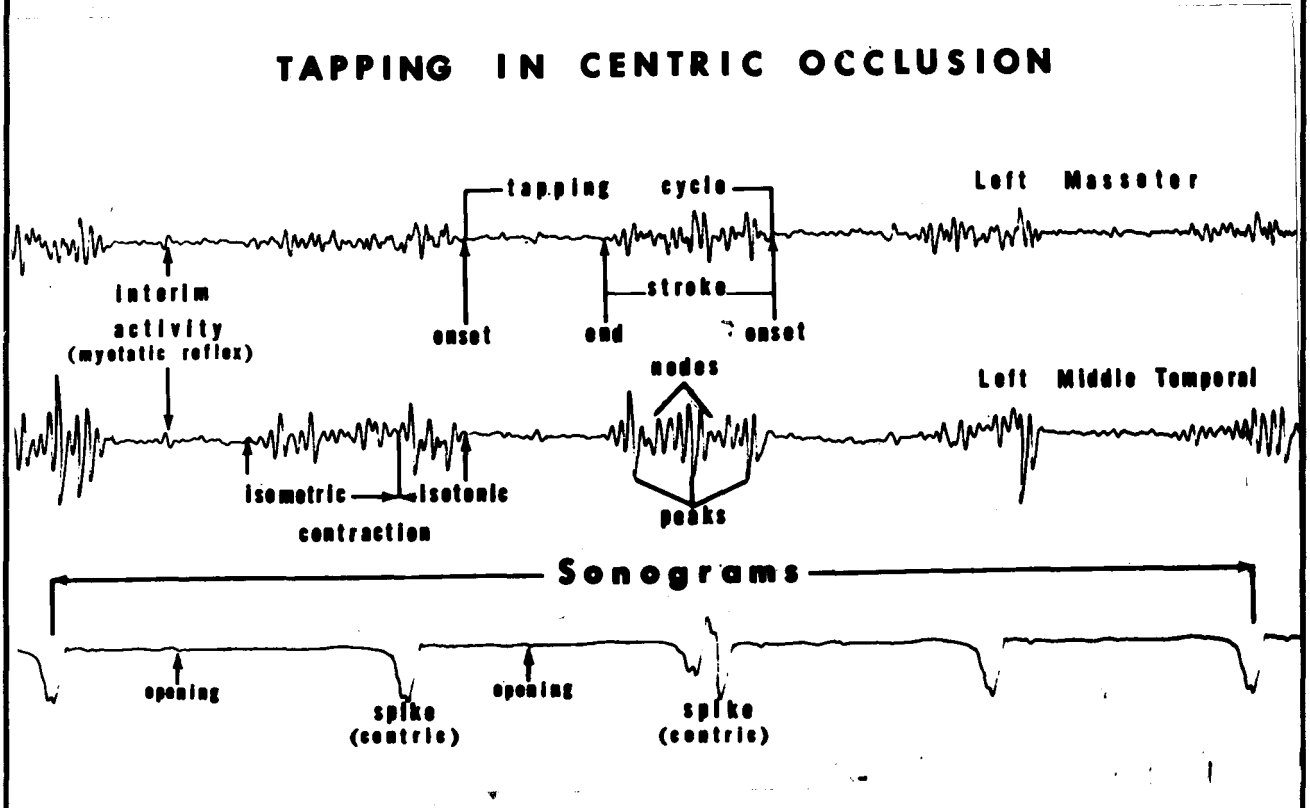

TAPPING IN CENTRIC OCCLUSION
tapping
cycle
Left Masseter
stroke
interim
activity
(myotatic reflex)
onset
end
onset
nodes
Left Middle Temporal
isometric
contraction
isotonic
peaks
Sonograms
opening
spike
(centric)
opening
spike
(centric)

FIGURE 3

The output from the preamplifier was sent into the tape recorder and auxiliary amplifiers. Tape recordings were made at 7 and $\frac{1}{2}$ feet per second with a volume level of 5, tone control at "treble" and the monitor switch at "on" position. The preceedings were monitored through the tape recorder as they were recorded to insure proper performance of the exercises. The output from the auxiliary amplifiers entered a channel of the electromyograph set at a gain of 9 and was converted into sound tracings by the crystograph. These sound tracings called "sonograms", were simultaneoulsy recorded with the myograms. The degree of synchrony between the sonograms and the myograms was studied and found to be within 1/1000 of a second. This slight difference in synchrony between the two types of recordings was due to the time necessary for the chewing and tapping sounds to travel from the area of the teeth to the forehead, where the microphone was located. The sonograms consisted of a base line and deflections from the base line (spikes) of varying amplitudes, frequencies and durations, which corresponded with the tapping and chewing sounds emitted during the test exercises. The sonograms of tapping were simple, consisting of single spikes, while those of chewing were more complex. (Figure 3 and 4).

E. Chewing Medium

The chewing medium used was Vicks cough drops. Vicks drops were selected because of their uniform size and hardness. Chewing this material yielded sounds easily detected by a bone conduction microphone placed on the forehead.

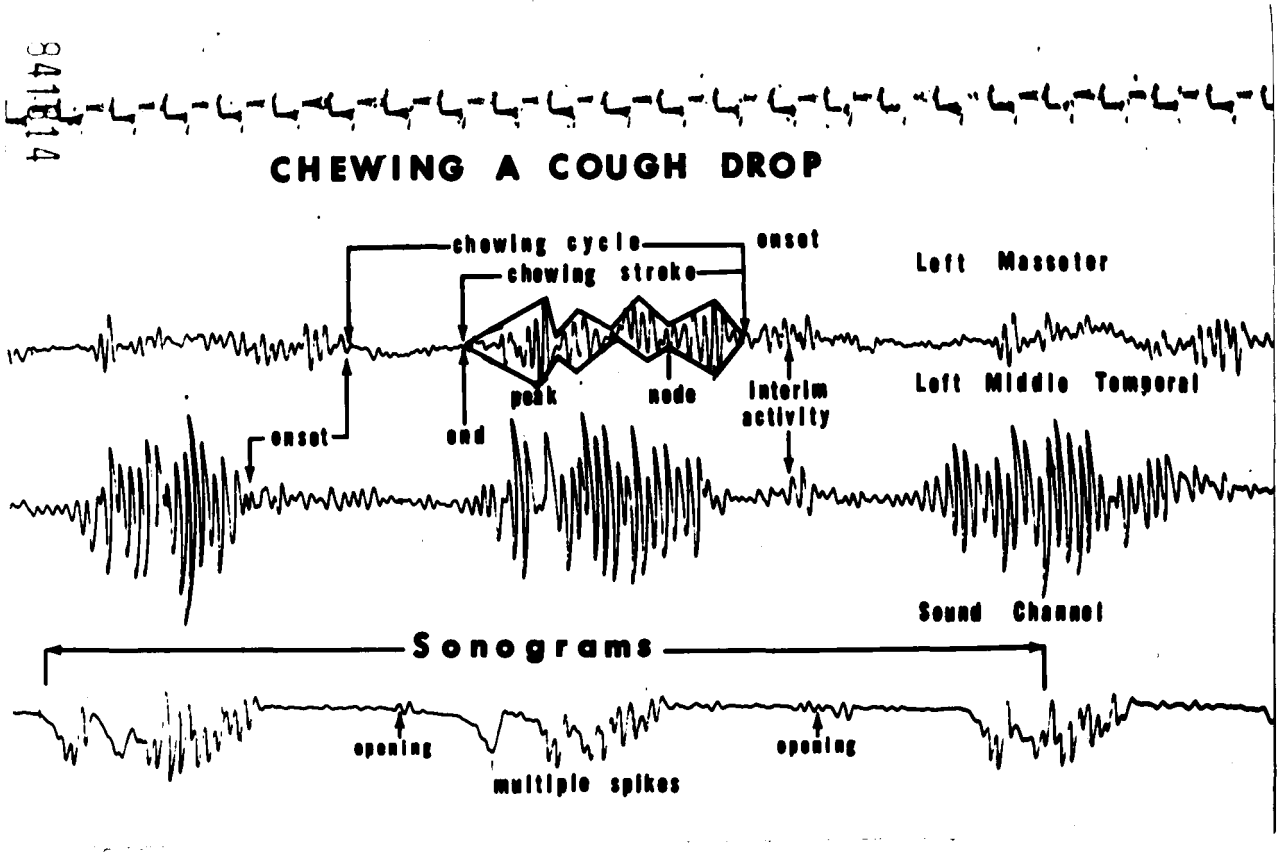


FIGURE 4

FIGURE 5

ELECTRODE PLACEMENT

F. Electrode Placement

Three types of electrodes were used; surface electrodes, a reference electrode, and a ground electrode. Monopolar disk surface electrodes were used because the temporal and masseter muscles lie close to the skin on the side of the head. The absence of underlying superficial or adjacent muscle tissue makes the use of this type of electrode more practical for studying these muscles. The surface electrodes were placed bilaterally on the bellies of the posterior and middle temporal muscles and on the masseter muscle midway between its origin and insertion. To facilitate correct electrode placement the patient was instructed to clench his teeth and then relax, enabling the operator to palpate and select representative areas of the muscles studied. When necessary, the hair was trimmed, exposing an area approximately $\frac{1}{2}$ inch in diameter. The selected areas were cleansed with soap and water, rubbed with acetone and then rubbed with electrode jelly. Skin resistance was thus reduced to 5,000 ohms or less which facilitated greater discrimination in pick-up of low amplitude electrical potentials of the muscles. The reference electrode was clipped to the left ear lobe after similarly preparing the skin surface. The ground electrode was attached to the left forearm after the same skin preparation. (Figure 5).

Photographs of each subject chewing electrode position were taken to insure proper replacement of electrodes in future experiments.

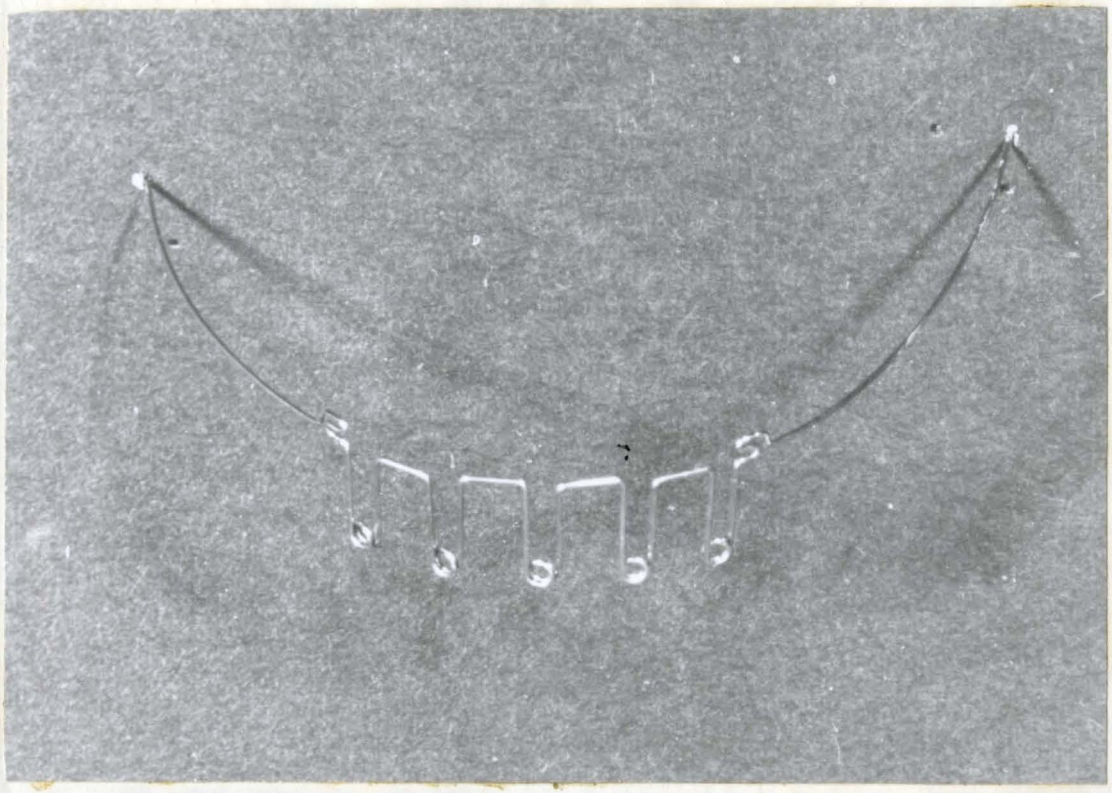


FIGURE 6

A DIFFERENTIAL FORCES ARCH

G. Experimental Procedure

1. Before Orthodontic Treatment - (Experiment I)

The subject was seated in a Faraday cage, the electrodes connected to the terminal board, and the bone conduction microphone placed on his forehead. A printed list of instructions was given to him and the procedure explained. The subject was told to recite each item on the list and perform the required exercises. These exercises were (1) "rest", (2) tap teeth together in centric occlusion, (3) chew a cough drop on the right side, (4) chew a cough drop on the left side. Resting was enhanced by instructing the subject to relax, close his eyes, allow his arms to lie passively in his lap, and his feet flat on the floor. When the crystographic pens showed minimum movement, activity at rest was recorded. Tapping was performed ten times, "slowly and hard". At the beginning of the chewing exercises the subject placed the cough drop between the teeth on the designated side and was told to "chew slowly and hard ten times." Duplicate exercises were performed to minimize the experimental error. Tape recordings of all recitations and exercises were made along with the myograms and sonograms. Rest and tapping exercises were recorded unilaterally and the chewing exercises were recorded ipsilaterally.

2. Orthodontic Procedure

Each subject was fully banded using angulated brackets on each band. The posterior brackets were angulated from the horisontal in order to give the teeth a distal tip - back when a straight wire was placed in the bracket slots.

In all of the subjects the initial, light, resilient round archwires were made of .016 inch diameter Elgiloy - Semi-spring wire. Prior to their insertion all archwires were fashioned individually for each subject, and then tempered to spring hardness. Three major configurations of archwire were used.

a. The differential forces arch.

This archwire was used in the upper and lower dental arches. It employs vertical helical loop springs in the anterior segment of the arch; bent-in hooks located against the mesial surface of the canine brackets; and straight posterior segments with a curve in the buccal-lingual plane of space to provide necessary arch form. (Figure 6).

b. A straight (horizontal) archwire.

This archwire was used in the upper and lower dental arch. It was fashioned to the shape of an ideal arch, individualized for arch width, and form for each subject. These archwires carried no attachments, helical loops, or bent-in hooks. (Figure 7).

c. A straight (horizontal) archwire with attachments.

This archwire was used in the lower dental arch. There were only slight bends incorporated in the posterior segments to conform to general arch form. (Figure 8). The attachments consisted of two sections of .010 open coil spring placed on the wire to advance two sliding hooks. The distal end of the coil spring contacted the bracket of the first premolar tooth and the hook was advanced by the coil to a position mesial to the canine tooth. The bands on the mandibular canine were removed in order to allow the springs and hooks to be

advanced without interference to a point mesial to the canine.

Headgear hooks were attached bilaterally to the sliding hooks in the mouth. These hooks from the headgear were attached extra orally to the material from which the headgear was constructed by means of "X" type Orthospec elastics.

The elastics used in conjunction with the archwires just described were: light one fourth inch latex elastics which exerted an average pull of two ounces when stretched a distance of one and one fourth inches. This is the average distance used in the treatment of the malocclusions.

The latex bands were worn bilaterally in one of three ways or in combinations.

1. A light intramaxillary elastic worn from the end of the archwire on the buccal surface of the first molar to the bent-in hook located mesial to the canine bracket.

2. A light intermaxillary elastic worn from a hook located on the lingual surface of the band on the mandibular first molar to the bent-in hook located mesial to the upper canine bracket.

3. A light triangular elastic worn buccally from the lower to the upper arch, the triangle had its base on the upper arch and its apex on the lower arch. The elastic worn in this fashion was attached from the end of the upper archwire on the first molar to a hook made from the ligature tie on the upper second premolar tooth, then down to a similar ligature tie on the lower second premolar tooth.

3. One Week After Placing an Orthodontic Appliance (Experiment IV)

Recordings were taken in Experiment IV in the same manner as in Experiment I, approximately one week after placing the orthodontic appliance. The electrodes were repositioned with the aid of photographs. The same instructions were given and complete records were taken as before.

H. Utilization of Sound Data to Interpret Electromyograms

The data consisted of myograms, sonograms, and tape recordings of the temporal and masseter muscles taken during tapping, chewing, and at rest. The myograms and sonograms taken at rest permitted an evaluation of the base line or minimum activity in the muscle and sound channels. Myograms compared with the sonograms taken during the tapping exercises, showed a correlation between tapping sounds and muscle activity. The sound of teeth meeting in centric occlusion produced a single spike sonogram. By noting the sound spike and its relation to the activity of the myogram, that part of the myogram preceding the spike was identified as the isotonic contraction of the "free stroke", while that part of the myogram succeeding the spike was identified as isometric contraction of the centric occlusion. (Figure 3). Thus, isotonic contractions were distinguished from isometric contractions. This information was then applied to the study of chewing activity. The chewing exercises were selected for two reasons. First, the act of chewing was mainly reflex in nature and therefore, relatively free from the influence of both subject and the experimentor. Secondly, chewing the selected medium subjected the teeth and their supporting

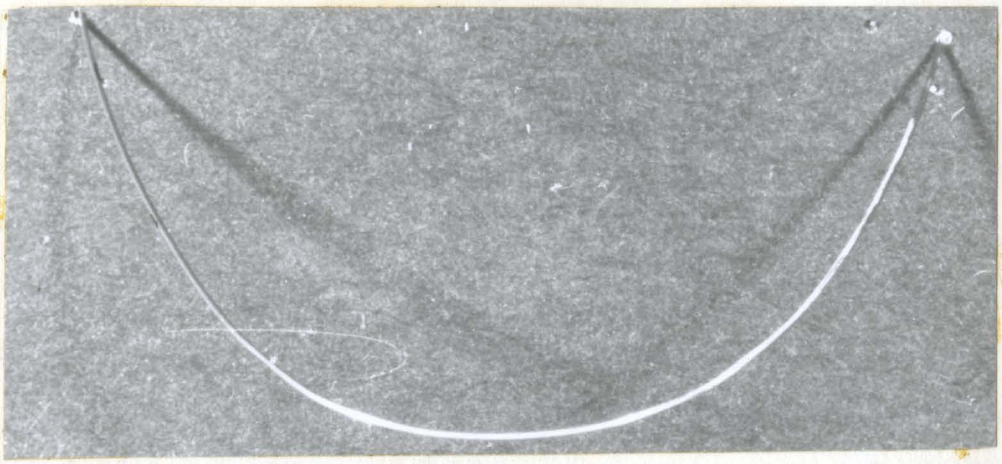


FIGURE 7

A STRAIGHT HORIZONTAL ARCH

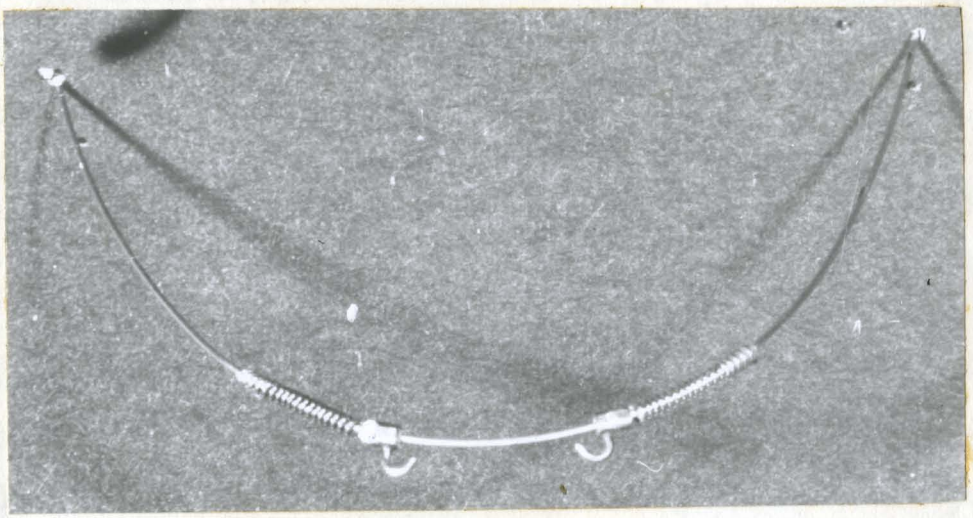


FIGURE 8

A STRAIGHT HORIZONTAL ARCHWIRE WITH ATTACHMENTS

structures, muscles and joints to stresses which tested their functional ability. The cough drop, selected because of its hard consistency, made chewing difficult and at times impossible. Thus, some of the resulting myograms showed that the masseter and temporal muscles were in "a state of confusion", and a "searching pattern" was recorded having no definite boundaries. One could not tell from looking at these myograms whether or not a chewing stroke had been completed. Therefore, sound data were resorted to as an interpretative aid. By playing the tape recording of the exercise in question at 7½ feet per second, and then at 3 3/4 feet per second (the slow motion appraisal), the actual sounds of the chewing exercises were scrutinized. The loudness of the sounds identified the chewing strokes. These recorded sounds of the chewing strokes matched the spikes on the sonograms. The sonograms were then related to the myograms which defined the boundaries of the chewing strokes. Thus, the sound data aided the interpretation of the electromyographic data.

I. Selection of Myograms for Study

The myograms from the first three chewing strokes of the right and left side of duplicate exercises were selected for study. Hence, a total of 36 myograms taken from 3 muscles during the first 3 chewing strokes of the 4 chewing exercises of each experiment were analyzed. Those of the succeeding chewing attempts were not selected because as chewing progressed the cough drop became an unmanageable tacky mass.

J. Defining Characteristics of the Myograms

The myograms presented three basic characteristics, amplitude, duration, and form, which were readily identified and studied. Amplitude was studied as a whole and as its parts; high amplitude "peaks", and low amplitude, sustained or transitory. Low amplitude transitory activity bordered by high amplitude activity was called "noding". (Figure 1). Some "nodes" showed amplitude reductions down to base line levels while others showed considerable amplitude. Sustained low amplitude was prolonged minimum activity devoid of "peaks" and "nodes". Duration of the muscular activity for each chewing stroke was studied as a whole and also divided into two components, onset of activity and end of activity. The rate of increase of amplitude at the onset of activity, and the rate of decrease of amplitude at the end of activity was also noted. Form of the electromyograph was analyzed for frequency of bursts of activity. To demonstrate the form graphically, lines were drawn on the myogram connecting spikes of minimum amplitude with spikes of maximum amplitude. (See Figure 2). The activity between the myograms of successive chewing strokes, termed "interim activity" was also identified and studied. (Figure 2).

K. Evaluation of the Electromyographic Data

To gain a knowledge of the behavior of the temporal and masseter muscles within the experimental conditions, the myograms from Experiments I and IV were analyzed and compared. The myograms were studied in the following manner:

Method I - Listing and evaluating their characteristics.
Method II - Evaluating synchrony and similarity of certain characteristics.
Method III - Analyzing the onset of the chewing activity.
Method IV - Measuring the duration of the chewing stroke.

The results of each method of study appear together in chart form for each subject, in the "Findings".

Method I - Characteristics of the Myograms

The following characteristics were grouped and grossly evaluated: bursts, amplitude, duration, "noding", sustained low amplitude, rate of onset, rate of ending, and interim activity.

The rating scale used for evaluating all of the characteristics other than bursts (which were counted) is as follows:

xxx - maximum
xx - medium
x - minimum

The results appear as Chart I in "Findings". For example, if the amplitude in the myograms of Experiment I was high, a rating of xxx appeared opposite AMPLITUDE in the appropriate experiment column. If the amplitude of the myograms was moderate, then xx value appeared opposite AMPLITUDE in the appropriate experiment column. If the amplitude was low, then the value of x appears opposite AMPLITUDE under the appropriate experiment column.

Method II - Concurrence and Similarity

A leeway of 1/40 of a second, equivalent to one half of the small vertically lined divisions of the myogram paper was allowed to account for the slight difference in alignment of the crystograph pens and for the variation in phase of the tracings.

1. Evaluation of Concurrence

In order to evaluate the degree of concurrence among the three muscles, their myograms were analyzed for concurrence of certain characteristics; namely, onset, ending, "nodes", and peaks and rated by the following scale and recorded on a tally sheet.

xxx high degree of concurrence
(3 muscles acting concurrently per chewing stroke)
xx medium degree of concurrence
(2 muscles acting concurrently per chewing stroke)
x low degree of concurrence
(used only in rating peaks and "nodes")
0 no concurrence
- see onset and end

The x signs were added up and given numerical totals which were used in testing concurrence between experiments. These values appear in Chart 2 of "Findings".

2. Similarity of the Myograms

Wave Form

Degree of similarity of wave forms between the masseter, middle temporal, and posterior temporal muscles for each chewing stroke was evaluated in the following manner. If the wave forms of three muscles from one chewing stroke showed a high degree of similarity, a value of xxx was given. If wave forms of two muscles from one chewing stroke resembled each other, than a value of xx was given to this muscle activity. If only parts of the wave forms resembled each other a value of x was given. When there was no resemblance between wave forms, a value of zero (0) was ascribed. These values were recorded on a tally sheet and the totals for each experiment appear in Chart 2 of "Findings".

Interim Activity

In appraising interim activity, a different scale was used. The complex nature of the activity posed a problem in evaluation, which necessitated a scale with more latitude to cover the various combinations of its characteristics. The scale used was as follows:

5 - 6x high degree of activity within each muscle
3 - 4x moderate degree of activity
1 - 2x minimum degree of activity
0x base line activity

The "x" signs were added up and given numerical values on the tally sheet and appear in Chart 2 in "Findings".

The identity of the masseter, posterior temporal and middle temporal was maintained throughout this evaluation to determine the similarity of activity between the muscles.

3. Test for Significance

The data represented by the column totals taken from the synchrony/similarity tally sheet of the experiments were put to the Chi-Square test to determine whether or not the difference in synchrony/similarity between experiments was significant.

Method III - Analysis of Onset

The myograms from twelve chewing strokes of each experiment (I and IV) were analyzed and compared to determine which muscle or combination of muscles, initiated the chewing stroke. These data were presented in chart form and the comparison of onset of activity between Experiments I and IV was noted.

Method IV - Duration

The duration of the chewing strokes were evaluated as a percentage of the chewing cycle rather than by direct measurement because the subjects were instructed to chew slowly. These instructions were necessary because some individuals chewed so fast that the myograms of the chewing strokes were so close together that they could not be separated from each other. Expressing duration as a percentage value helped to correct this artifact. The percentage value formed histograms which were converted into bar graphs. Comparisons between Experiments I and IV were then made. (See graph).

L. Amplitude

The amplitude was not quantitiated because of varying sensitivity of response of the crystograph pen writers and also because of the variability of the resistance in the tracing pens.

M. Statistical Discipline

This study was basically a qualitative study. Few variables were controlled; the population was heterogenous due to various treatments and malocclusions presented. Therefore, each individual was a separate experimental unit unto himself. The nature of this experiment precluded pooling of data for statistical evaluation.

Three observers gathered and analyzed the data collectively and standardized the method of interpretation. The experimental reliability was determined after each of the observers analyzed the same set of data separately and secre-

tly and submitted their results to a Chi-Square test of significance. The results of these tests showed no statistical significant difference among the observers in evaluating the data at the .05 level of probability. This indicated there was less than 5% error among observers.

Statistical discipline was applied to only one of the four methods used to study the data. The synchrony/similarity data of Experiment I and IV were put to the Chi-Square test and judged for significance at the .05 level of probability for 9 degrees of freedom.

> Chi-Square is the statistical test most generally suitable for determining whether or not an observed frequency or occurence differs significantly from that expected in accordance with some hypotheses. Symbolically, Chi-Square is defined as:
>
> $$x^2 = E \frac{(O - E)^2}{E}$$ where E denoted the sum
>
> of all values; O, the observed frequency of occurence; and E, the frequency expected in accordance with an hypotheses. (Batson).

CHAPTER III

FINDINGS

The findings are presented as graphs and charts with accompanying explanations noting differences between experiments for each of sixteen subjects studied. Photographs of each subject's plaster casts are shown and classified according to Angle's classification of malocclusion and the treatments rendered are stated.

Chart I

Comparing the Characteristics of the Myograms Between Experiment I and IV (Qualitative Data)

The characteristics of the myogram have been evaluated as described in Methods and Materials and the findings are represented symbolically (xxx; xx; and x).

Chart II

Comparing Concurrence and Similarity of the Myograms Between Experiment I and IV

The data represents the column totals taken from a tally sheet for each experiment. The Chi-Square test was the statistical method employed to determine whether the difference of concurrence and similarity between experiments was significant.

Chart III

Analysis of Onset of Activity

The analysis of onset chart shows the number of times each muscle or combination of muscles initiated the chewing stroke.

Bar Graph

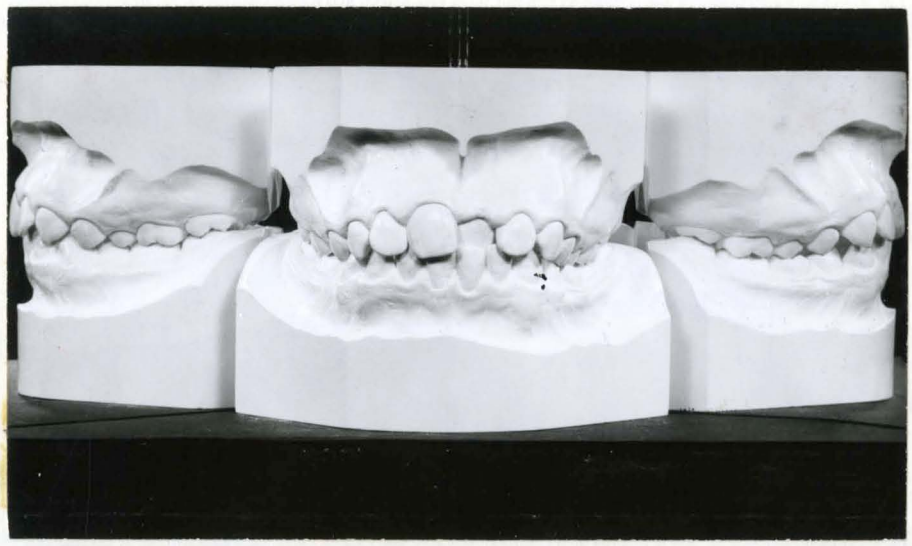
Duration of the Chewing Stroke (Quantitative Data)

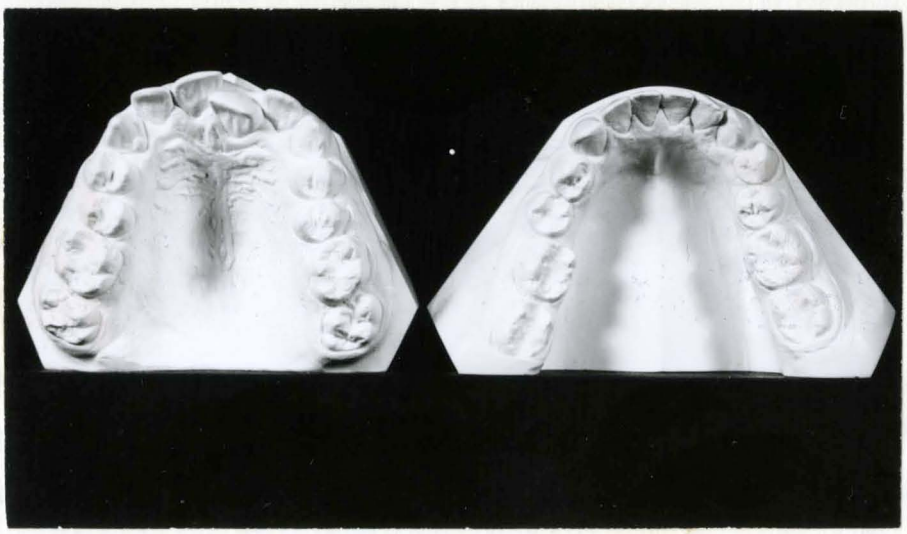
The duration of the chewing stroke expressed as percentage values, was compiled as histograms and converted into bar graphs. See Methods and Materials for details, page 28.

FINDINGS

Subject #1 (L.C.) Age 14

Angle Classification of Malocclusion: Class I





Subject # 1

Treatment:

A. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a typical differential forces arch. (Figure 6).

2. The mandibular archwire was a straight (horizontal) arch without attachments.

3. The elastics used were of type 2 and 3 mentioned in methods and materials (page 20). They were worn between the arches in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 1-2 bursts, moderate amplitude, short duration, indistinct noding, no sustained low amplitude activity, rapid rate of onset and ending, and minimal interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in the number of bursts and an increase in the amount of noding. This patient seems to find chewing a little more difficult.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of the characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 1.5667. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing strokes in Experiment I showed that 10 out of 12 times, the three muscles studied initiated the chewing activity almost at the same time. Experiment IV shows that the three muscles studied acted harmoniously fewer times, and the masseter became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 15-55% of the chewing cycle, with the greatest frequency occurring at the 25-35 percentile. In Experiment IV the duration of the chewing stroke ranged from 25-55% of the chewing cycle with the greatest frequency occurring at the 35-45 percentile. The results from the bar graph indicate that there was a slight increase in the duration of the chewing stroke. That is, it took longer for him to chew the cough drop. Conclusion: This subject shows a slight change of neuromuscular pattern in response to orthodontic treatment.

#1 L.C. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	1-2	2-4	x
Amplitude	moderate xx	xx	0
Duration	short x	x	0
Noding	x	xx	x
Sustained low amp.	0	0	0
Rate of onset	xxx	xxx	0
Rate of ending	xxx	xxx	0
Interim activity	x	x	0

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

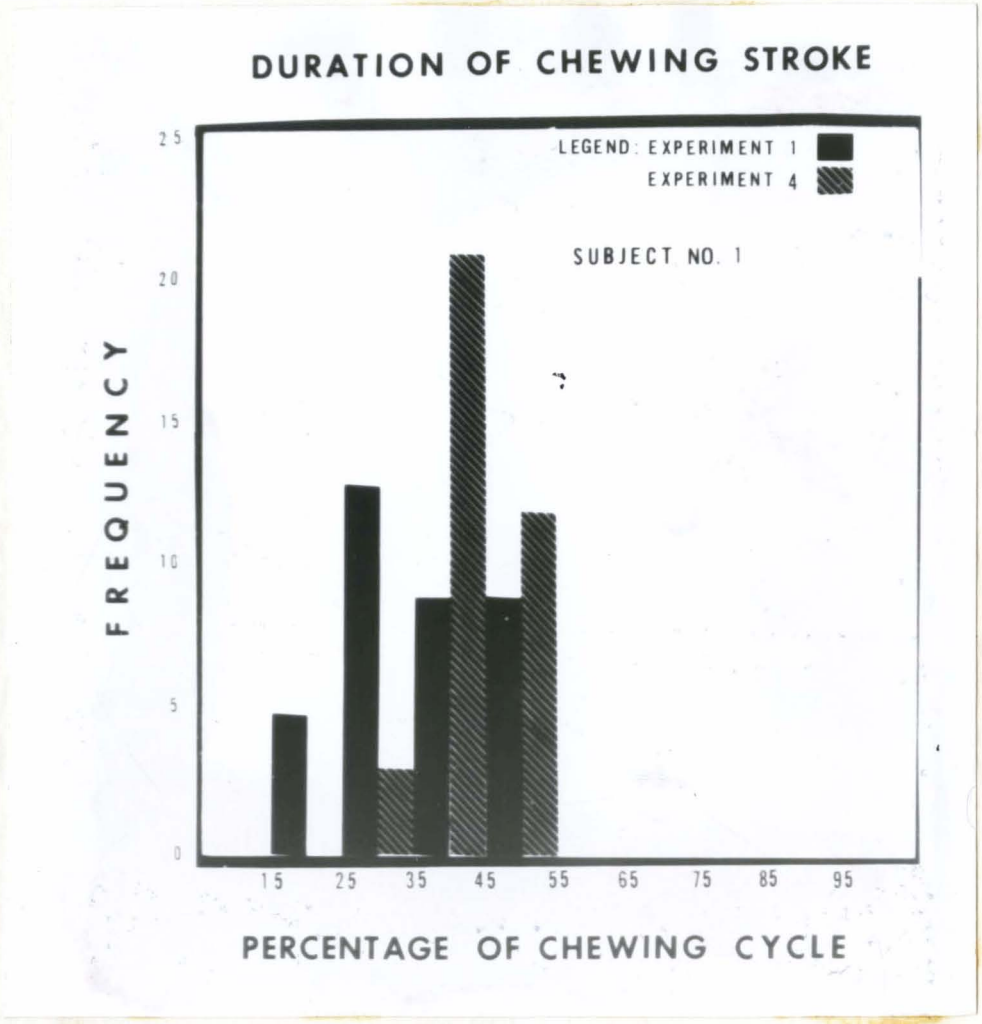
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	23	30	3/4	3/4	10	10	11	2	2	4
Exp. 4	33	33	30	33	9	12	11	4	1	3

Chi Square = 1.5667
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

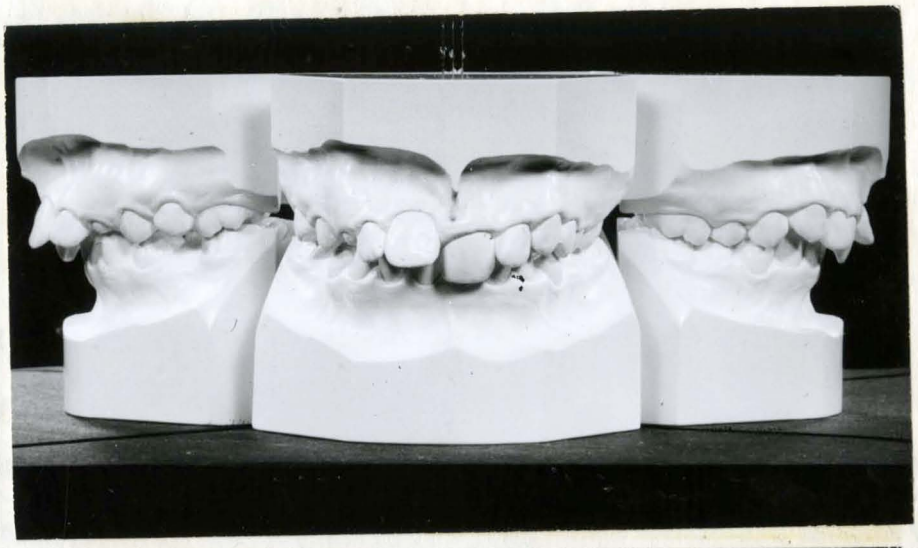
Exp. 1		Exp. 4
1	Masseter first	5
0	Masseter and middle temporal first	1
0	Masseter and posterior temporal first	0
0	Middle temporal first	0
0	Middle and posterior temporal first	0
1	Posterior temporal first	0
10	All together (synchronous)	6
12	Total number of chewing strokes	12

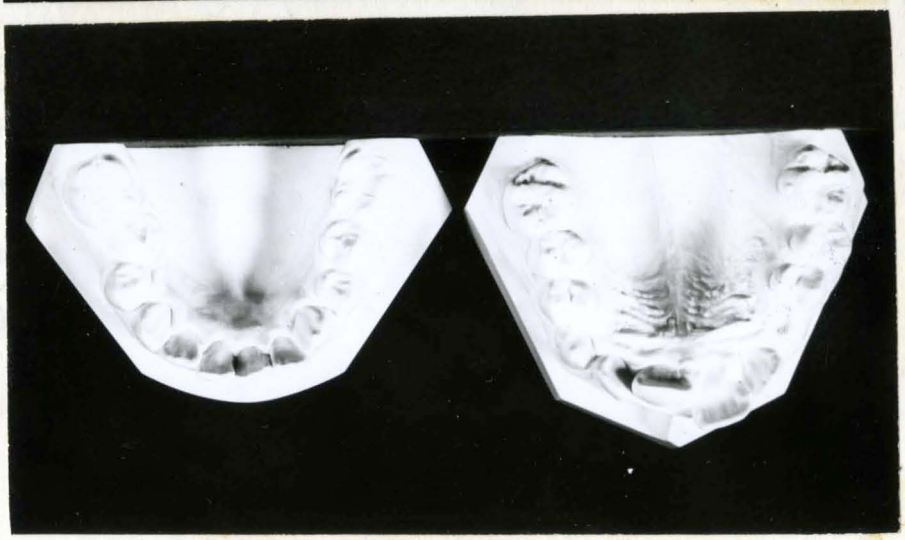

DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 1
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 2 (E.G.) Age 11

Angle Classification of Malocclusion: Class II - Division I





Subject # 2

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a straight (horizontal) arch without attachments. (Figure 7).

2. The mandible archwire was a straight (horizontal) archwire with headgear attachments and headgear to the lower arch.

3. The elastics were of the third type mentioned in methods and materials (page 20). They were worn in a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 4-6 bursts moderate amplitude, long duration, distinct noding, no sustained low amplitude activity, moderate rate of onset and ending, and a maximal degree of interim activity.

Experiment IV as compared to Experiment I showed that there was a decrease in duration; there was some sustained low amplitude activity in the masseters, and there was a great decrease in the degree of interim activity. The other characteristics showed no apparent differences. This shows that the subject may have adapted to treatment.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 8.8884. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing strokes in Experiment I showed that 4 out of 12 times the masseter initiated the activity; the rest of the time the three muscles studied initiated the chewing strokes concurrently. Little change was observed in Experiment IV.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-95% with the greatest frequency occurring at the 65-75 percentile. In Experiment IV the duration of the chewing stroke ranged from 35-75% of the chewing cycle with the greatest frequency occurring at the 55-65 percentile. The results from the bar graph indicate that there was little change in the duration of the chewing stroke. Conclusion: This subject may have adapted to treatment.

#2 E.G. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	4-6	4-5	0
Amplitude	xx	xx	0
Duration	xxx	xx	x
Noding	xxx	xxx	0
Sustained low amp.	0	mass. a little	x
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	xxx	x	xx

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

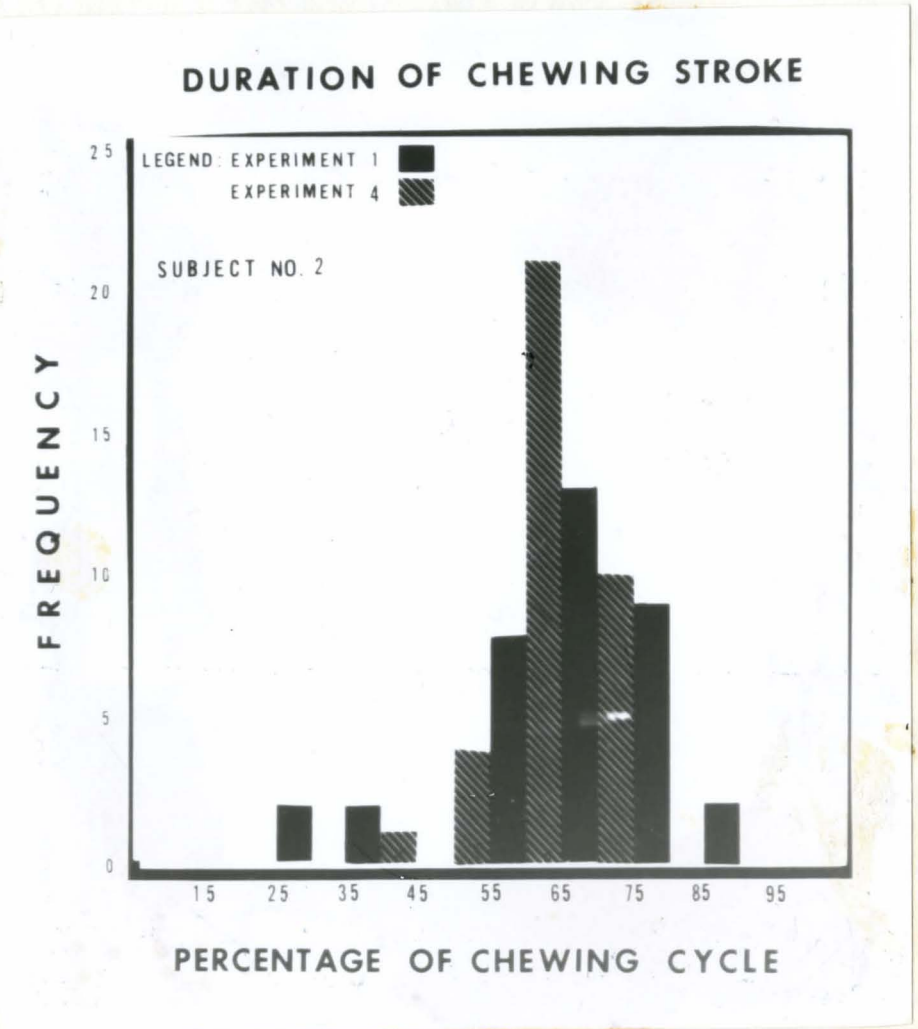
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	27	26	26	28	11	12	10	21	19	19
Exp. 4	31	33	32	35	9	12	12	10	10	11

Chi Square = 8.8884
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

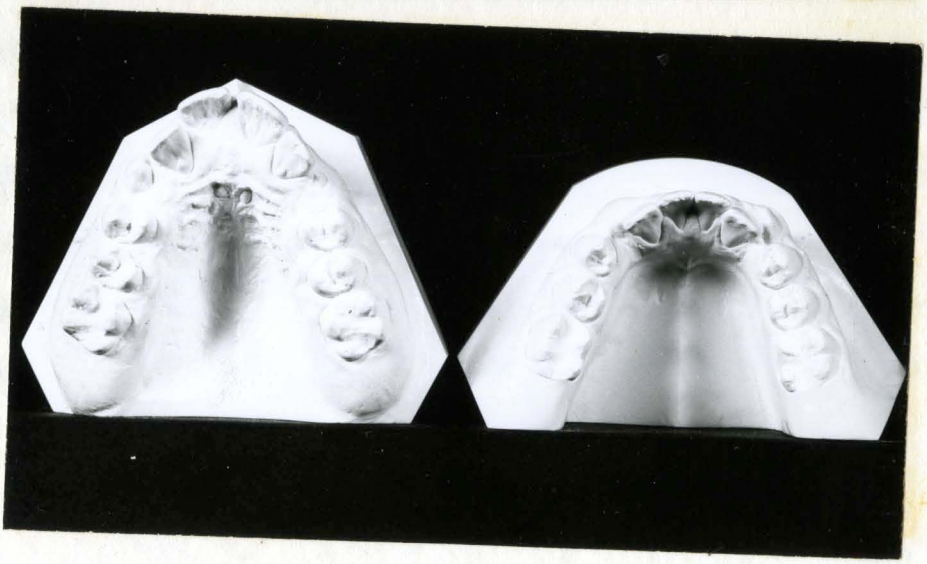
Exp. 1		Exp. 4
4	Masseter first	4
1	Masseter and middle temporal first	0
1	Masseter and posterior temporal first	0
0	Middle temporal first	0
0	Middle and posterior temporal first	0
0	Posterior temporal first	0
6	All together (synchronous)	8
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 2
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 3 (R.H.) Age 11

Angle Classification of Malocclusion: Class II - Division I



Subject # 3

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a differential forces arch with only two loops, one placed mesial to each cuspid tooth.

2. The mandible archwire was a differential forces arch with only two loops, one placed mesial to each cuspid tooth.

3. The elastics were of all three types mentioned in methods and materials (page 20). There were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 1-3 bursts, low to moderate amplitude, short duration, indistinct noding, some sustained low amplitude activity, moderate rate of onset and ending and moderate degree of interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in the number of bursts, amplitude on the left side, noding, and sustained low amplitude activity. The other characteristics showed no apparent differences. This subject showed some change in the behavior of the muscles.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 2.6574. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity in Experiment I was variable. The masseter initiated the chewing stroke 3 out of 12 times; the posterior temporal 3 out of 12 times; and the muscles acted at about the same time 5 out of 12 times. Experiment IV shows that the posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 5-85% of the chewing cycle with the greatest frequency occurring at the 35-45 percentile. In Experiment IV the duration of the chewing stroke ranged from 25-100% of the chewing cycle with the greatest frequency occurring between the 35-55 percentile. The results from the bar graph indicate that there was some change in the duration of the chewing stroke. Conclusion: This subject showed some change in muscular behavior which is probably due to altered periodontal proprioception.

#3 R.H. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	1-3	3-6	xx
Amplitude	right - xx left - x	right - xx left -xx	right - 0 left - x
Duration	x	xx	x
Noding	x	xx	x
Sustained low amp.	left masseters	rt. and lt. masseters	x
Rate of onset	xx	xx	0
Rate of ending	xx faster on right side	xx	0
Interim activity	xx	xx	0

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

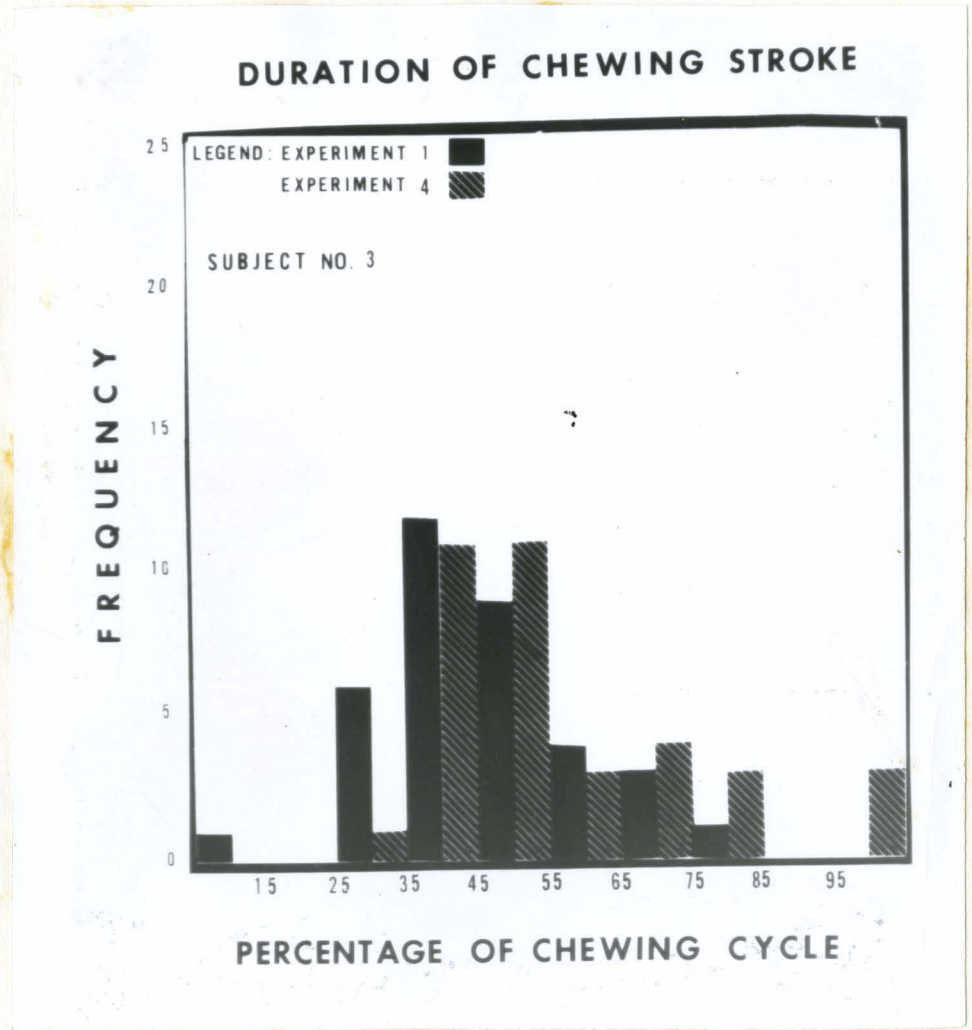
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	26	27	29	28	6	10	10	12	7	15
Exp. 4	23	25	23	30	7	11	7	11	3	22

Chi Square = 2.6574
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

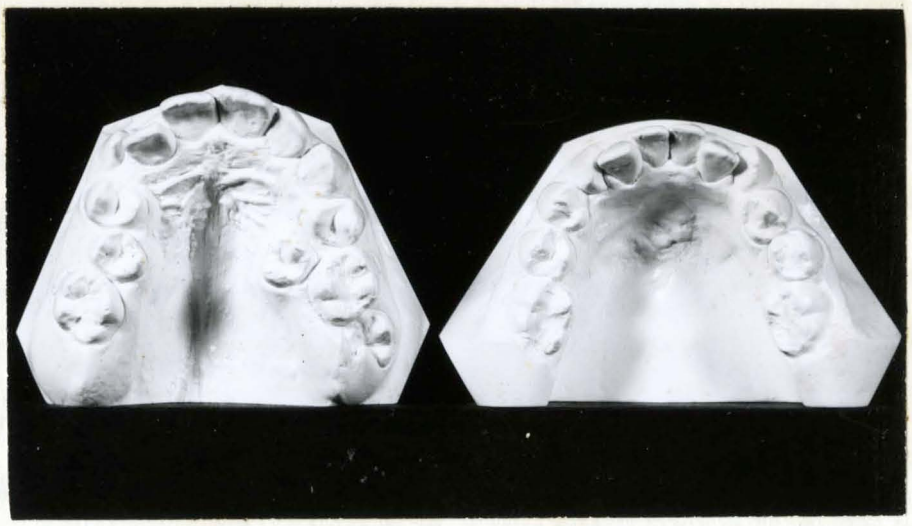
Exp. 1		Exp. 4
3	Masseter first	2
0	Masseter and middle temporal first	1
0	Masseter and posterior temporal first	0
0	Middle temporal first	0
1	Middle and posterior temporal first	0
3	Posterior temporal first	8
5	All together (synchronous)	1
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 3
FREQUENCY
0
5
10
15
20
25
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 4 (M.K.) Age 10

Angle Classification of Malocclusion: Class II - Division I



Subject # 4

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials) page 19.

1. The maxillary archwire was a differential forces arch with only two loops. They were placed between the right cuspid and lateral incisor and between the right central incisor and lateral incisor teeth.

2. The mandibular arch was a differential forces arch with four loops. This is quite similar to the archwire in Figure 6, except there is no loop between the central incisor teeth.

3. The elastics used were of three types mentioned in methods and materials (page 20). There were intramaxillary elastics in the mandibular arch and between the arches elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 1-3 bursts, moderate amplitude, short duration, fairly distinct noding, some sustained low amplitude activity, moderate rate of onset and ending, and minimal degree of interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in the number of bursts, a decrease in sustained low amplitude activity, and a slight increase in the degree of interim activity. The other characteristics

showed no apparent differences. It seems that this subject was trying harder to chew the cough drop.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 4.8803. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity in Experiment I showed that the masseter muscles initiated the activity 6 out of 12 times, and 5 out of 12 times the three muscles studied initiated the onset at about the same time. There was little change in Experiment IV.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 5-75% of the chewing cycle, with the greatest frequency occurring at the 55-65 percentile. In Experiment IV the duration of the chewing stroke ranged from 15-85% of the chewing stroke with the greatest frequency occurring at the 45-55 percentile. The results from the bar graphs indicate that there was a slight decrease in the duration of the chewing stroke. Conclusion: This subject seemed to show some change of muscular function as a result of treatment.

#4 M.X. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	1-3	2-4	x
Amplitude	xx	xx	0
Duration	x	xx	x
Noding	xx	xx	0
Sustained low amp.	x rt. mass. & lt. post. temp.	x rt. mass.	x
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	x	x mass. & post. temp.	x slight

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

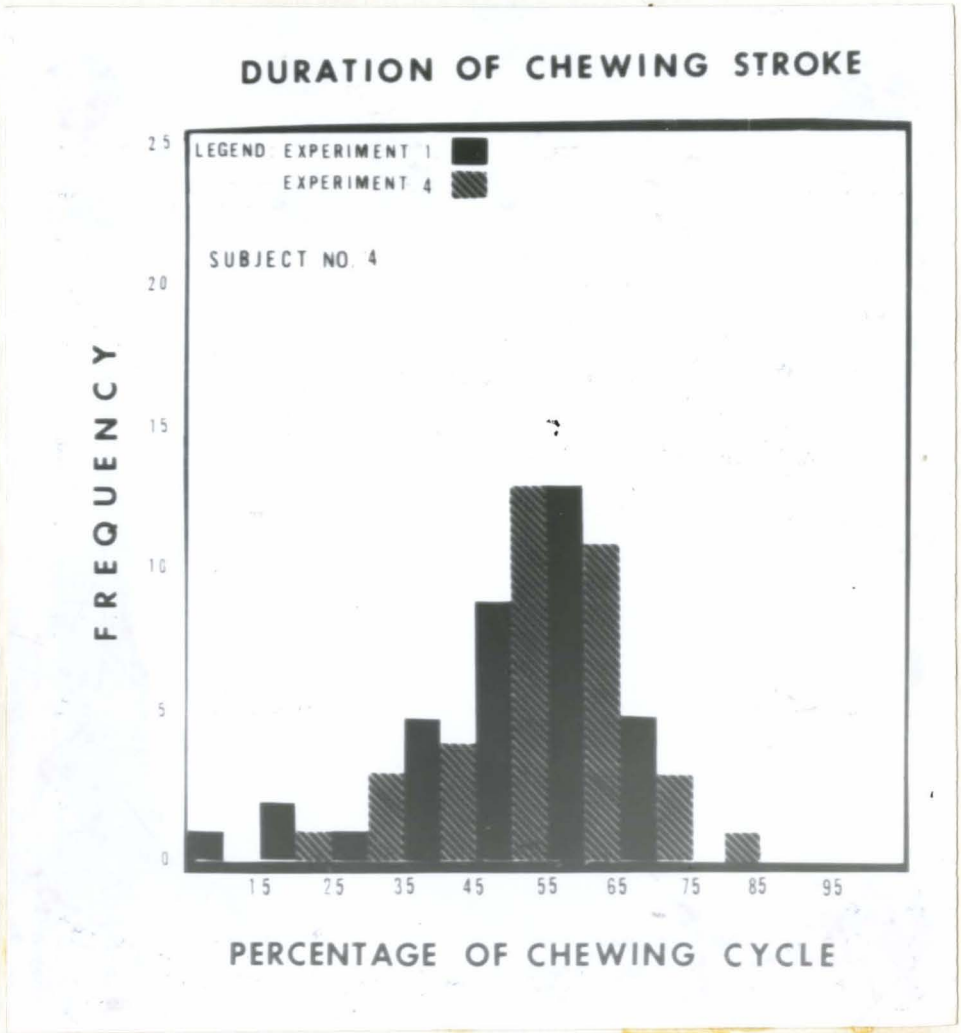
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	25	31	30	32	10	11	9	9	8	9
Exp. 4	29	29	26	33	10	11	11	16	3	17

Chi Square = 4.8803
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

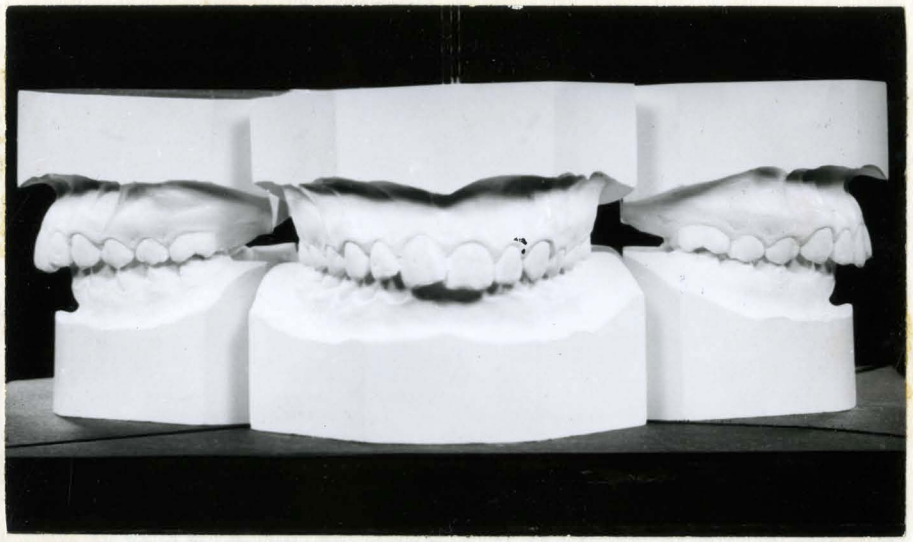
Exp. 1		Exp. 4
6	Masseter first	8
1	Masseter and middle temporal first	0
0	Masseter and posterior temporal first	0
0	Middle temporal first	0
0	Middle and posterior temporal first	1
0	Posterior temporal first	1
5	All together (synchronous)	2
12	Total number of chewing strokes	12

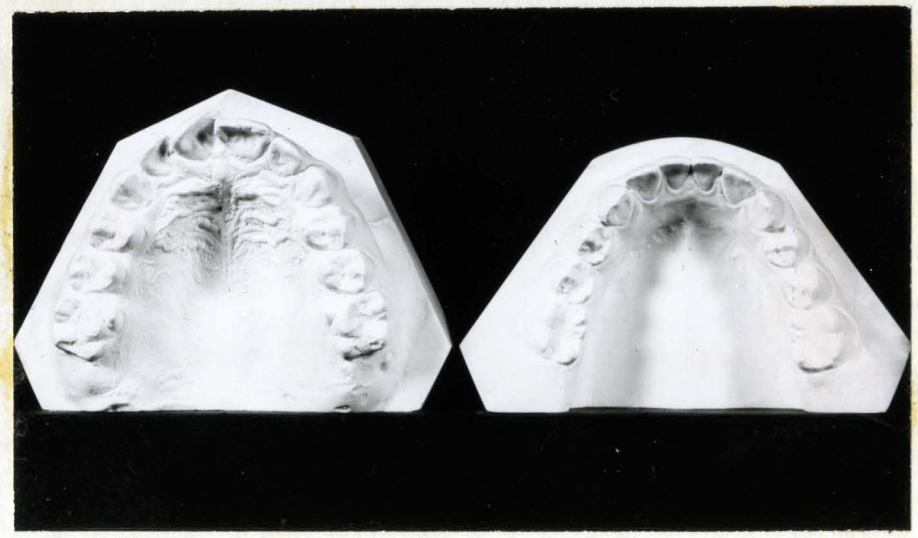

DURATION OF CHEWING STROKE
LEGEND EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 4
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 5 (M.M.). Age 11

Angle Classification of Malocclusion: Class II - Division I





Subject # 5

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a differential forces arch with four loops. This is quite similar to the archwire in Figure 6, except there is no loop between the central incisor teeth.

2. The mandibular archwire was a typical differential forces arch. (Figure 6).

3. The elastics used were of the three types mentioned in methods and materials (page 20). There were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 2-3 bursts, low amplitude, short duration, fairly distinct noding, some sustained low amplitude activity, moderate rate of onset and ending, and a minimal degree of interim activity.

Experiment IV as compared to Experiment I showed that there was an increase of sustained low amplitude activity in the masseters. The other characteristics showed no apparent differences. This may indicate that the subject had adapted to the orthodontic treatment.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 8.1789. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing stroke in Experiment I showed that the masseter muscles initiated the activity 6 out of 12 times, and 5 out of 12 times the three muscles acted at about the same time. Experiment IV shows that the masseter muscle became less active and the middle temporal and posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-75% of the chewing cycle with the greatest frequency occurring at the 45-55 percentile. In Experiment IV the duration of the chewing stroke ranged from 15-85% of the chewing stroke with the greatest frequency occurring at the 55-65 percentile. The results from the bar graph indicates that there was a slight increase in the duration of the chewing stroke. That is, it took longer for him to chew the cough drop. Conclusion: This subject appears to have adapted to treatment.

#5 H.M. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	2-3	2-3	0
Amplitude	x	x	0
Duration	x	x	0
Noding	xx	xx	0
Sustained low amp.	masseters	more in masseters	x
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	x	x	0

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

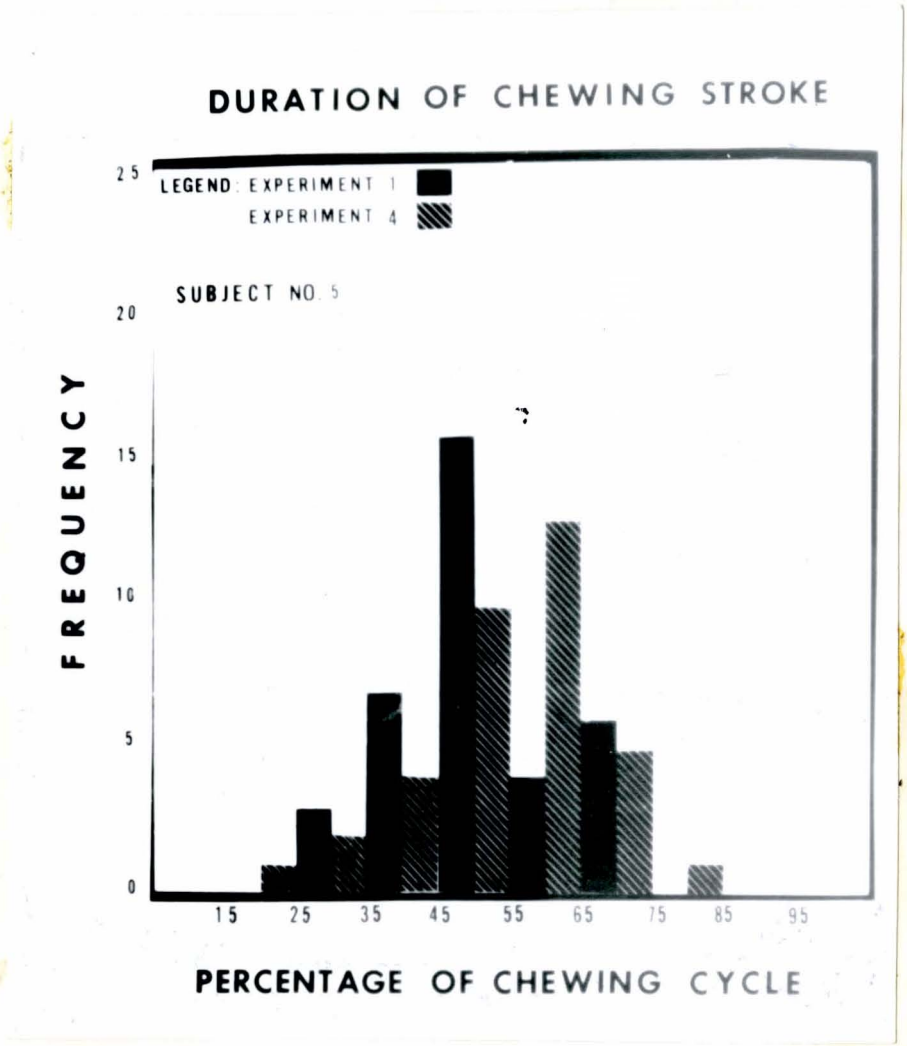
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	23	27	27	30	5	11	11	19	13	13
Exp. 4	28	28	28	27	8	10	10	5	8	13

Chi Square = 8.1789
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

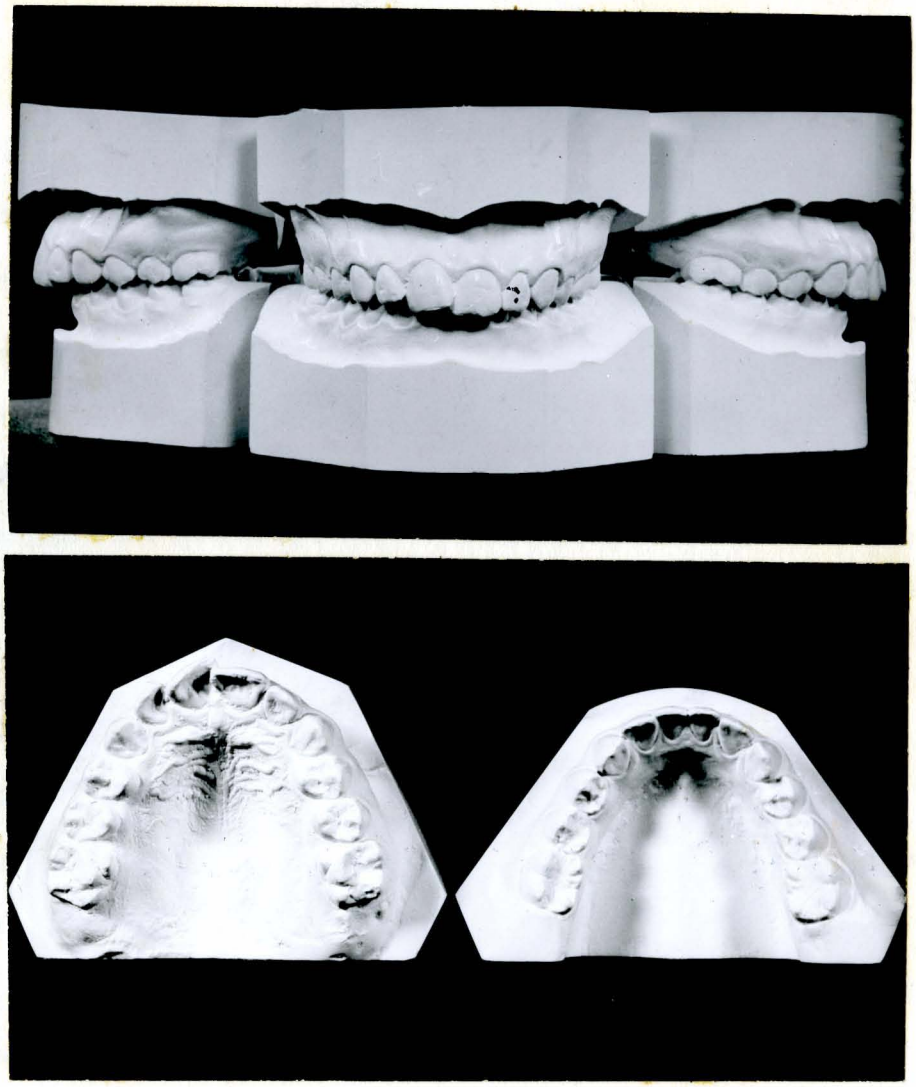
Exp. 1		Exp. 4
6	Masseter first	2
0	Masseter and middle temporal first	0
0	Masseter and posterior temporal first	1
0	Middle temporal first	0
0	Middle and posterior temporal first	5
1	Posterior temporal first	1
5	All together (synchronous)	3
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 5
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 6 (K.M.) Age 13

Angle Classification of Malocclusion: Class II - Division I



Subject # 6

Treatment:

A. Appliance design (see methods and materials page 19)

1. No maxillary archwire.

2. The mandibular archwire was a straight (horisontal) arch with headgear attachments and headgear to lower arch.

3. No elastics were used.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 3-6 bursts, moderate amplitude, moderate duration, distinct noding, some sustained low amplitude activity, moderate rate of onset and ending, and a maximal degree of interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in amplitude and rate of ending, and a decrease in the degree of interim activity. The other characteristics showed no apparent differences. This subject seems to be trying harder to crush the cough drop.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 3.6112. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing stroke in Experiment I showed that the masseter muscle initiated the activity 8 out of 12 times and 3 out of 12 times the three muscles acted at about the same time. Experiment IV shows that the middle and posterior fibers of the temporal muscles became more active in initiating the activity of the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 35-65% of the chewing cycle with the greatest frequency occurring at the 65-75 percentile. In Experiment IV the duration of the chewing stroke ranged from 35-95% of the chewing cycle with the greatest frequency occurring at the 65-75 percentile. The results from the bar graph indicated that there was little change in the duration of the chewing stroke. Conclusion: This subject seems to have adapted to treatment.

#6 K.M. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	3-6	2-6	0
Amplitude	xx	xxx	x
Duration	xx	xx	0
Noding	xxx	xxx	0
Sustained low amp.	lt. masseters	lt. masseters	0
Rate of onset	xx	xx	0
Rate of ending	xx	xxx	x
Interim activity	xxx	xx	x

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

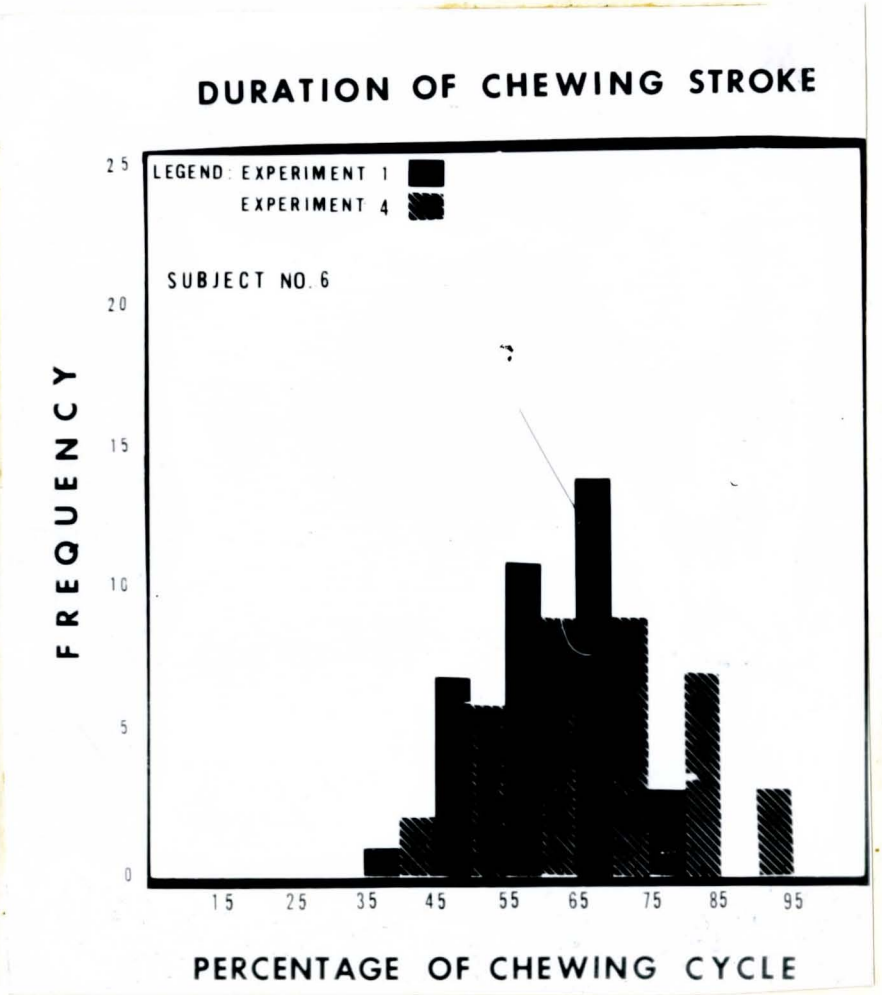
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	28	30	27	28	8	9	11	29	22	26
Exp. 4	22	28	26	31	5	12	12	16	15	21

Chi Square = 3.6112
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

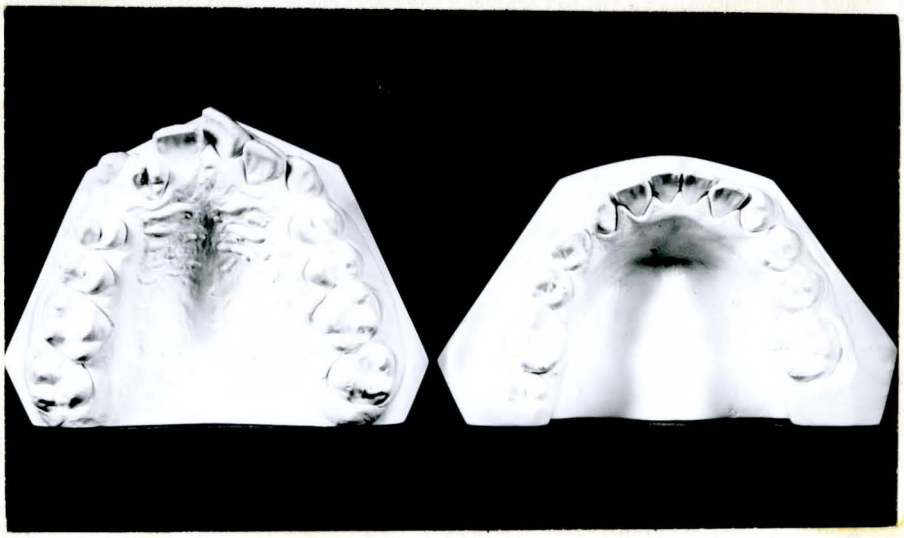
Exp. 1		Exp. 4
8	Masseter first	0
0	Masseter and middle temporal first	1
0	Masseter and posterior temporal first	0
0	Middle temporal first	0
1	Middle and posterior temporal first	5
0	Posterior temporal first	4
3	All together (synchronous)	2
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 6
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 7 (J.N.) Age 13

Angle Classification of Malocclusion: Class II - Division I



Subject # 7

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a typical differential forces arch. (Figure 6).

2. The mandibular archwire was a typical differential forces arch with only two loops, one mesial to each cuspid tooth.

3. The elastics used were of the three types mentioned in methods and materials (page 20). They were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 1-3 bursts and multiburst patterns limited to the first chews, high amplitude moderate duration, fairly distinct nodding, some sustained low amplitude activity, moderate rate of onset, rapid rate of ending, and moderate interim activity, except in the right masseter and post temporal where it was maximal.

Experiment IV as compared to Experiment I showed that there was a change in the kind of bursts from a few multiburst patterns to many multiburst "painful" searching patterns; a decrease in amplitude, and increased duration, slightly more sustained low amplitude activity, a decrease in the rate of ending and a decrease in the degree of interim activity for the right masseter muscle, but an

increase in the degree of interim activity for the right posterior temporal muscles. The other qualities showed no apparent differences. This seems to indicate that the subject was reacting to altered periodontal proprioception and pain.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing stroke in Experiment I showed that the masseter muscles initiated the activity 3 out of 12 times by itself, along with the middle temporal muscle twice, and synchronously with the other muscles 7 out of 12 times. Experiment IV shows that the three muscles studied acted harmoniously fewer times, and that the posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-75% of the chewing cycle, with the greatest frequency occurring at the 35-45 percentile. In Experiment IV the duration of the chewing stroke ranged from 35-100% of the chewing cycle with the greatest frequency occurring at the 55-65 percentile. The results from the bar graph indicates that there was an increase in the duration of the chewing stroke. Conclusion: This subject seemed to be having a difficult time chewing.

#7 J.M. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	1-3; multibursts limited to 1st chew	multibursts, painful searching patterns	xx
Amplitude	xxx	xx	x
Duration	xxx	xxx	0
Noding	xx	xx	0
Sustained low amp.	rt. mass. 1st chew stroke	slightly more	x
Rate of onset	xx	xx	0
Rate of ending	xxx	xx	0
Interim activity	xx(rt. mass. & post. temp. greater than lt. side & xxx	xx(rt. mass. less & post. temp. xxx)	x some

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

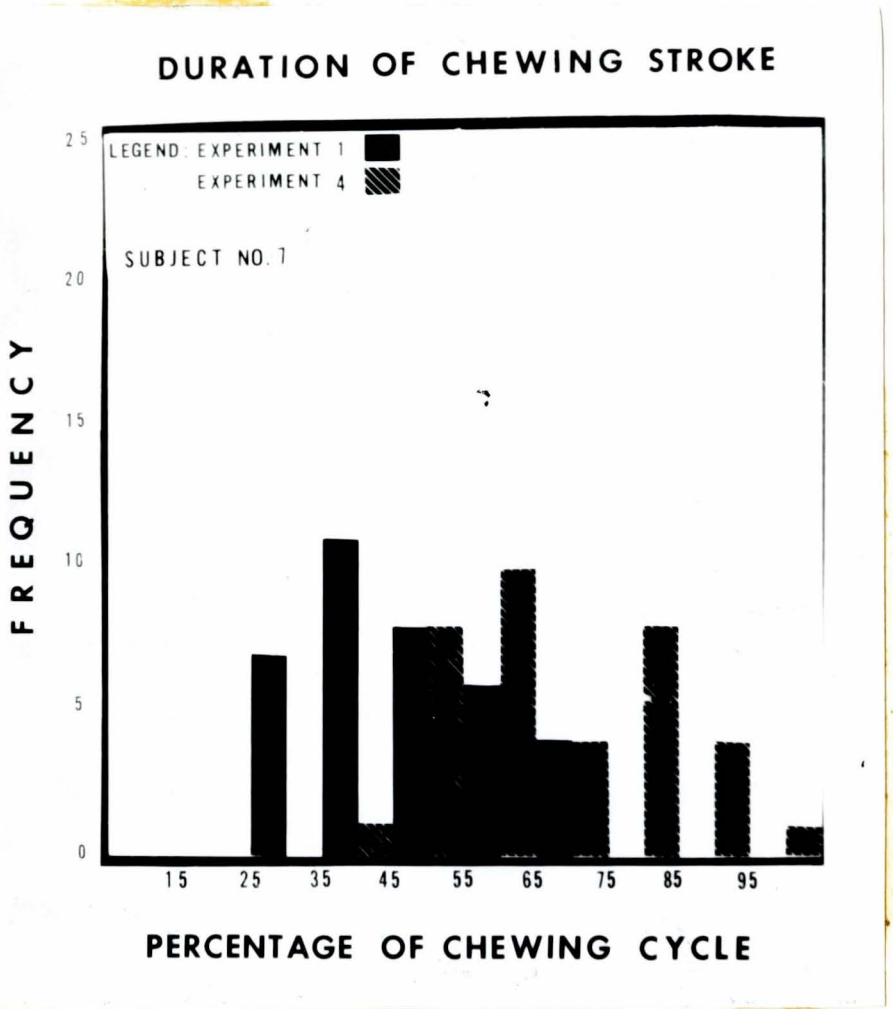
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	26	27	31	23	6	11	12	24	16	19
Exp. 4	27	27	26	31	8	9	10	12	7	21

Chi Square = 5.6347
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

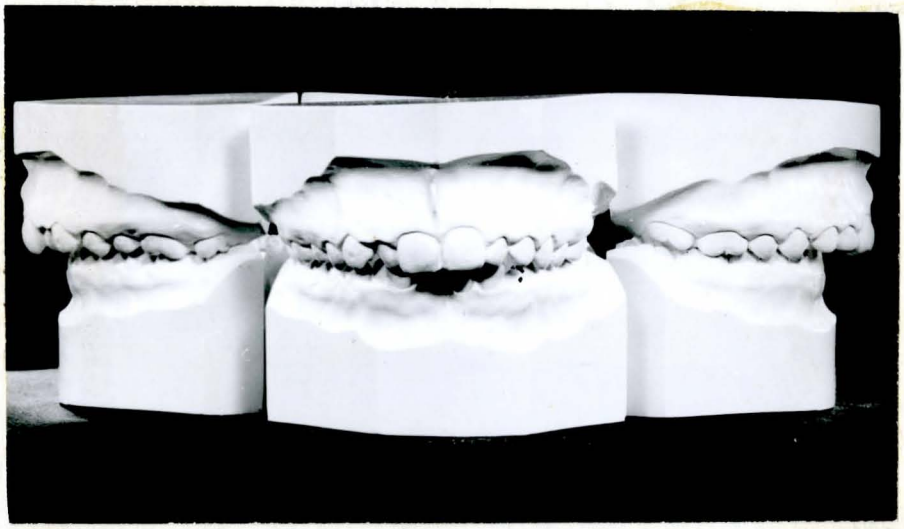
Exp. 1		Exp. 4
3	Masseter first	4
2	Masseter and middle temporal first	0
0	Masseter and posterior temporal first	1
0	Middle temporal first	0
0	Middle and posterior temporal first	0
0	Posterior temporal first	5
7	All together (synchronous)	2
12	Total number of chewing strokes	12

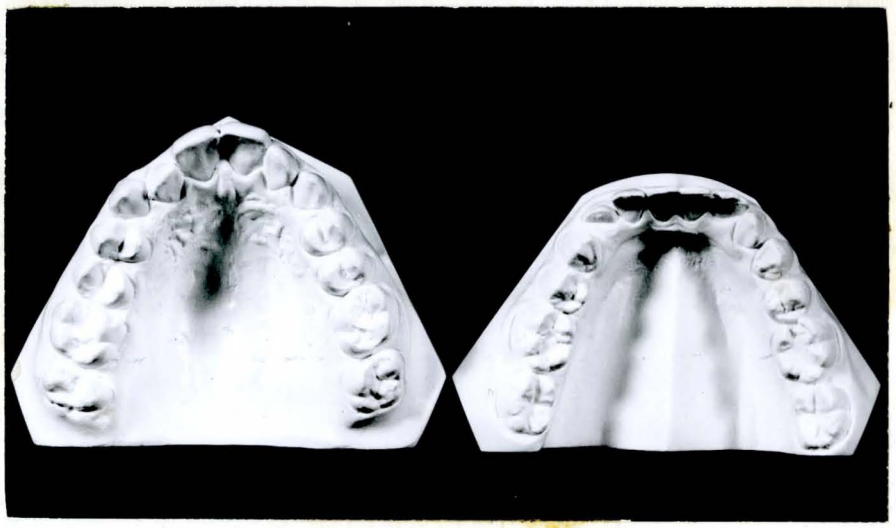

DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 1
FREQUENCY
0
5
10
15
20
25
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 8 (L.F.) Age 12

Angle Classification of Malocclusion: Class II - Division I





Subject # 8

Treatment:

A. Extract the maxillary first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a differential forces arch with four loops. This is quite similar to the archwire in Figure 6, except there is no loop between the central incisor teeth.

2. The mandibular archwire was a straight (horizontal) arch without attachments.

3. The elastics were of type 2 and 3 mentioned in methods and materials (page 20). There were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 2-6 bursts, high amplitude, short duration, distinct noding, some sustained low amplitude activity in the middle temporal, moderate rate of onset and ending and maximal interim activity, especially in the masseter muscles.

Experiment IV as compared to Experiment I showed that there was a change in the kind of bursts to sustained "searching" patterns, a decrease in amplitude, a moderate increase in duration, an increase in sustained low amplitude activity, a decrease in the rate of onset and ending, and a change in character of interim

activity from high amplitude activity with a beginning and an end to continuous low amplitude activity. The only quality to remain unchanged was noding. This subject seems to show a definite change of function.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 1.8858. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing stroke in Experiment I showed that 6 out of 12 times the masseter muscle initiated the activity, and 4 out of 12 times the three muscles studied acted at about the same time. There was little change in Experiment IV.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-85% of the chewing cycle with the greatest frequency occurring between 45-75 percentile. In Experiment IV the duration of the chewing stroke ranged from 45-100% of the chewing cycle with the greatest frequency between the 45-75 percentile. The results from the bar graph indicate that there was a little change in the duration of the chewing stroke. Conclusion: There seems to be an altered behavior of

the temporal and masseter muscles which may be due to changes in periodontal proprioception.

#8 L.P. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	2-6	sustained searching patterns	x
Amplitude	xxx	xx	x
Duration	x	xxx	xx
Noding	xxx	xxx	0
Sustained low amp.	middle temp.	in all muscles	x
Rate of onset	xx	x	x
Rate of ending	xx	x	x
Interim activity	xxx esp. mass.	xxx(cont., but of moderate amplitude)	x

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

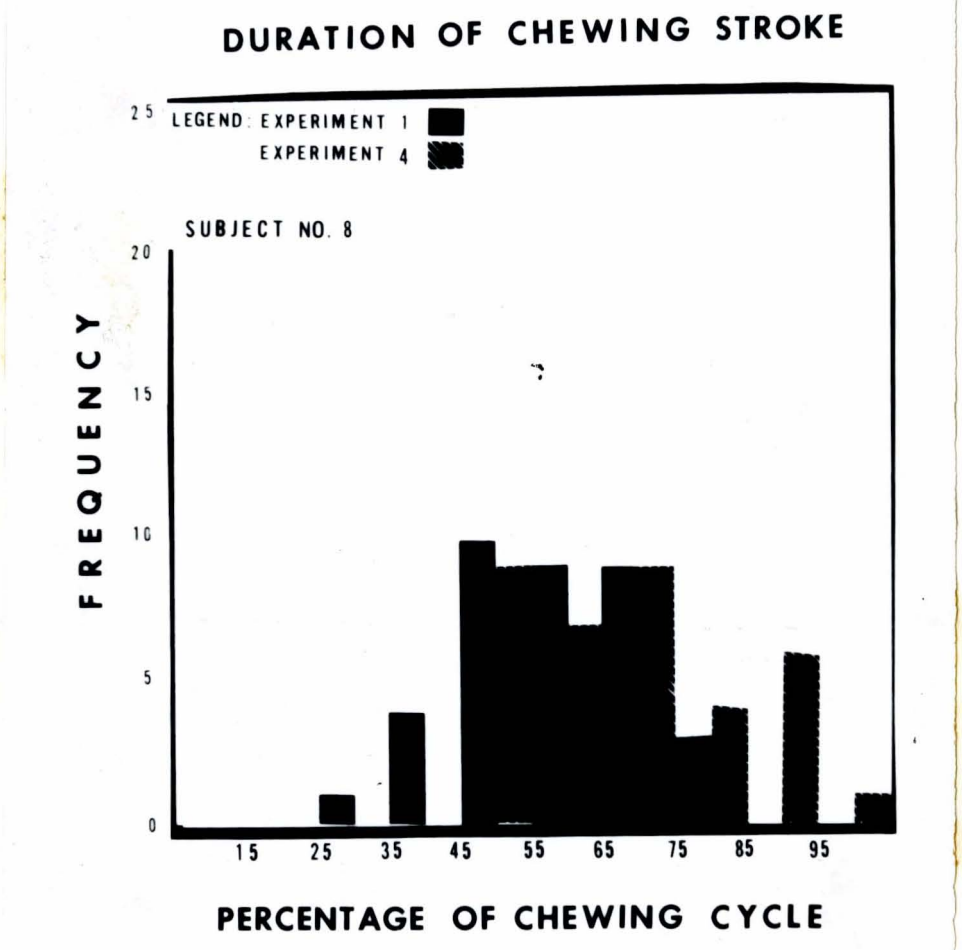
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	29	28	24	25	7	10	8	33	8	9
Exp. 4	29	30	27	32	7	11	11	26	5	10

Chi Square = 1.8858
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

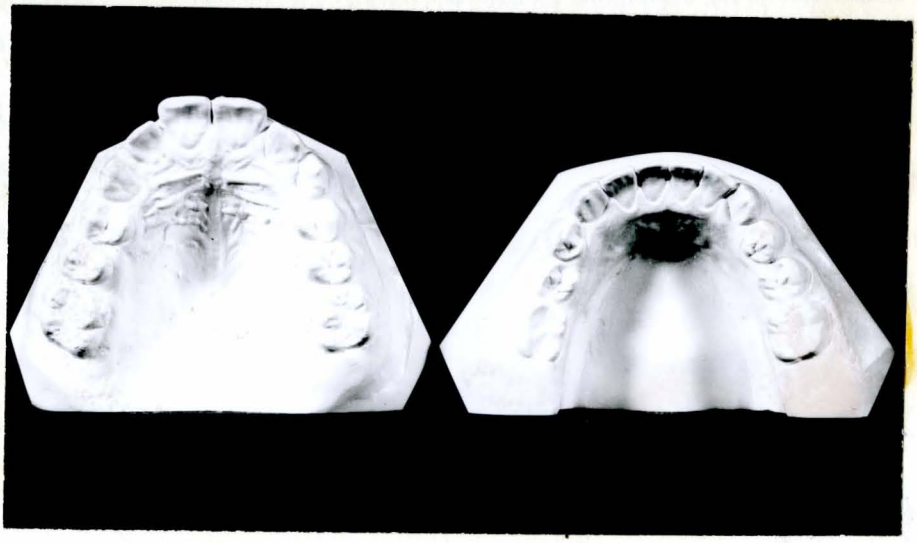
Exp. 1		Exp. 4
6	Masseter first	5
0	Masseter and middle temporal first	1
0	Masseter and posterior temporal first	1
0	Middle temporal first	0
2	Middle and posterior temporal first	1
0	Posterior temporal first	1
4	All together (synchronous)	3
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 8
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 9 (C.R.) Age 10

Angle Classification of Malocclusion: Class II - Division I



Subject # 9

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a differential forces arch with only two loops, one placed mesial to each cuspid.

2. The mandibular archwire was a differential forces arch with only two loops, one placed mesial to each cuspid.

3. The elastics used were of the three types mentioned in methods and materials (page 20). There were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of multiburst activity, moderate amplitude in the temporals, and low amplitude in the masseters, moderate duration, distinct noding, sustained low amplitude activity in the masseters, moderate rate of onset and ending, and minimal interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in amplitude in the temporal muscles, an increase in duration, and a decrease in the rate of onset. The other qualities showed no apparent differences. This subject seems to be trying a little harder to bite through the cough drop.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 10.3174. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing strokes in Experiment I showed that the masseter muscles initiated the activity 2 out of 9 times; and middle and posterior temporal muscles initiated the activity 2 out of 9 times; and the three muscles studied acted about the same time 5 out of 9 times. (Series B Chew right Vicks missing). Experiment IV shows that the middle and posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 45-95% of the chewing cycle with the greatest frequency occurring at the 65-75 percentile. In Experiment IV the duration of the chewing stroke ranged from 35-100% of the chewing cycle with the greatest frequency occurring at the 55-65 percentile. The results from the bar graph indicate that there was a slight decrease in the duration of the chewing stroke. Conclusion: This subject, though she appeared to be biting harder, seemed to have adapted to the treatment.

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	multibursts	multibursts	0
Amplitude	mass. - x temp. - xx	mass. - x temp. - xxx	mass. - 0 temp. - x
Duration	xx	xxx	x
Noding	xxx	xxx	0
Sustained low amp.	masseters	masseters	0
Rate of onset	xx	x	x
Rate of ending	xx	xx	0
Interim activity	x	x	0

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	27	26	23	30	8	8	8	16	1	8
Exp. 4	27	25	27	26	3	12	10	3	2	10

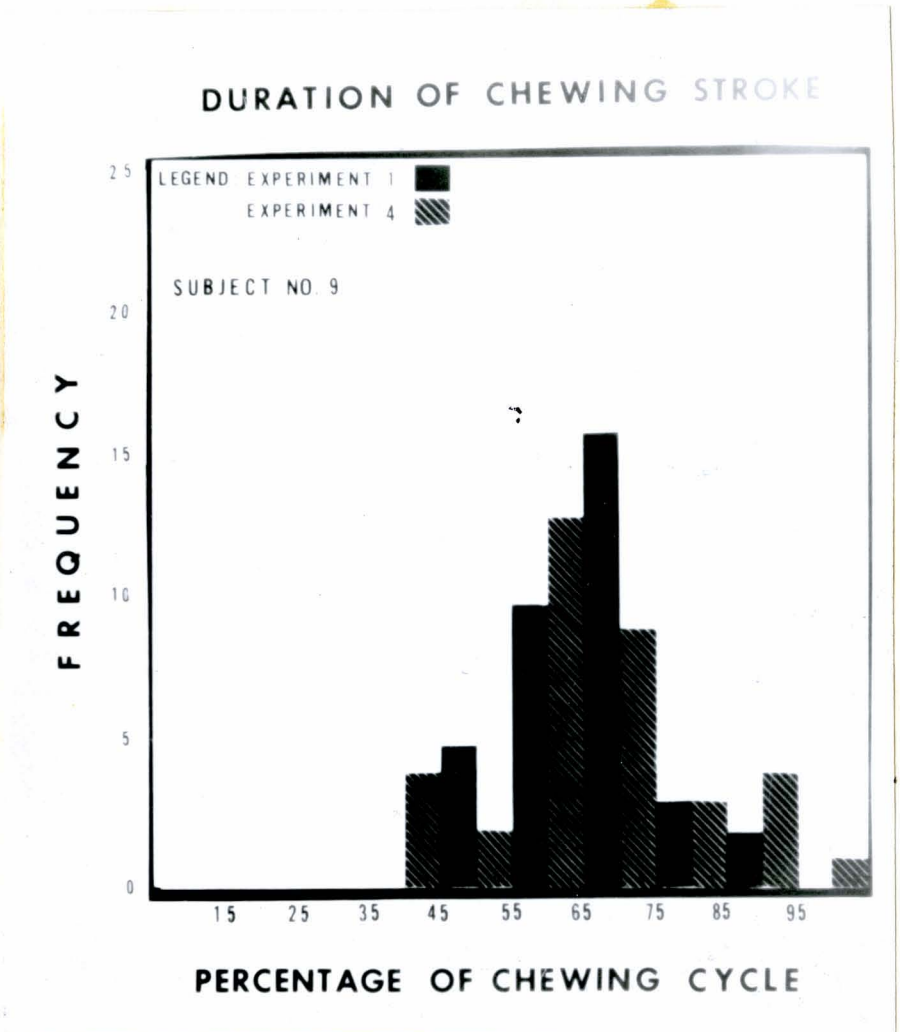
Chi Square = 10.3174
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

Exp. 1		Exp. 4
2	Masseter first	0
0	Masseter and middle temporal first	0
0	Masseter and posterior temporal first	0
0	Middle temporal first	1
2	Middle and posterior temporal first	6
0	Posterior temporal first	1
5	All together (synchronous)	4
9	Total number of chewing strokes *	12

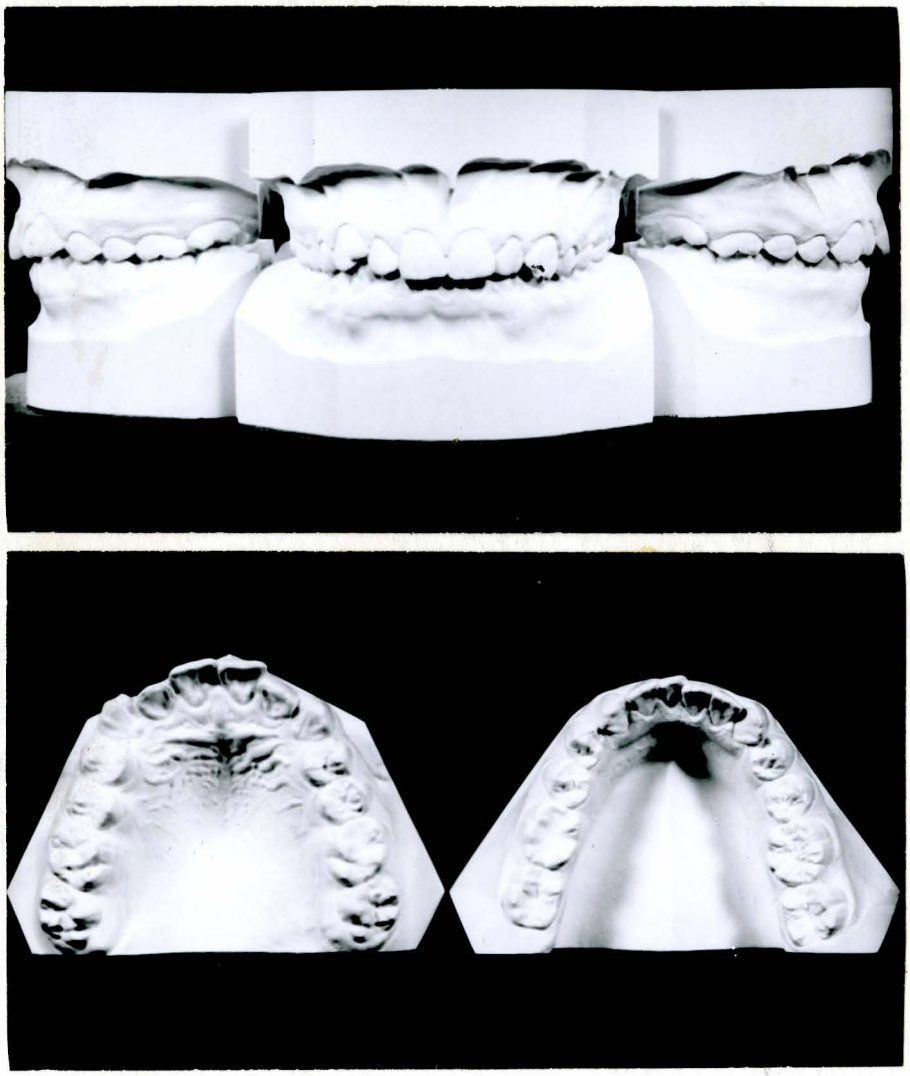
* Series B chew right Vick's is missing


DURATION OF CHEWING STROKE
LEGEND EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 9
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 10 (H.S.) Age 14

Angle Classification of Malocclusion: Class I



Subject # 10

Treatment:

A. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a straight (horizontal) arch with no attachments.

2. The mandibular arch was a straight (horizontal) arch with headgear attachments and headgear to the lower arch.

3. The elastics used were of type three mentioned in methods and materials (page 20). They were worn in a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 2-3 bursts, high amplitude, short duration, indistinct noding, sustained low amplitude activity in the masseters, moderate rate of onset, rapid rate of ending, and minimal interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in the number of bursts, a decrease in amplitude, an increase in duration and noding, a decrease in the sustained low amplitude activity of the masseter muscles, and an increase in the degree of interim activity, especially in the posterior temporal muscles. The other qualities showed no apparent differences. This subject seems to show an altered muscular behavior. This is probably due to altered periodontal proprioception.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 13.5316. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing strokes in Experiment I showed that 2 out of 12 times the masseter acted first; and 5 out of 12 times the three muscles acted at about the same time. Experiment IV shows that the posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 45-85% of the chewing cycle with the greatest frequency occurring at the 55-65 percentile. In Experiment IV the duration of the chewing stroke ranged from 45-100% of the chewing stroke with the greatest frequency occurring at the 65-75 percentile. The results from the bar graph indicates that there was an increase in the duration of the chewing stroke. Conclusion: The subject seemed to show a change in the behavior of the muscles involved. This is probably due to altered periodontal proprioception.

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	2-3	2-6	x
Amplitude	xxx	xx	x
Duration	x	xx	x
Noding	x	xx	x
Sustained low amp.	x(masseter)	0	x
Rate of onset	xx	xx	0
Rate of ending	xxx	xxx	0
Interim activity	x	xx(posterior temporal)	x

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

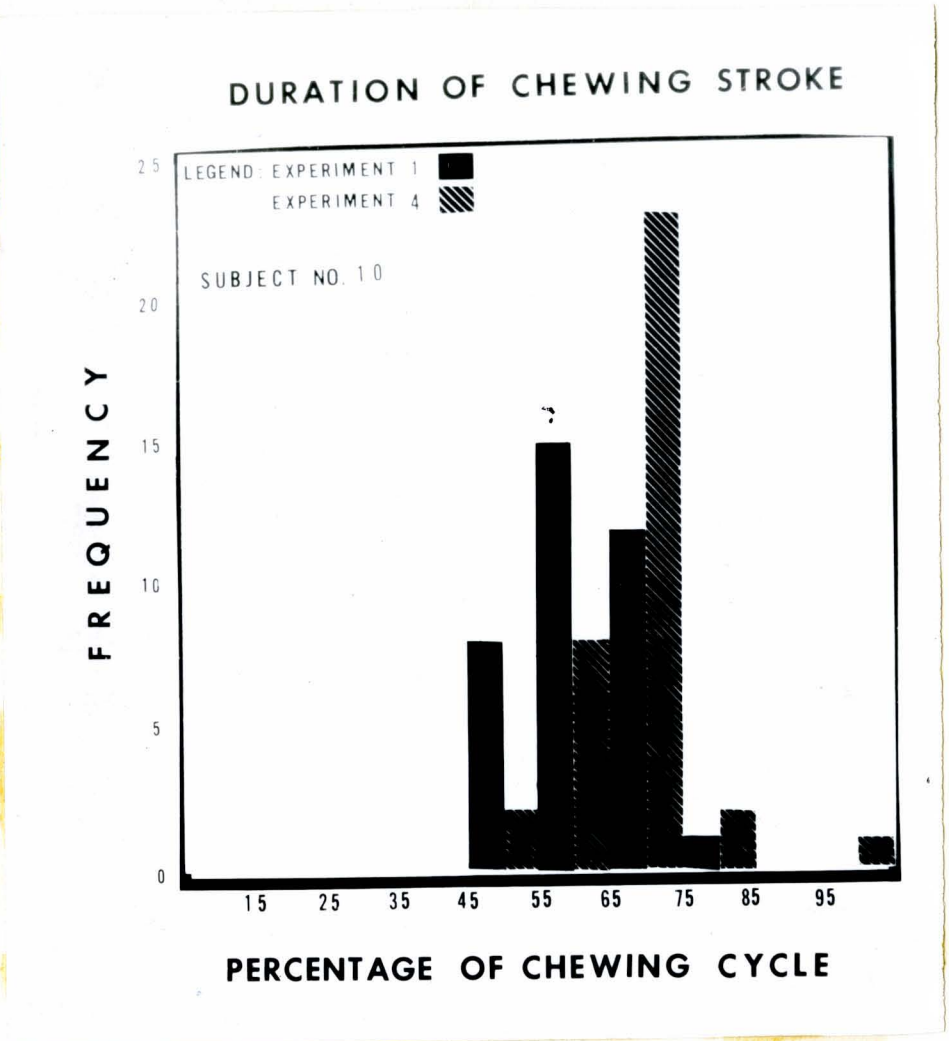
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	19	25	29	33	4	9	9	7	2	5
Exp. 4	33	35	28	28	11	11	11	10	12	20

Chi Square = 13.5316
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

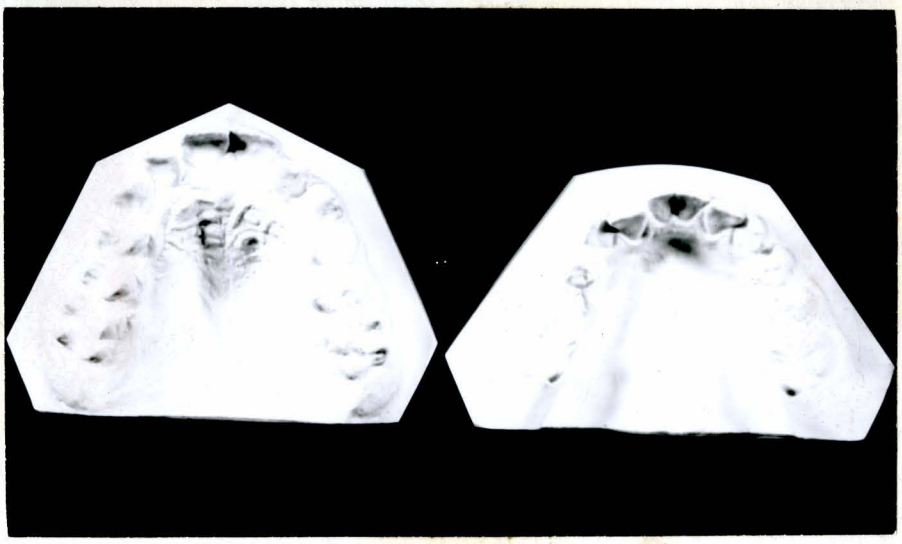
Exp. 1		Exp. 4
2	Masseter first	0
1	Masseter and middle temporal first	1
0	Masseter and posterior temporal first	0
1	Middle temporal first	0
3	Middle and posterior temporal first	3
0	Posterior temporal first	2
5	All together (synchronous)	6
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 10
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 11 (E.S.) Age 12

Angle Classification of Malocclusion: Class II - Division I



Subject # 11

Treatment:

A. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a straight (horizontal) arch with no attachments.

2. The mandibular archwire was a straight (horizontal) arch with headgear attachments and headgear to the lower arch.

3. The elastics used were of type three mentioned in methods and materials (page 20). They were worn in a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of multiburst "searching" activity, moderate amplitude except the right masseter which was low, moderate duration on the right side and long duration on the left side, fairly distinct noding, sustained low amplitude activity in the right masseters, moderate rate of onset and ending, and maximal interim activity in the right masseters and moderate degree in the other muscles.

Experiment IV as compared to Experiment I showed that there was an increase in the number of multiburst searching patterns, a decrease in the sustained low amplitude activity of the masseter muscles and an increase of the degree of interim activity in the posterior temporal muscles. The other qualities showed no apparent differences. This subject seemed to be having slightly more trouble chewing after the archwires were placed.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 4.6980. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing strokes in Experiment I showed that 3 out of 12 times the masseter acted first; 7 out of 12 times the three muscles studied acted at about the same time. Experiment IV shows that the posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-100% of the chewing cycle with the greatest frequency occurring at the 45-55 percentile. (9 out of 36 chews or attempts, fell in the 100% category). In Experiment IV the duration of the chewing stroke ranged from 25-100% of the chewing stroke with the greatest frequency occurring at the 45-55 percentile. (9 out of 36 chews fell in the 100% category). The results from the bar graph indicates that there was little change in the duration of the chewing stroke. Conclusion: This subject presented myograms which seemed to indicate that she was able to adapt to the placement of archwires.

#11 E.S. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	multiburst "searching"	more multiburst "searching"	x
Amplitude	xx	xx	0
Duration	rt. side - xx lt. side - xxx	xx-xxx	0
Noding	xx	xx	0
Sustained low amp.	right mass.	0	x
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	rt. mass. - xxx others - xx	xxx(mass. & post. temporal)	x

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

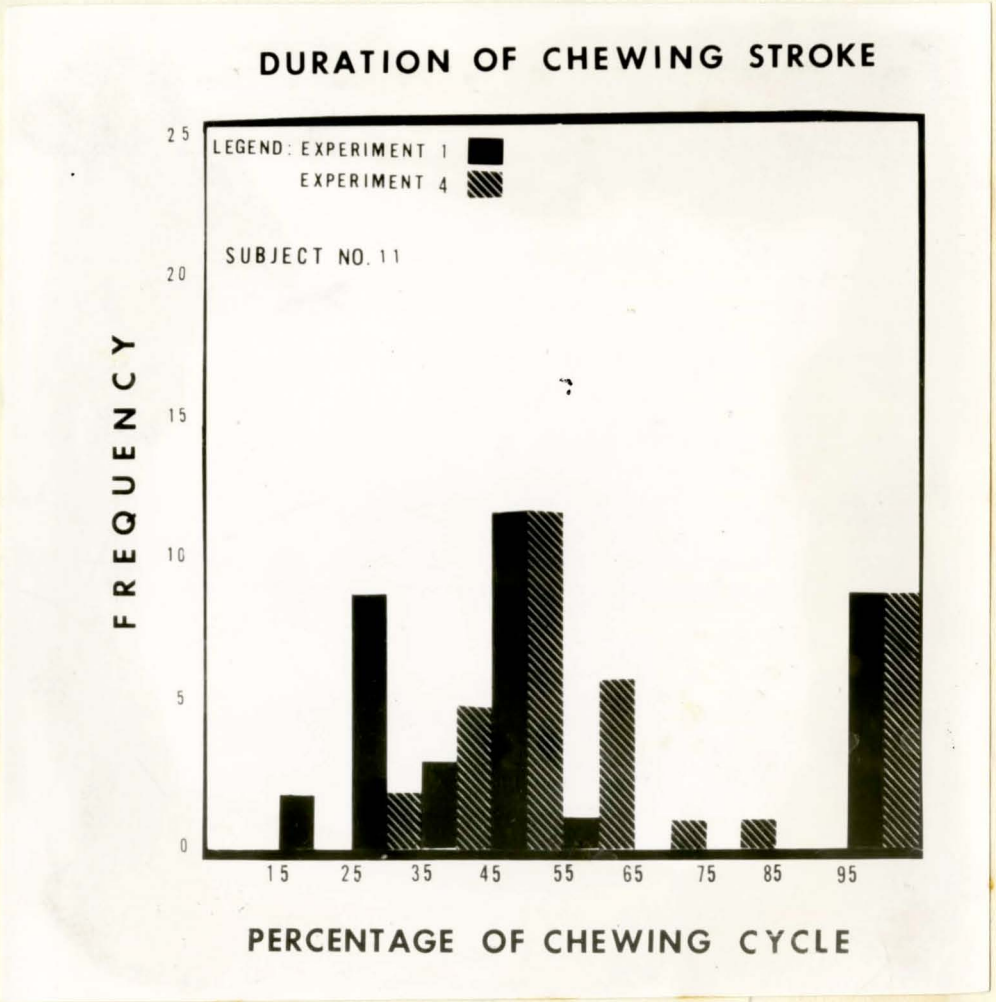
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	24	28	31	27	7	11	11	18	17	18
Exp. 4	32	30	29	30	10	11	11	33	24	36

Chi Square = 4.6980
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

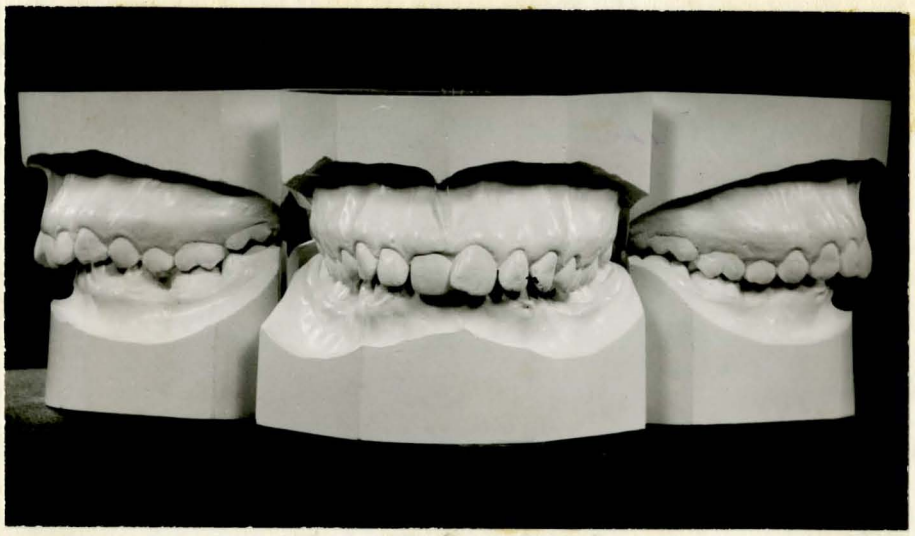
Exp. 1		Exp. 4
3	Masseter first	2
1	Masseter and middle temporal first	0
0	Masseter and posterior temporal first	0
0	Middle temporal first	0
1	Middle and posterior temporal first	2
0	Posterior temporal first	3
7	All together (synchronous)	5
12	Total number of chewing strokes	12

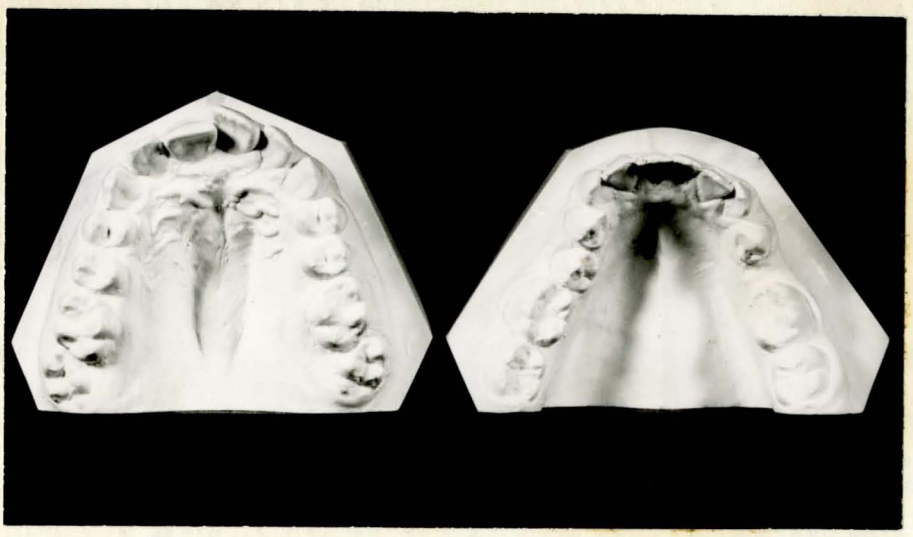

DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 11
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 12 (J.S.) Age 14

Angle Classification of Malocclusion: Class II - Division I





Subject # 12

Treatment:

A. Appliance design - (see methods and materials page 19).

1. The maxillary archwire was a straight (horizontal) arch with no attachments.

2. The mandibular archwire was a straight (horizontal) arch with headgear attachments and headgear to the lower arch.

3. The elastics used were of type 3 mentioned in methods and materials (page 20). They were worn in a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of multiburst activity on the right and few bursts on the left, moderate amplitude on the right, and high amplitude on the left side, moderate duration on the right and short duration on the left, indistinct noding on the right and fairly distinct noding on the left, no sustained low amplitude activity, moderate rate of onset and ending, and maximal interim on the right side and minimal on the left side.

Experiment IV as compared to Experiment I showed that there was an increase in duration on the left side, a decrease in noding on the left side and change in the character and degree of interim activity to continuous low amplitude activity on both sides from maximal interim activity on the right side and minimal interim activity on the left side. The other qualities showed no apparent differences. The activity of the chewing stroke seemed to be more prolonged and of lower amplitude in Experiment IV.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 1.1819. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing strokes in Experiment I showed that 5 out of 12 times the masseter muscle initiated the activity; the rest of the time onset was varied. Experiment IV shows that the middle and posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-100% of the chewing cycle with the greatest frequency occurring at the 65-75 percentile. In Experiment IV the duration of the chewing stroke ranged from 35-100% of the chewing stroke with the greatest frequency between 45-85 percentile. The results from the bar graph indicated that there was a slight change in the duration of the chewing stroke. Conclusion: This subject seemed to show some alteration in the behavior of the temporal and masseter muscle. This was probably due to altered periodontal proprioception.

#12 J.S. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	multiple on rt. side fewer bursts on lt. side	multiple on rt. side	0
Amplitude	xx - rt. side xxx- lt. side	xx - rt. side xxx- lt. side	0
Duration	xx - rt. side x - lt. side	xxx- rt. side xx - lt. side	x
Noding	x - rt. side xx - lt. side	x - rt. side x - lt. side	x
Sustained low amp.	0	0	0
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	xxx - rt. side x - lt. side	continuous low activity	x

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

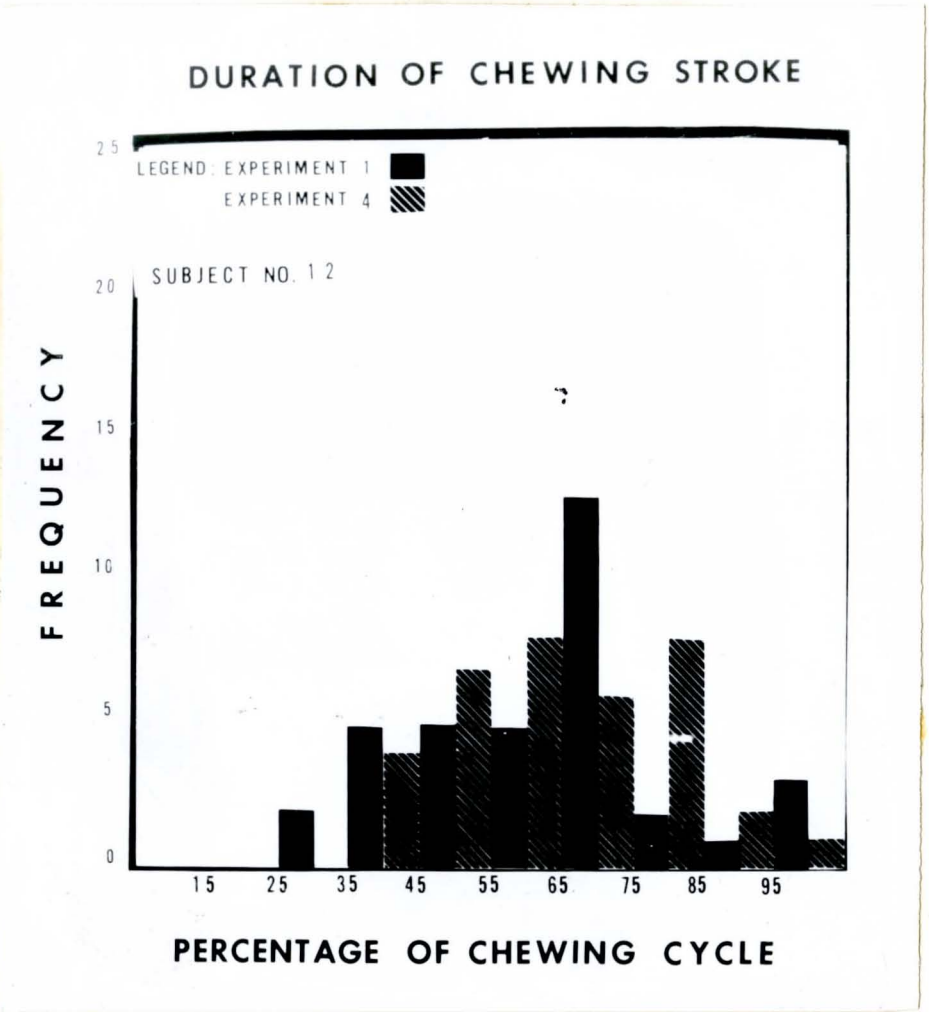
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	30	30	27	30	9	11	11	33	18	19
Exp. 4	29	32	28	28	8	11	10	24	12	20

Chi Square = 1.4819
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

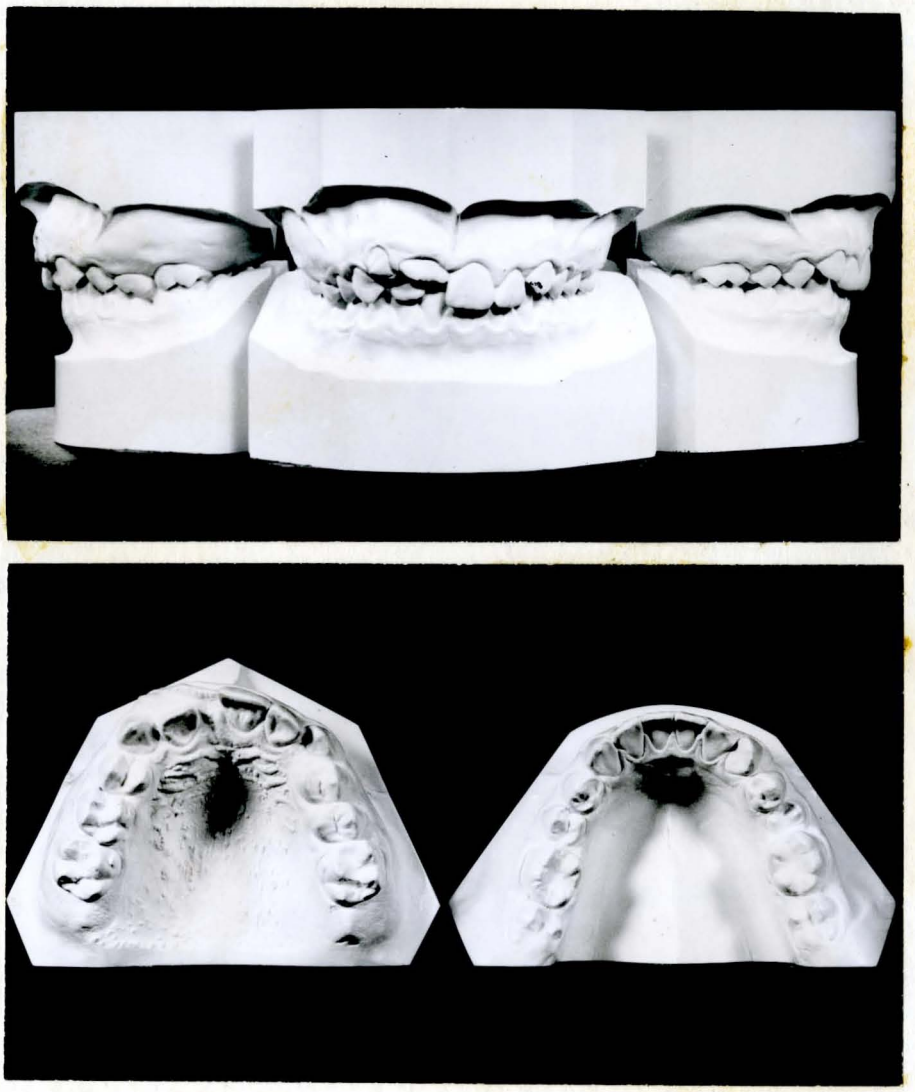
Exp. 1		Exp. 4
5	Masseter first	2
1	Masseter and middle temporal first	0
1	Masseter and posterior temporal first	1
0	Middle temporal first	1
2	Middle and posterior temporal first	3
0	Posterior temporal first	1
3	All together (synchronous)	4
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 12
FREQUENCY
0
5
10
15
20
25
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 13 (A.S.) Age 11

Angle Classification of Malocclusion: Class II - Division I



Subject # 13

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a differential forces arch with three loops. Two loops were on either side of the right lateral incisor, and the other loop was mesial to the left cuspid tooth.

2. The mandibular archwire was a differential forces arch with only two loops, one mesial to each cuspid tooth.

3. The elastics used were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 2-3 bursts, high amplitude, moderate duration, fairly distinct noding, no sustained low amplitude activity, moderate rate of onset and ending, and maximal interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in the number of bursts, and the amount of noding, but a moderate decrease in the degree of interim activity. The other qualities showed no apparent differences. This subject showed some change in the characteristics of the myograms.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics os the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 24.5547. Statistically, this means that there was a significant difference between experiments at the 95% confidence level. This is the only subject that showed a difference.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing stroke in Experiment I showed that 6 out of 12 times the masseters initiated the chewing stroke; 3 out of 12 times the three muscles studied acted at about the same time. Experiment IV shows that the muscles acted at about the same time more often, and the masseter muscles became less active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 35-95% of the chewing cycle with the greatest frequency occurring at the 45-55 percentile. In Experiment IV the duration of the chewing stroke ranged from 25-85% of the chewing stroke with the greatest frequency occurring at the 55-65 percentile. The results of the bar graph indicated that there was an increase in the duration of the chewing stroke. Conclusion: The subject presented myograms which seemed to show a change in the behavior of the temporal and masseter muscles. This may be due to altered periodontal proprioception.

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	2-3	2-5	x
Amplitude	xxx	xxx	0
Duration	xx	xx	0
Noding	xx	xxx	x
Sustained low amp.	0	0	0
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	xxx	x	xx

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

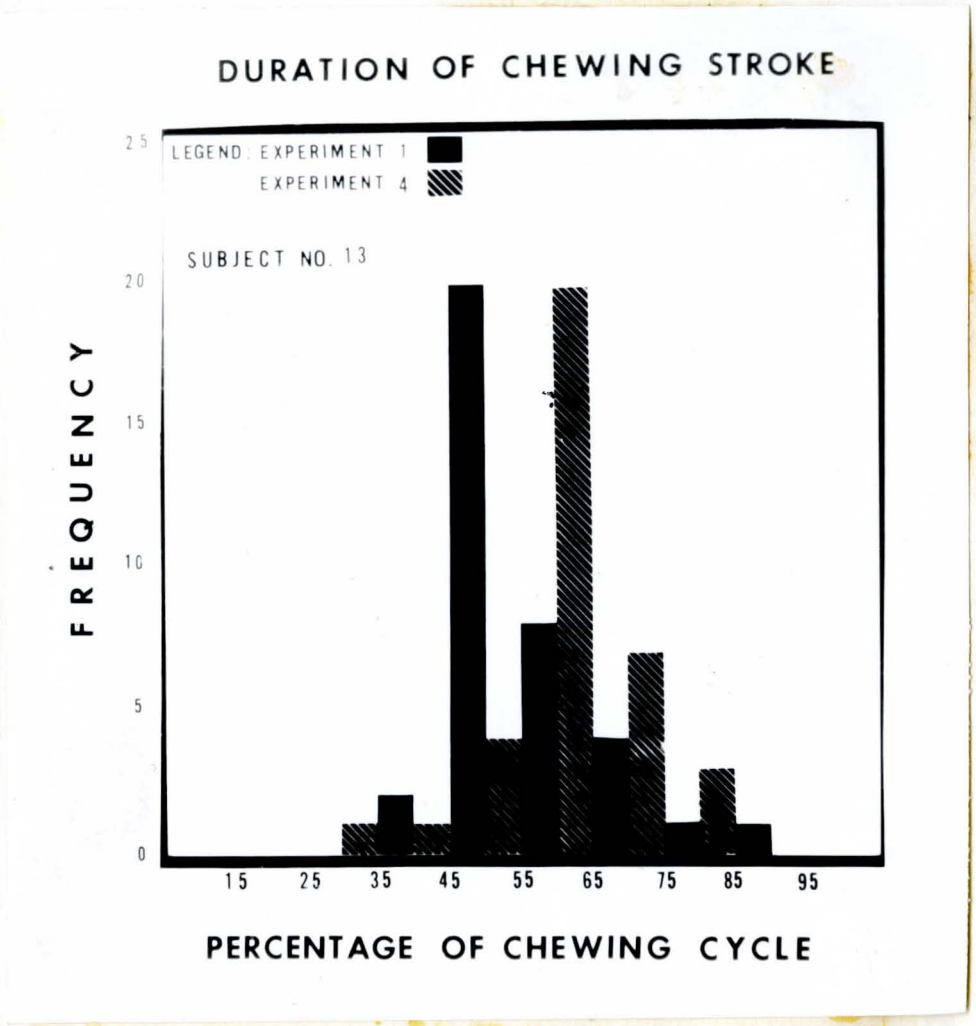
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	27	27	24	26	7	10	10	34	19	21
Exp. 4	35	35	30	31	11	12	12	11	3	11

Chi Square = 24.5547
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

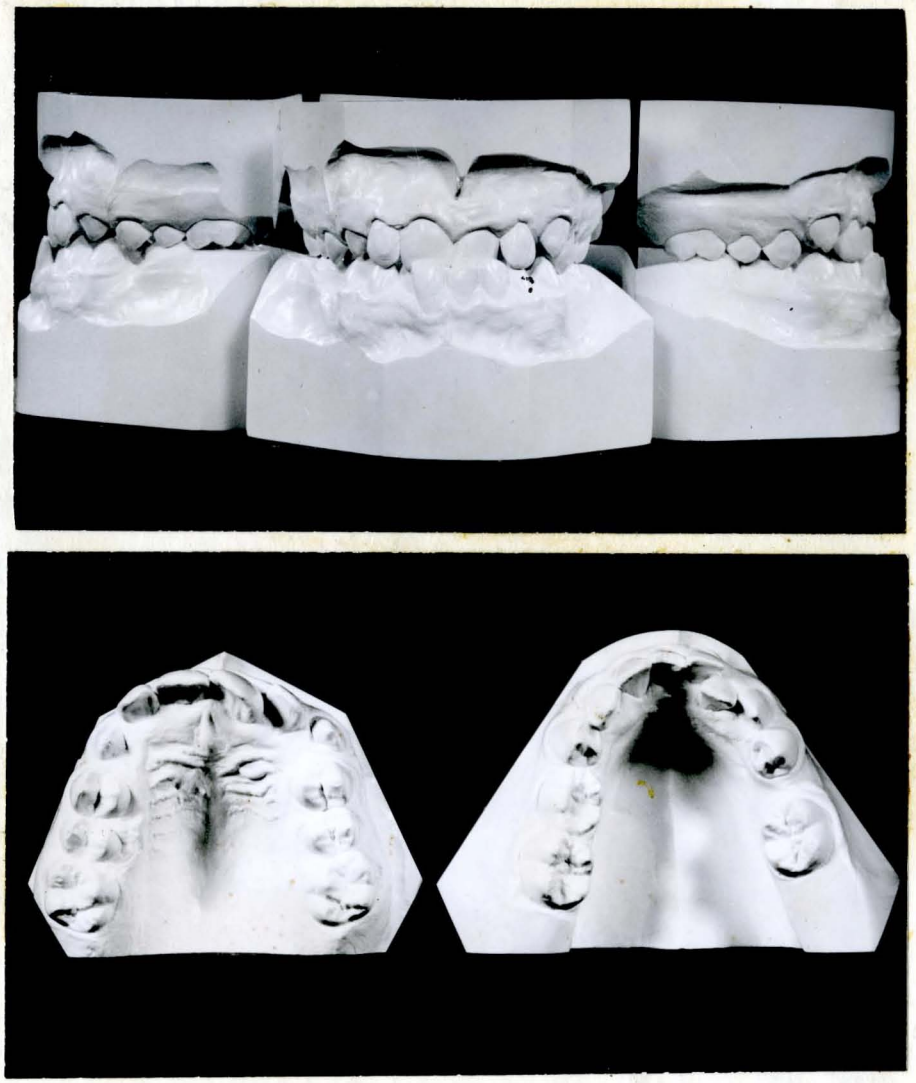
Exp. 1		Exp. 4
6	Masseter first	3
1	Masseter and middle temporal first	1
1	Masseter and posterior temporal first	0
0	Middle temporal first	0
1	Middle and posterior temporal first	2
0	Posterior temporal first	0
3	All together (synchronous)	6
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 13
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 14 (D.T.) Age 12

Angle Classification of Malocclusion: Class I, pseudo Class III



Subject # 14

Treatment:

A. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a differential forces arch with only two loops, one mesial to each cuspid tooth.

2. The mandibular archwire was a straight (horizontal) arch with headgear attachments and headgear to the lower arch.

3. The elastics used were of type three mentioned in methods and materials (page 20). They were worn in a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 2-6 bursts, moderate amplitude, and duration, distinct noding, sustained low amplitude activity in the right middle temporal, in the first chewing stroke of all the masseters, moderate rate of onset and ending, and minimal interim activity.

Experiment IV as compared to Experiment I showed that there was an increase of duration on the left side, a decrease in the sustained low amplitude activity of the masseter muscles and right middle temporal muscles, and an increase in the degree of interim activity. The other qualities showed no apparent differences. The subject seemed to show chewing strokes with more continuous activity.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 13.8604. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing stroke in Experiment I showed that the masseters acted first 6 out of 12 times; the rest of the time onset was varied. Experiment IV shows that the muscles acted at about the same time more often, the posterior fibers of the temporal became more active and the masseter muscles became less active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-75% of the chewing cycle with the greatest frequency occurring at the 55-65 percentile. In Experiment IV the duration of the chewing stroke ranged from 25-95% of the chewing stroke with the greatest frequency between 25-75 percentile. The results from the bar graph indicates that there was little change in the duration of the chewing stroke. Conclusion: The patient seemed to be trying to find the most advantageous position to chew the cough drop.

#14 D.T. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	2-6	3-6	0
Amplitude	xx	xx	0
Duration	xx	xx - rt. side xxx - lt. side	x
Noding	xxx	xxx	0
Sustained low amp.	mass. & lst mid. temp. (lst chew stroke)	0	x
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	x	xx	x

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

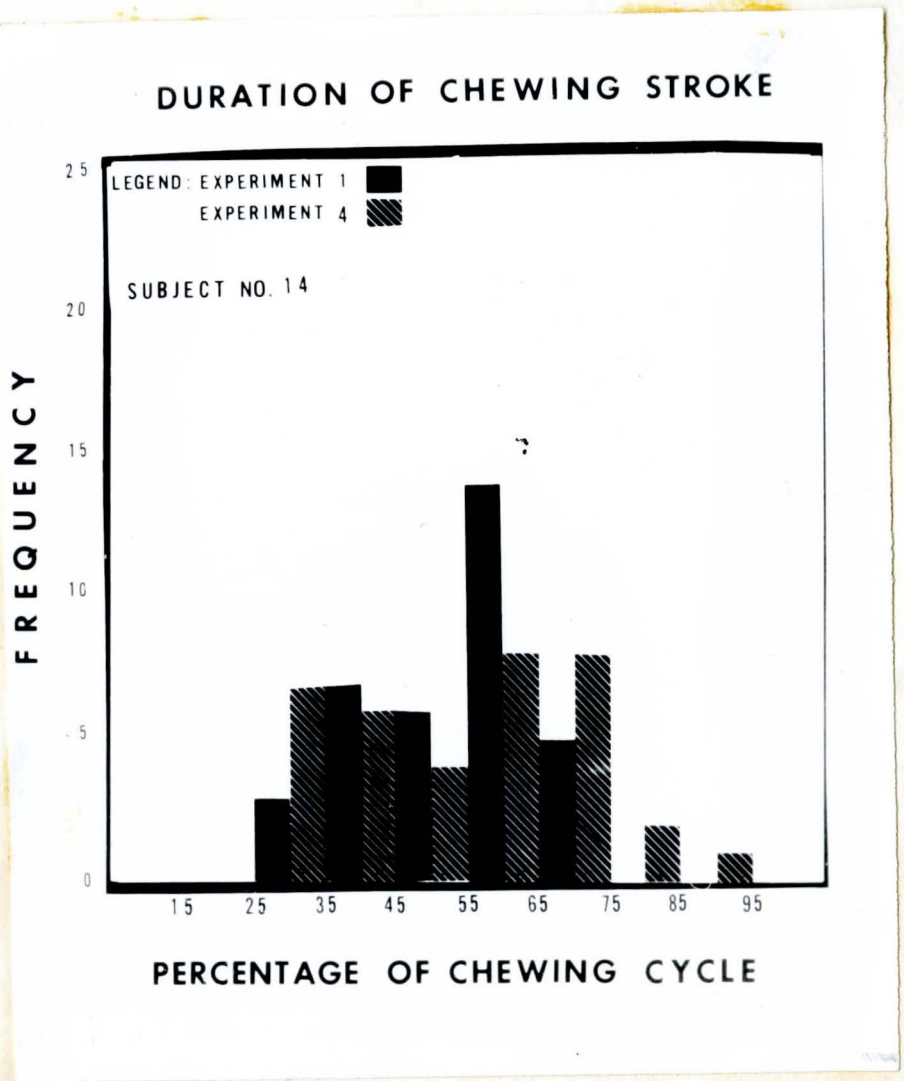
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	33	32	26	38	11	11	8	9	4	2
Exp. 4	29	29	29	31	9	11	11	14	1	17

Chi Square = 13.8604
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

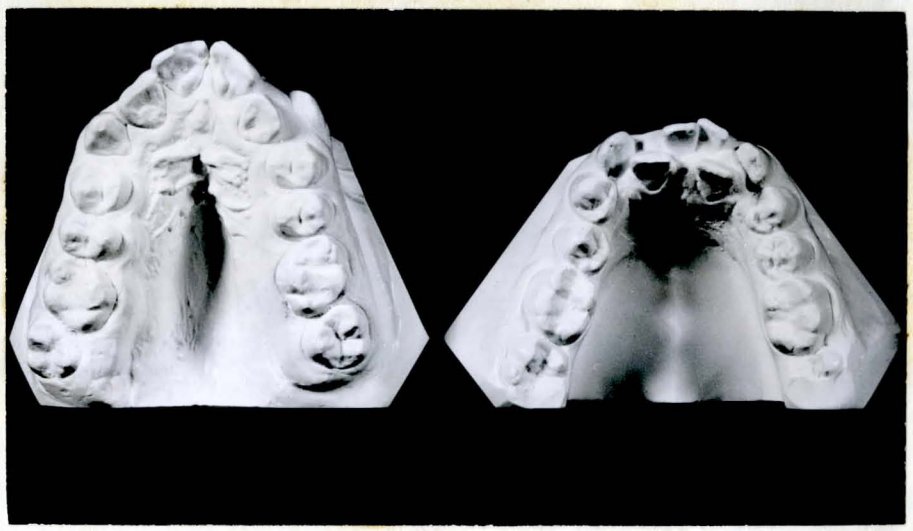
Exp. 1		Exp. 4
6	Masseter first	0
0	Masseter and middle temporal first	0
1	Masseter and posterior temporal first	0
1	Middle temporal first	0
2	Middle and posterior temporal first	2
0	Posterior temporal first	5
2	All together (synchronous)	5
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 14
FREQUENCY
25
20
15
10
5
0
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 15 (J.V.) Age 14

Angle Classification of Malocclusion: Class II - Division I



Subject # 15

Treatment:

A. Extract the four first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a typical forces arch.

2. The mandible archwire was a differential forces arch with four loops. This is quite similar to the archwire in Figure 6, except there is no loop between the central incisor teeth.

3. The elastics used were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 1-6 bursts, moderate amplitude and duration, fairly distinct noding, sustained low amplitude activity in the posterior temporals, moderate rate of onset and ending, and minimal interim activity.

Experiment IV as compared to Experiment I showed that there was an increase in the number of bursts, amplitude, duration, amount of noding, and a slight increase in the degree of interim activity on the right side. The other qualities showed no apparent differences. This subject seemed to be have a difficult time chewing.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 2.4443. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity of the chewing strokes in Experiment I showed that 3 out of 12 times the masseter muscle initiated the activity; the rest of the time the muscle acted at about the same time. All three muscles initiated the chewing stroke a greater number of times in Experiment IV.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 25-85% of the chewing cycle with the greatest frequency occurring at the 45-55 percentile. In Experiment IV the duration of the chewing stroke ranged from 35-100% of the chewing stroke with the greatest frequency between 65-85 percentile. The results from the bar graph indicate that there was an increase in the duration of the chewing stroke. Conclusion: The subject seemed to have a difficult time chewing in Experiment IV. This could be due to altered periodontal proprioception.

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	1-6	multiburst	x
Amplitude	xx	xxx	x
Duration	xx	xxx	x
Noding	xx	xxx	x
Sustained low amp.	x post. temp.	x post. temp.	0
Rate of onset	xx	xx	0
Rate of ending	xx	xx	0
Interim activity	x	slight increase on the rt. side	x(slight)

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

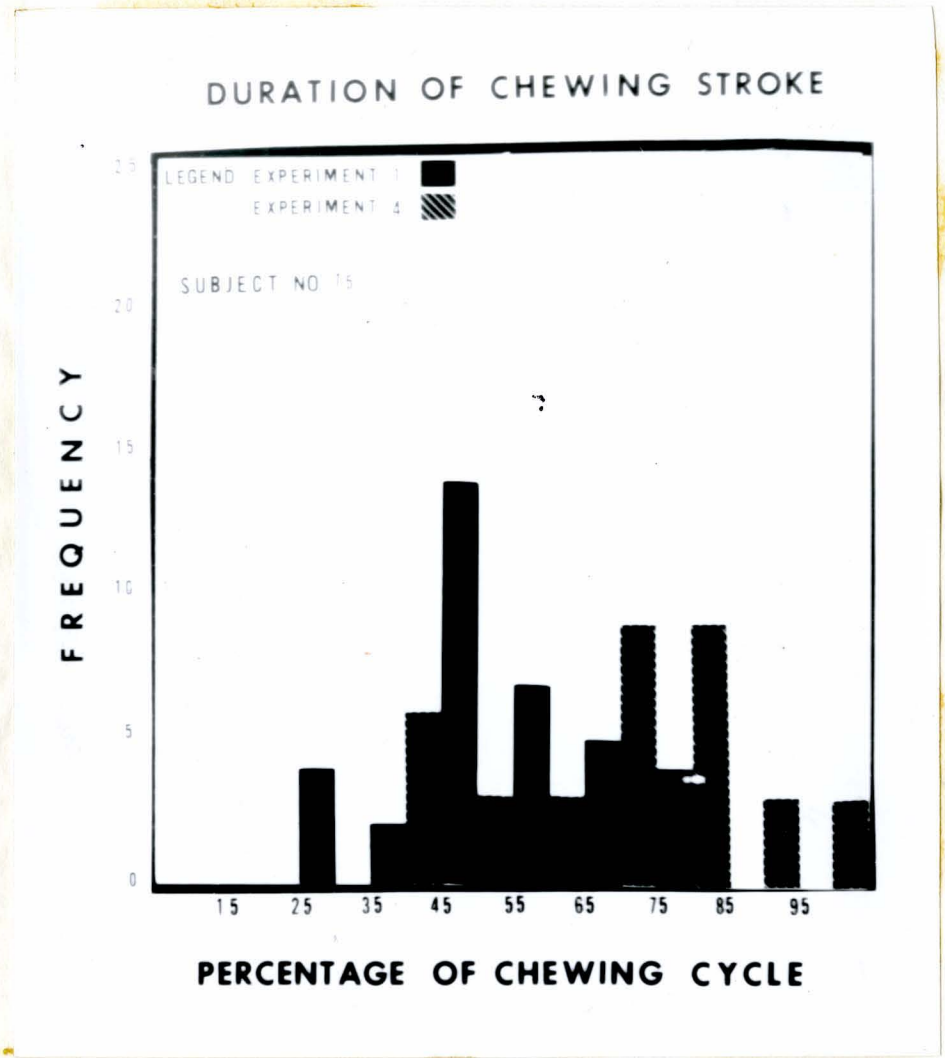
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	17	23	22	23	7	5	7	17	6	9
Exp. 4	25	27	34	30	8	10	8	16	14	18

Chi Square = 2.4443
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

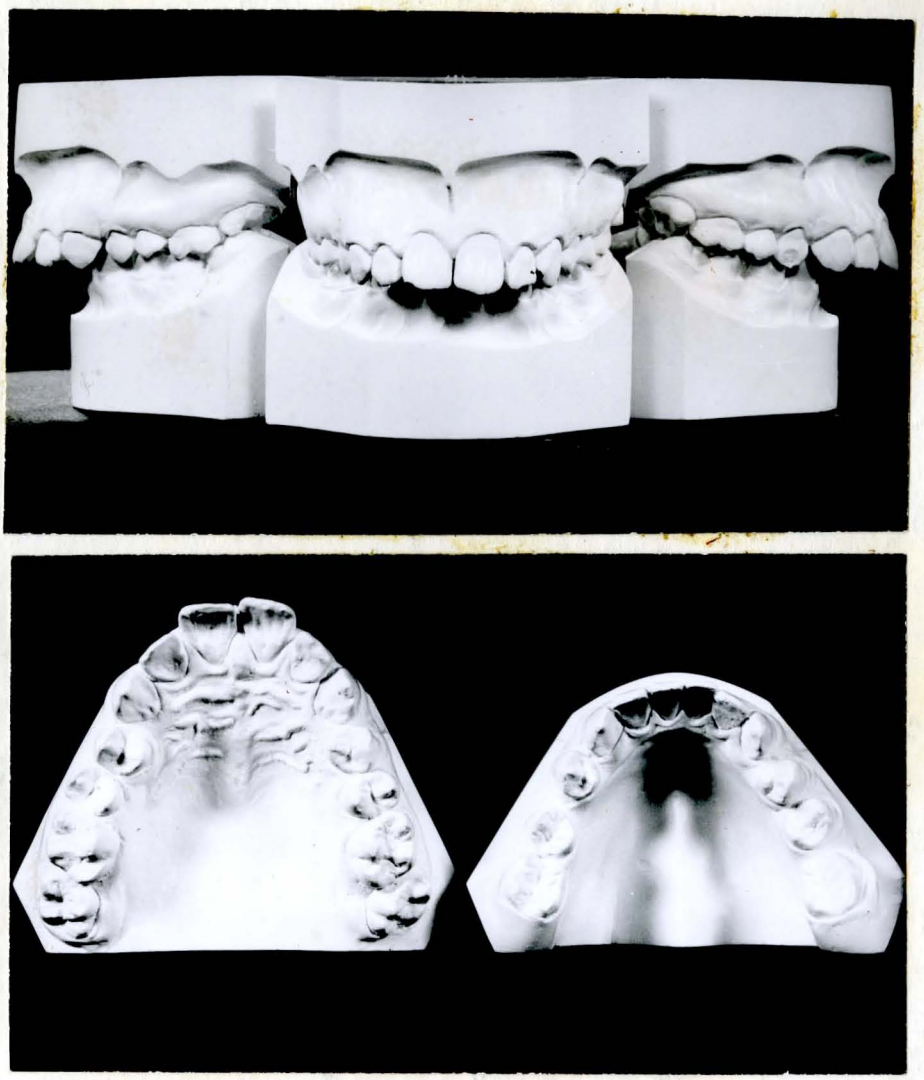
Exp. 1		Exp. 4
3	Masseter first	0
0	Masseter and middle temporal first	1
0	Masseter and posterior temporal first	0
1	Middle temporal first	0
1	Middle and posterior temporal first	1
1	Posterior temporal first	0
6	All together (synchronous)	10
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO 15
FREQUENCY
0
5
10
15
20
25
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

FINDINGS

Subject # 16 (J.W.) Age 12

Angle Classification of Malocclusion: Class II - Division I



Subject # 16

Treatment:

A. Extract the maxillary first premolars

B. Appliance design - (see methods and materials page 19)

1. The maxillary archwire was a differential forces arch with only two loops, one mesial to each cuspid tooth.

2. The mandibular archwire was a straight (horizontal) arch with no attachements.

3. The elastics worn were of type 2 and 3 mentioned in methods and materials (page 20). There were intramaxillary elastics in the mandibular arch, and between the arches, elastics were worn in a Class II and a triangular fashion.

Chart I

Comparison of the Characteristics of Myograms Between Experiments

Experiment I presented myograms of 2-6 bursts of low amplitude, short duration, indistinct noding, sustained low amplitude activity in all the muscles, slow rate of onset and ending, and minimal interim activity.

Experiment IV as compared to Experiment I showed that the myograms changed to a pattern which had sustained low amplitude activity of long duration. The other qualities showed no apparend differences. This subject seemed to chew cautiously.

Chart II

Comparison of the Similarity of Myograms Between Experiments

The dissimilarity of certain characteristics of the myograms between Experiments I and IV was put to the Chi-Square test of significance. The value obtained was 10.5195. Statistically, this means that there was no significant difference between experiments at the 95% confidence level.

Chart III

Comparison of Onset of Activity Between Experiments

The onset of activity in Experiment I showed that 3 out of the 12 times the middle temporal and posterior temporal acted first; 3 out of 12 times the posterior temporal acted first; and 3 out of 12 times all muscles acted at about the same time. Experiment IV shows that the posterior fibers of the temporal muscles became more active in initiating the chewing stroke.

Chart IV

Comparison of the Duration of the Chewing Strokes Between Experiments

The duration of the chewing stroke in Experiment I ranged from 15-85% of the chewing cycle with the greatest frequency occurring at the 35-45 percentile. In Experiment IV the duration of the chewing stroke ranged from 35-100% of the chewing cycle with the greatest frequency occurring at the 95-100 percentile. The results from the bar graph indicates that there is a marked increase in the duration of the chewing stroke. Conclusion: The subject did not seem to be exerting much force during the chewing exercises. This could be due to experiencing pain during the exercises.

#16 J.W. THE BEHAVIOR OF THE MASSETER AND TEMPORAL MUSCLES

CHART 1. COMPARISON OF THE CHARACTERISTICS OF MYOGRAMS BETWEEN EXPERIMENTS

	Experiment 1	Experiment 4	Difference
Bursts	2-6(low level)	lower sustained	x
Amplitude	x		0
Duration	x		xx
Noding	x		0
Sustained low amp.	xxx		x
Rate of onset	x		0
Rate of ending	x		0
Interim activity	x		0

Legend: xxx = maximum, xx = moderate, x = minimum, 0 = no obvious change

CHART 2. COMPARISON OF CONCURRENCE AND SIMILARITY OF MYOGRAMS BETWEEN EXPERIMENTS

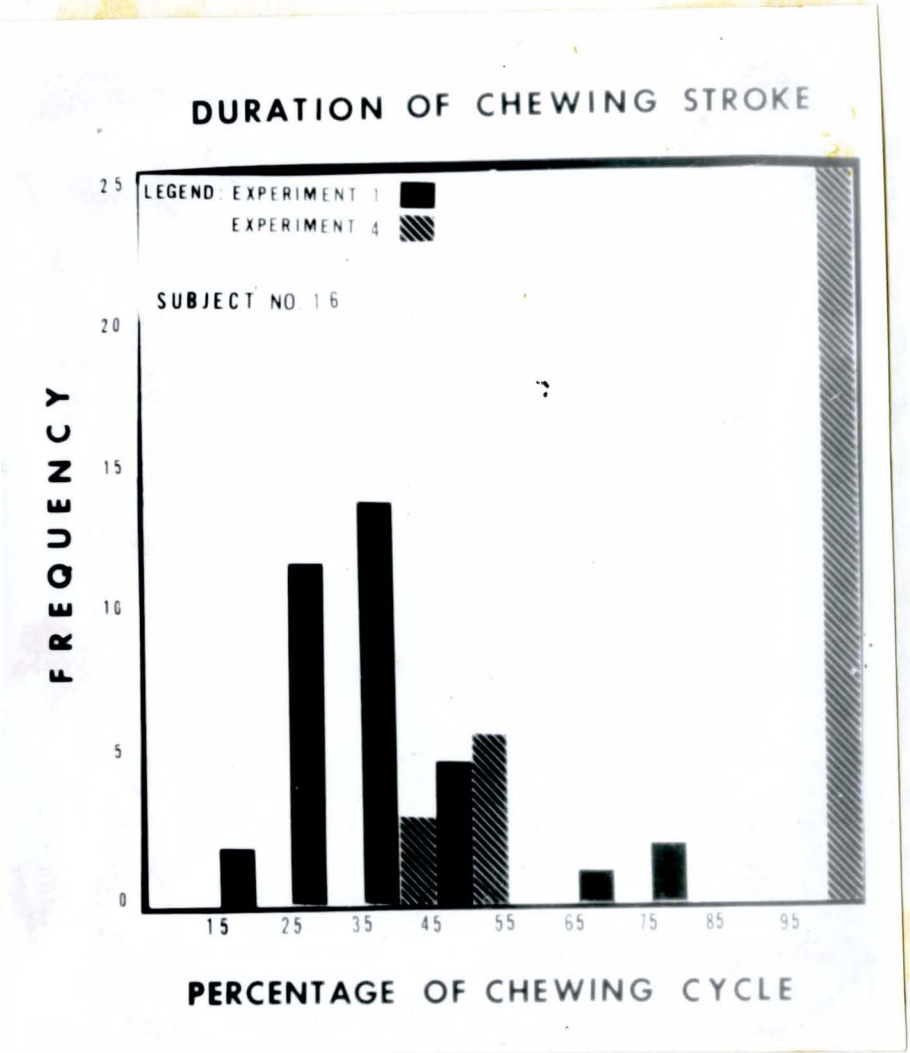
	Concurrence				Similarity					
					Form			Interim Activity		
	Nodes	Peaks	Onset	End	Mass.	M.Temp.	P.Temp.	Mass.	M.Temp.	P.Temp.
Exp. 1	25	22	25	25	11	11	7	14	12	14
Exp. 4	31	24	26	33	3	12	12	6	6	15

Chi Square = 10.5195
Degree of Freedon = 9.
Significance level at .05 = 16.92

CHART 3. COMPARISON OF ONSET OF ACTIVITY BETWEEN EXPERIMENTS

MUSCLES

Exp. 1		Exp. 4
1	Masseter first	1
1	Masseter and middle temporal first	0
1	Masseter and posterior temporal first	0
0	Middle temporal first	0
3	Middle and posterior temporal first	9
3	Posterior temporal first	0
3	All together (synchronous)	2
12	Total number of chewing strokes	12


DURATION OF CHEWING STROKE
LEGEND: EXPERIMENT 1
EXPERIMENT 4
SUBJECT NO. 16
FREQUENCY
0
5
10
15
20
25
15
25
35
45
55
65
75
85
95
PERCENTAGE OF CHEWING CYCLE

CHAPTER IV

DISCUSSION

A. General Consideration

This study was undertaken as the third part of a longitudional electromyographic study designed to investigate the effect of orthodontic treatment on muscular behavior of the temporal and masseter muscles. Sixteen individuals having various types of malocclusion (Angle) were asked to chew a "Vicks" cough drop ten times. The action potentials from the muscles of the ipsilateral side were recorded for each chewing stroke, but only the myograms from the first three chewing strokes of each chewing cycle were evaluated. This evaluation consisted of comparing the myograms taken before the onset of orthodontic treatment with the myograms taken one week after placement of the first orthodontic appliance.

The first phase of this longitudinal study consisted of placing separating wires and taking myograms one day later. The results of this study reported by Widen (1960) showed that some change in the normal behavior of muscles took place incident to this phase of treatment. Asahino (1960) reporting on Part II, one week after placement of separating wires, found that the subjects had apparently adapted to the treatment procedure.

This part of the study deals with patients who have had an orthodontic appliance on their teeth for one week. This fixed appliance utilizes light highly

resilient archwires and latex elastics to effect tooth movements.

B. Interpretation of the Findings

The characteristics of the myograms were studied by subdividing the form of a myogram into bursts of activity, and periods of comparative quiesence we called nodes. The amplitude of the bursts was assessed and sustained low amplitude activity was noted when it occured. The onset and end of the activity and duration of each chewing stroke were evaluated. Interim activity, that activity occuring between chewing strokes, was also studied qualitatively.

All of the findings presented may not be found in any one subject since they represent the result of combining the individual responses of 16 subjects.

C. Similarity of Certain Characteristics

The results of the statistical test of significance for similarity and dissimilarity of certain characteristics of the myograms, showed that there was no difference between Experiment I and IV, in all but one patient. (See Chart III, subject # 13). This means that there was no difference when the individual characteristics were grouped and tested.

D. Characteristics of the Myograms

1. Bursts of Activity

In general, there was an increase in the number of bursts between Experiments I and IV. This was pointed out by the fact that no patients in Experiment

IV showed myograms of few bursts, where as 6 subjects (see Chart I, subjects no. 1, 3, 4, 5, 10, and 13.) in Experiment I yielded myograms of few burst patterns.

2. Nodes

Noding showed little change between Experiments I and IV since it was rated on distinctness. Distinct noding depends on either a relative decrease of amplitude between bursts of activity, or a decrease of amplitude to the base line. Thus one could see that even though an increase in the number of bursts would automatically increase the number of nodes, it would not necessarily increase their distinctness.

Jarabak (1954) studied the form of myograms in a manner similar to that described in methods and materials. He reported brief pauses between groups of electrical activity. He attributed these pauses to a protective proprioceptive reflex mechanism who's receptors are located in the periodontal membrane and in the muscles. In our study, brief pauses are referred to as nodes and groups of activity as bursts.

The increase in the number of bursts could be due to altered proprioceptive stimuli resulting from orthodontic tooth movement and would indicate the subject was having difficulty chewing.

It is possible that nodes are due to a reflex inhibitory stimuli as described by Sherrington (1917), Corbin and Harrison (1940) and Jarabak (1954).

3. Amplitude

There was a slight change in amplitude between Experiments. The low amplitude activity exhibited in the masseter muscles of some patients in Experiment

I remained just about as prevelant in the same muscles in Experiment IV. Two patients (subject no. 8 and 16), however, exhibited continuous low amplitude activity in all muscles in Experiment IV. It is possible that the sustained low amplitude activity is caused by the subject experiencing pain or fearing that pain will result from biting the cough drop with a force great enough to crush it. O'Rourke and Miner (1953) state that pain or fear of pain is the factor which controls the expression of the biting power.

E. Onset of Muscular Activity

It was found that about half of the time the muscles to initiate the chewing stroke acted similiarly within 1/40 of a second. The other half of the time it was evident in Experiment I that the masseter muscles were most active in initiating the chewing strokes. In Experiment IV the posterior fibers of the temporal muscles were most active in initiating the chewing strokes. The increased activity in the posterior fibers of the temporal muscle in Experiment IV may be due to the subject trying to find an advantageous position to chew the cough drop. In those cases in which teeth have been extracted, the changes may also have been due to the patient trying to keep the hard material away from the extraction site.

F. End of Muscular Activity

The muscular activity of a chewing stroke tapered off more slowly in Experiment IV than in Experiment I. This was enhanced by an increase in the

number of individuals exhibiting continuous activity for 100% of the chewing cycle. (See chart 4, subjects no. 3, 7, 9, 10, 11, 12, 15, and 16.) We may postulate from this that these patients were chewing very cautiously.

G. Interim Activity

Because the sound recordings aided us in determining when the teeth came into contact with the cough drop during the chewing exercises, it became possible to determine the onset and the end of the activity of a chewing stroke. It was evident that there was some electrical activity present between the chewing strokes that was not associated with the closing stroke. This activity was called interim activity. It was of varying amplitude, and duration. Sometimes it was of high amplitude, other times it was of low amplitude, the duration was either short or long. A few times the activity was so long that one could not distinguish the interim activity from the end of the activity of the last chewing stroke or the beginning of the next.

Three major types of interim activity could be distinguished: 1) Short bursts of activity occuring immediately after the chewing stroke. This may be due to central rebound as described by Sherrington (1917). 2) Bursts of activity of short duration occuring about half way between closing strokes. This may be due to the myotatic (stretch) reflex as described by Sherrington (1894). 3) Interim activity of long duration which may be similar to the spontaneous hyperactivity described by Jarabak (1956).

In Experiment 4, 8 out of 16 patients (no. 4, 7, 8, 10, 11, 12, 14, and 15) showed an increase of interim activity. This may be due to some spontaneous

hyperactivity after exercise since the patient seemed to find it more difficult to chew.

H. Duration

There was some increase in the duration of the activity of the chewing stroke, when it was assessed grossly and when graphs were made for each individual (see methods and materials). The duration of the chewing strokes observed in the bar graphs (Chart 4) either remained the same, or seemed to increase in 13 out of 16 subjects. It should be noted that in Experiment I only two patients (see Chart 4, subjects no. 11 and 12) exhibited sustained activity for 100% of the chewing cycle, but in Experiment 4, 9 subjects (see Chart 4, subjects no. 3, 7, 8, 9, 10, 11, 12, 15, and 16) had sustained actively for 100% of the chewing cycle.

It seems that an increase in the duration of activity of the chewing cycle stroke would indicate that the subject was having a more difficult time chewing. This could be expected since archwires were activity moving the teeth and probably altering the proprioceptive stimuli from the periodontal membrane.

A general analysis of muscular behavior of the aforementioned characteristics to the effect of orthodontic treatment, shows about one half of the subjects exhibited no observable changes in myographic characteristics, while the other half did show changes in the pattern of muscular behavior. Those subjects in which little or no change was observed very likely showed a rapid adaptation to tooth movement as described by Sicher (1953). Those subjects in

whom differences in muscular behavior did occur appeared to be having a more difficult time chewing. The reason for this may be due to alterations in the periodontal sensory mechanism.

CHAPTER V

CONCLUSIONS AND SUMMARY

A. Summary

This study is the third part of an electromyographic study comparing the behavior of the temporal and masseter muscle before separating wires and during orthodontic appliance therapy. It investigates the effect of placing light resilient archwires and light elastic forces for one week. Sixteen subjects presenting varying degrees of malocclusion chewed "Vicks" cough drops while electromyograms were recorded from the ipsilateral side. The behavior of the temporal and masseter muscle one week after placement of the appliance has been compared with the behavior of these muscles before treatment. Half of the subjects did not show a notable difference. The experimental results from the subjects which did show a difference were partially attributed to altered periodontal proprioception.

B. Conclusions

1. Some of the subjects which seemed to have adapted to the placement of separating wire between the teeth in Part II of this longitudional study, Asahino (1960), again show an altered pattern of muscular behavior.
2. Half of the subjects show similar patterns of muscular behavior in Experi-

ments I and IV.

3. The group of subjects in Experiment IV showing a change in muscular behavior presented myograms with:

   a. An increase in the duration of a chewing stroke.

   b. An increase in the number of bursts (groups) of electrical activity in the myograms of the chewing strokes.

   c. The temporal muscle, especially the posterior fibers, showing a more active role in initiating the activity of a chewing stroke.

   d. The masseter muscle showing a less active role in initiating the activity of a chewing stroke.

4. There was little difference in the similarity of certain characteristics of the myograms between Experiments I and IV. (One out of sixteen subjects showed a difference.)

5. The appearance of changes in this study could be attributed in part to altered periodontal proprioception.

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APPROVAL SHEET

The thesis submitted by Dr. Richard John Shanahan has been read and approved by four members of the Departments of Anatomy and Oral Anatomy.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Science.

5-18-66
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