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### EMG and its possible use in the treatment of vertical imbalance

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## EMG and its possible use in the treatment of vertical imbalance

### Abstract

EMG recordings were measured on the frontalis muscle of nine subjects, two of which were controls. Prism was then placed before the subject's left eye and changes in EMG were recorded. We found substantial changes in only three subjects. The other subjects showed no significant trends with the placement or removal of prisms.

### Degree Type

Thesis

### Degree Name

Master of Science in Vision Science

### Committee Chair

Robert Yolton

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Optometry

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EMG AND ITS POSSIBLE  
USE IN THE TREATMENT  
OF VERTICAL IMBALANCE

A SENIOR THESIS

Presented to

The Faculty of the College of Optometry  
Pacific University

In Partial Fulfillment  
of the Requirements for the Degree  
Doctor of Optometry

by

Wayne R. Conrad

Duane M. Swanz

March 1978

## Acknowledgements

We are grateful to BSK and the Oregon Optometric Association for funding of this project. Also, we would like to extend our appreciation to Dr. Robert Yolton for his technological help and guidance.

Also, for his ability to endure the trials and tribulations of two fourth year optometry students.

ABSTRACT

EMG recordings were measured on the frontalis muscle of nine subjects, two of which were controls. Prism was then placed before the subject's left eye and changes in EMG were recorded. We found substantial changes in only three subjects. The other subjects showed no significant trends with the placement or removal of prisms.

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## INTRODUCTION

Two general uses of electromyographic feedback have emerged so far--its utility in enhancing the control of voluntary muscles where that control has either not been developed or where it is diminished through dysfunction; the second area consists of attempts at achieving low levels of muscle tension with patients who experience chronic tension headaches and chronic anxiety. Other possible uses include the treatment of bronchial asthma, insomnia (Raskin et al, 1973) or any disorder that is associated with muscle tension.

In the past few years, practitioners have found other uses for the EMG (electromyograph). Whereas before its main usage was in the area of therapy, it is now found to be a valuable diagnostic tool. In a study by Dr. Raymond R. Roy, he found that many patients complaining of chronic, severe headache, cervical tension and other related symptoms following head or neck injuries were not malingerers or psychoneurotics. In actuality, they did show a problem which had developed from a latent binocular stress, and would respond with the proper therapy.

With clinically normal subjects it can be shown that prism placed in front of the subject's eyes will show an increase in tension in the frontalis, cervical, and trapezius muscles, using the EMG (Roy 1961). It has now been found in post-whiplash syndromes, that physiotherapy, traction, and



pharmacotherapy designed to relax the posterior cervical tension, are only treating a secondary pain and by use of prolonged monocular occlusion, a latent binocular stress has been shown to be the primary cause and once relieved, then all secondary symptoms cease to exist.

Research has shown that the neck is the primary site of total body posture and orientation in space, along with the extra-ocular muscles and vestibular apparatus. Any type of neck disorder is capable of secondarily altering the postural information.

Eckardt, McLean, and Goodell have shown with electromyographic evidence that neck muscle spasm and severe neck pain can be caused by a continued abnormal stress on the oculorotary muscles (Eckardt, McLean, and Goodell 1943).

An example of how human beings desire to maintain single binocular vision has long been shown in ocular palsies. In the case of a paresis of a vertical acting extraocular muscle, a compensatory torticollis to alleviate the resultant diplopia can occur. In this situation, the neck is being forced into an abnormal position to be able to compensate for a binocular anomaly. Therefore it can be seen that lesions which create binocular stress can, in turn, cause resultant stress in the neck.

Vasilescu and Dieckmann (1975) conducted experiments with EMG on cervical and spinal muscles in relation to torticollis or neural muscular activity. Their interest was mainly in

relation to disease caused by muscular tension in certain muscle groups. They concluded that in the majority of the cases of horizontal and rotary torticollis, a strong spontaneous activity exists in the sternocleidomastoid muscle on the side opposite the deviation of the head, and in the splenius, on the side of the torticollis, and either of these two muscle groups may predominate.

The use of EMG as a feedback technique for relaxation has shown it to be more effective in lowering tension in a specific muscle than either simple verbal instructions or the reduction in tension achieved by the subject's own unaided efforts. Those with higher initial EMG baselines achieved greater reductions in tension than those with lower levels. Coursey (1975) showed that there is a possible limitation of the EMG feedback because of its failure to generalize relaxation across other parts of the body. An integrated recording of multiple muscle groups would probably solve this aspect of the generalization problem. Many researchers have had mixed results, generally finding that EMG feedback training did not generalize outside the laboratory, and that many subjects reached their deepest levels of relaxation by adopting a more passive stance, letting themselves drift, and essentially abandoning the task of lowering the pitch (in this case the EMG feedback was via a variable tone).

Other uses of electromyography in relation to the human visual system were done by Scott and Collins (1973). They

found that during tracking movements where the muscle worked as agonist there is a progressive increase in firing frequency that diminished slightly as the eye attained the new gaze position. The frequency of activity was the same for each fixation position whether that position was attained by saccadic movement or by tracking from the earlier target position.

In this study we investigated the relationship between change in muscle tension and application of vertical prism, using the EMG.

#### APPARATUS

For instrumentation we used a Tektronix single trace oscilloscope and a Princeton PAR #113 low level differential pre-amplifier. Our electrodes were surface, tape on electrodes. Also, loose prisms in a trial frame were used during the procedure.

Room illumination was set at seven footcandles. Patients had a 10 minute adjusting period after the electrodes were attached to help eliminate influences caused by nervous tension from the anxiety of the situation. Patient's eyes were in the primary position to control for variability of readings due to different directions of gaze. The target for these experiments was two black lines which were bisected on a white background to control fusion, at a distance of six meters, Figure 1.

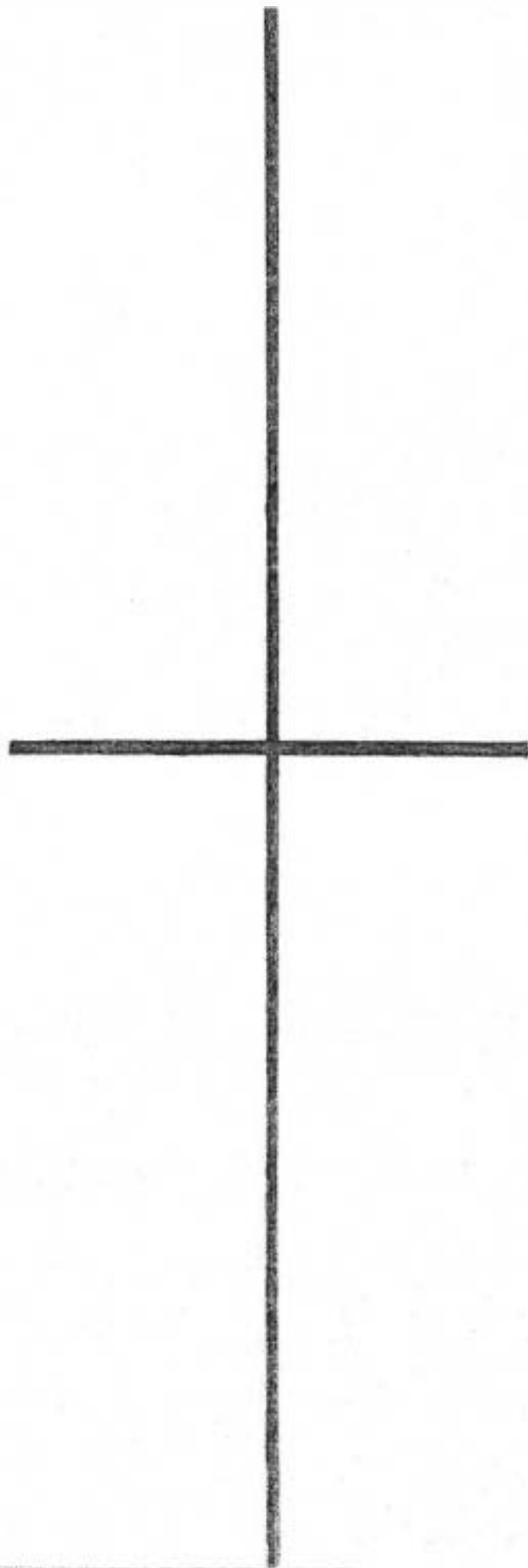


Figure 1.

## METHODOLOGY

Our subjects for this experiment were taken from the student population of Pacific University School of Optometry. We took vertical ductions with rotary prisms and a phoropter. Then we placed a vertical prism before the left eye equal to the base down duction of the left eye. The orientation of the vertical prism was base down left eye.

A baseline level of tension was taken from EMG recordings of the frontalis muscle. Our electrodes, Figure 2, were placed such that there were two grounds, one to each ear lobe. The third electrode, the active one, was placed approximately one and a half inches above the left eyebrow.

The prisms were loose prisms placed before the patient's eye using trial frames. The amount of the prism was unknown to the subjects, thereby minimizing some of the experimental bias. Readings were taken every minute for a period of 50 minutes. The first 10 minutes were to allow the subjects to relax once hooked up to the apparatus. The next 30 minutes were with the prism in place. Then we followed the subjects for another 10 minutes to see if there were any trends that might occur after the prisms were removed. We then plotted the information on a scattergram. This showed us any trends to the data that we have gathered.



Figure 2.

## RESULTS

As can be seen from the graphs (1 & 2), subjects (1), (6), and (9) show a substantial change in the EMG potentials when prisms were introduced before their left eyes, at the ten minute interval. Subjects (1) and (6) showed a decrease in the electrical potential, whereas subject (9) showed an increase. Only subject (1) showed a change in his electrical potential upon the removal of the vertical prism, and this showed up as a decrease in muscle tension. Subjects (4) and (5) were controls. Their graphs show no trends beyond a flat-line progression with allowable variability.

There were no apparent effects due to the prism inducement or removal on subjects (2), (3), (7), and (8). Graph (3) shows all subjects starting from point zero and the change of the EMG from this point. The red line is the mean of the EMG changes.

See Appendix A for raw data.

## DISCUSSION

At the beginning of our thesis we explored the dc (steady state) values of the frontalis, trapezius, levator, and sternocleidomastoid muscles. We did not record any changes in the EMG regardless of the amount of prism used. We were only able to influence the EMG with gross motor movements such as head movements and gross contractions of the frontalis muscle.

Some of the problems we encountered using the dc values were the variations caused by heart beats, blinking and any extraneous body movements.

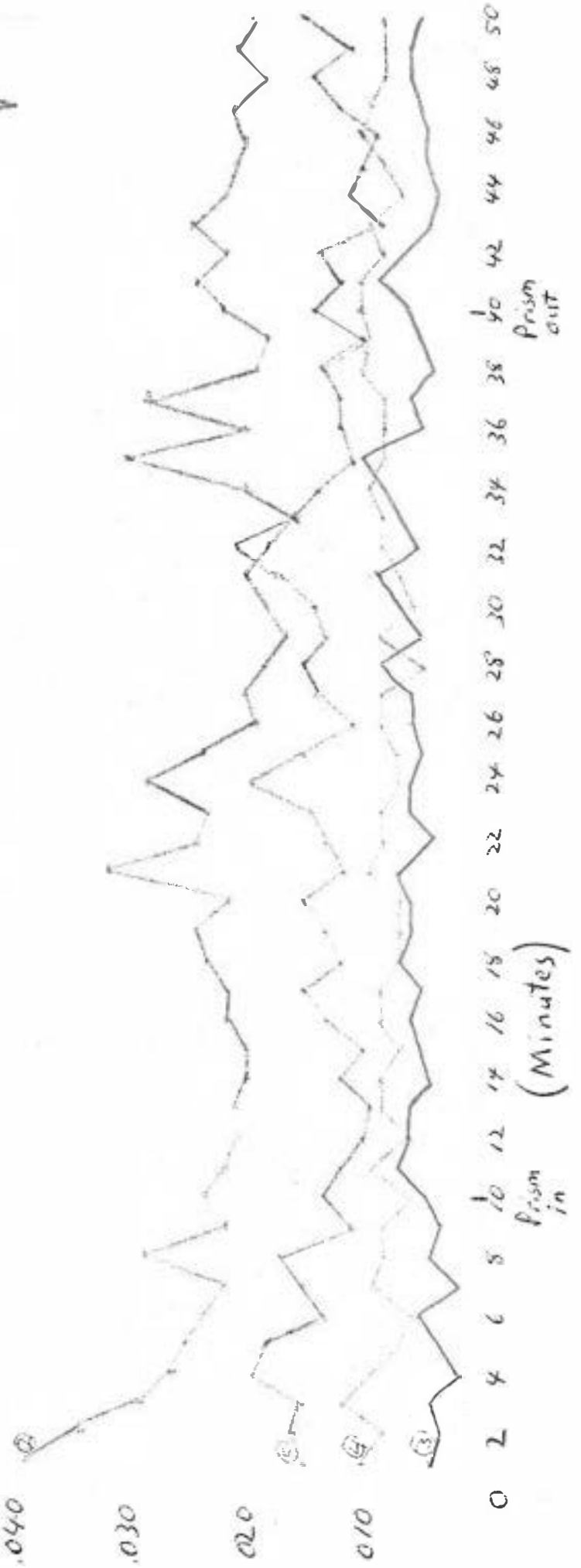
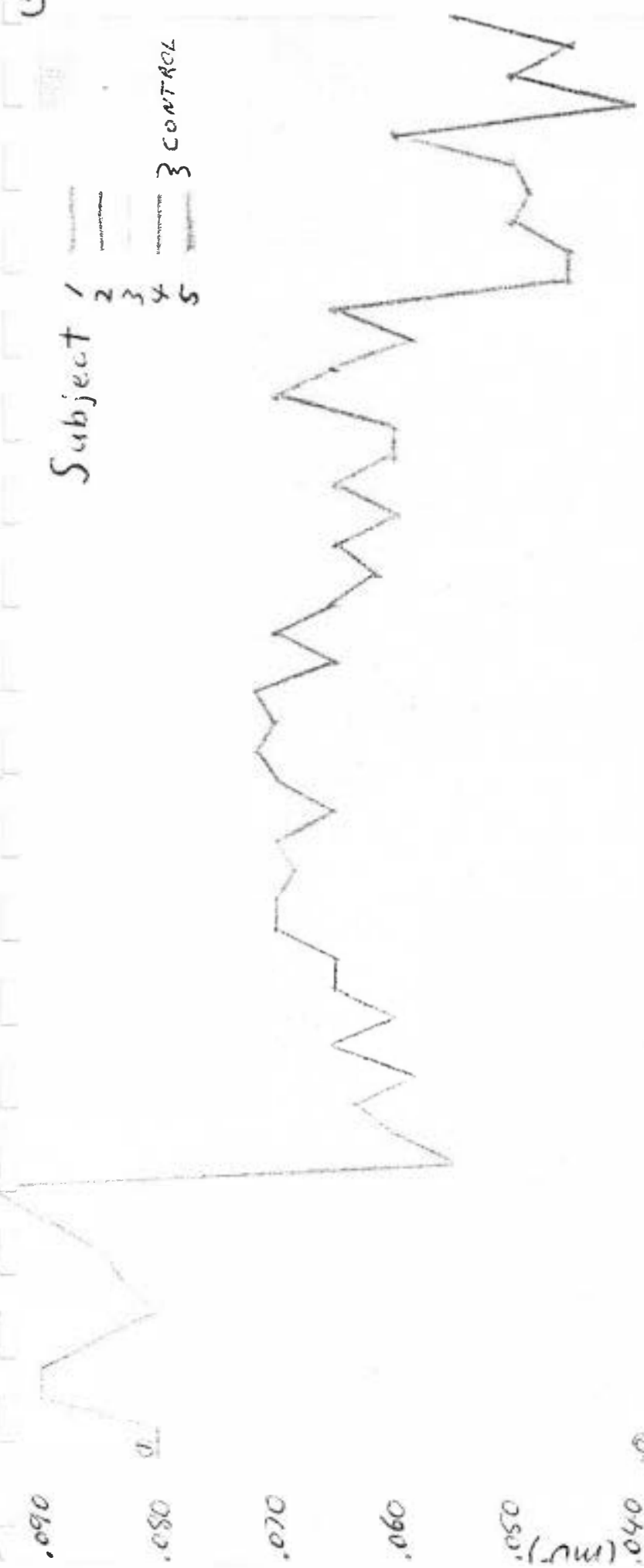
It was at this time we decided to record the ac potentials (spikes) because it better represented the changing neural impulses into the muscles. The frontalis was the muscle of choice because previous literature had indicated that the frontalis would act in a shorter period of time to latent binocular stress. Therefore, it would be more clinically applicable than the previously mentioned muscles.

As can be seen from the plots, three of the subjects showed a substantial change in potentials when prism was placed before the left eye. Four of the subjects showed no substantial changes in their potentials when prisms were introduced. Upon removal of the prisms, only one subject showed a significant change in his potential. Therefore, it would appear that indeed there are changes recorded in some individuals, whereas in others no significant changes occur.

The controls show that our EMG recordings were relatively stable over our time course.

In conclusion, we feel that the EMG is not as reliable as current methods being used for neutralizing vertical imbalance. There may be uses for the EMG in other areas of Optometry, but further investigation will be needed.

Subject 1  
 2  
 3  
 4  
 5 } CONTROL



0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50  
 Prism in (Minutes)  
 Prism out

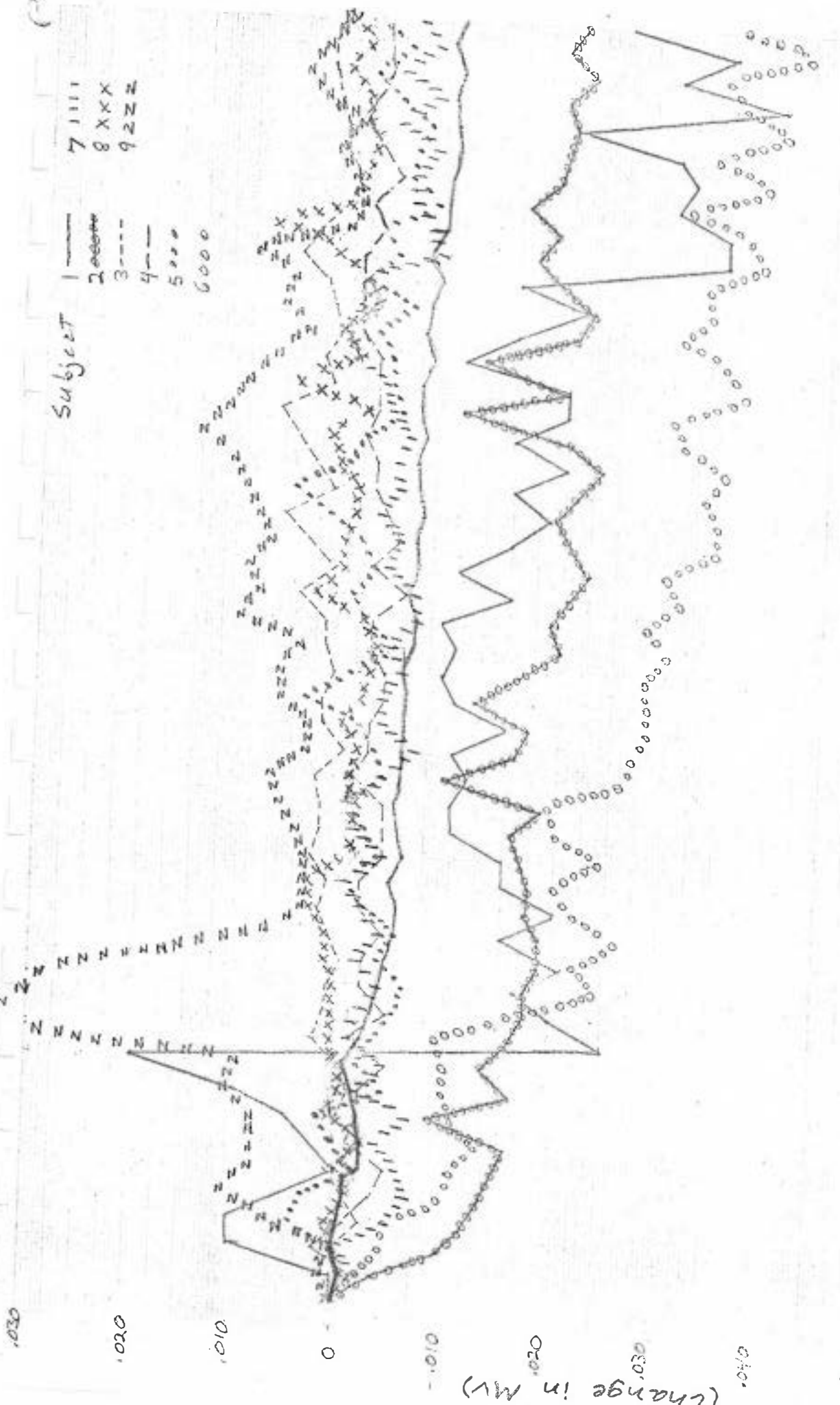




Subject

- 1 —————
- 2 -----
- 3 - - - - -
- 4 - - - - -
- 5 . . . . .
- 6 0 0 0 0

7 1111  
 8 XXXX  
 9 ZZZZ



0 2 4 6 8 10 12 14 16 18 20 22 23 24 26 28 30 32 34 36 40 42 44 46 48 50

(MINUTES)

PRISM IN      PRISM OUT

APPENDIX A

Raw data is included in the copy of our thesis housed at the Pacific University library, Forest Grove, Oregon.

SUBJECT RELEASE FORM

1. Institution

A. Title of Project: EMG and its Possible Use in the Treatment  
of Vertical Imbalance

B. Principle Investigators: Duane M. Swaney  
Wayne R. Conrad  
Dr. Robert Yolton

C. Location: Pacific University College of Optometry

D. Date: 1977

2. Description of Project

This project is designed to determine the feasibility of  
electromyography in neutralizing vertical imbalance.

3. Description of Risks

Data will be gathered using electronic instrumentation.  
The risks are the same as those taken when using any type  
of electronic equipment.

4. Description of Benefits

Depending upon the results of the data gathered, the EMG may  
be another approach at neutralizing vertical imbalance.

5. Offer to Answer any Inquiries

The experimenters will be happy to answer any questions that  
you may have at any time during the course of this study.

6. Freedom to Withdraw

You are free to withdraw your consent and to discontinue  
participation in this project at any time without prejudice  
to you.

I have read and understand the above. I am 18 years of age  
or over.

Signed \_\_\_\_\_ Date \_\_\_\_\_

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