3-1-1977

The effect of reading on intraocular pressure

R Hugh Brumley
Pacific University

John L. Duffy
Pacific University

The effect of reading on intraocular pressure

Abstract

Twenty-three subjects were tested with American Optical's Non-Contact Tonometer under four randomly-sequenced conditions: 1) before and after reading for ten minutes through a +2.00D add; 2) before and after reading for ten minutes through a plano add; 3) before and after reading through a -1.00D add; and 4) before and after a ten minute period during which the subject sat relaxed with a plane add and fixated normally. The mean change in IOP for each of the four conditions was analyzed using a one-tailed analysis of variance and revealed no significant differences among any of the means. Results were discussed with relation to the findings of Armaly and Burian (1958), and Armaly and Rubin (1961).

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Scott E. Pike

Subject Categories

Optometry

THE EFFECT OF READING ON INTRAOCULAR PRESSURE

A THESIS

PRESENTED TO

THE FACULTY OF THE COLLEGE OF OPTOMETRY

PACIFIC UNIVERSITY

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR

DOCTOR OF OPTOMETRY DEGREE

by

R. HUGH BRUMLEY

and

JOHN L. DUFFY

Advisor: Dr. SCOTT E. PIKE

March 1, 1977

Accepted by the faculty of the College of Opometry, Pacific University, as partial fulfillment of the Doctor of Optometry Degree.

Scott E. Abe

TABLE OF CONTENTS

ABSTRACT 1

INTRODUCTION 2

INSTRUMENTATION 4

SUBJECTS 5

PROCEDURE 6

RESULTS 8

TABLES 9

DISCUSSION 12

CONCLUSION 14

FOOTNOTES 15

GRAPHS 16

REFERENCES 20

SUBJECT RELEASE FORMS 21

ABSTRACT

Twenty-three subjects were tested with American Optical's Non-Contact Tonometer under four randomly-sequenced conditions: 1) before and after reading for ten minutes through a +2.00D add; 2) before and after reading for ten minutes through a plano add; 3) before and after reading through a -1.00D add; and 4) before and after a ten minute period during which the subject sat relaxed with a plano add and fixated normally.

The mean change in IOP for each of the four conditions was analyzed using a one-tailed analysis of variance and revealed no significant differences among any of the means. Results were discussed with relation to the findings of Armaly and Burian (1958), and Armaly and Rubin (1961).

INTRODUCTION

One of the standard clinical findings in the modern optometric examination is the determination of the patient's intraocular pressure(IOP). This measurement is a valuable tool in the detection of glaucoma when used in conjunction with other findings such as visual fields, internal examination of the eye, and the patient's ocular history. It is obvious, therefore, that accurate determination of IOP is essential, and that changes in IOP which are due to factors other than pathology should be recognized and taken into account when interpreting these values.

Some of the factors that affect IOP level are: Normal diurnal variation of pressure related to a similar variation in the rate of aqueous formation; external pressure on the globe which may be caused by forced lid closure, rubbing the eyes, or cocontraction of the rectus muscles; changes in the arterial blood pressure;[1] or physical exercise.[2,3]

Another variable which may affect the IOP is the state of accommodation of the eye. Although this should be an area of prime interest to the Optometric and Ophthalmological professions, little published information is available. Armaly and Burian(1958)[4] used a Schiotz indentation tonometer on young "normal" subjects and found that the calculated IOP dropped 1-6 mm Hg when tonometry was done during

4.00 D of accommodation. This was due to the increase of the C value, or outflow facility, under this condition. In a later study, Armaly and Rubin (1961)[5] used the Goldmann applanation tonometer on young and old "normal" subjects and found a mean IOP reduction of 3.58 mm Hg during 4.00 D of accommodation for all subjects, a 4.5 mm Hg reduction for young subjects, and a 2.3 mm Hg reduction for the older subjects. Of interest also is the fact that the change in pupil size resulting from accommodation was found not to be a significant factor in IOP reduction. Borish(1970),[6] in a listing of provocative tests for the diagnosis of glaucoma, states that reading fine print for 45 minutes may raise ocular tension 10-15 mm Hg.

The purpose of the present experiment is to investigate the effect of accommodation during reading on intraocular pressure. In addition, the effects of reading through minus and plus lenses will be studied. The hypothesis which will be tested is that IOP will drop significantly from normal during accommodation. Results will be discussed in relation to the findings of Armaly(1958&1961), and with respect to implications for the clinical optometrist.

INSTRUMENTATION

All IOP measurements were taken with an American Optical Non-Contact Tonometer. Measurements were taken before and after reading through +2.00D, -1.00D, and plano lenses. These lenses were placed before the subjects' eyes by inserting them in Halberg clips, which were attached to the subjects' habitual glasses. If the subject had no glasses a comfortable fitting frame was selected from the frame board at Pacific University Optometric Clinic. If the subject's habitual correction overcorrected or undercorrected his refractive error by more than .25D, proper lenses were inserted in the Halberg clips to provide accurate correction of the refractive error. Passages used for reading material were selected from The Pharmacological Bases of Therapeutics by Goodman and Gilman. The print size of this material is approximately .80M (20/40). The reading material was placed 16 inches away from the subject, at eye level, on an adjustable reading stand.

SUBJECTS

The 25 subjects used were all students at Pacific University and met the following requirements:

1.) A corrected visual acuity of 20/20 or better.

2.) No evidence or history of ocular disease or surgery.

3.) Age between 20 and 30 years.

PROCEDURE

Each subject was tested on four different occassions and under four different conditions. In condition one, three IOP measurements were taken immediately before and after reading for 10 minutes through a plano add. In condition two, three IOP measurements were taken immediately before and after reading for 10 minutes through a +2.00D add. The same method was used in condition three, except that a -1.00D add was used. In the fourth condition, the stand and reading material were removed, and the subject was required to sit relaxed for 10 minutes with a plano add and fixate normally. Three IOP measurements were taken immediately before and after this 10 minute period. The order in which these conditions were performed by was randomized to avoid any possible effects from the testing sequence.

In each of the first three conditions, the subject was seated comfortably with the reading material situated at eye level, in order to minimize any changes in pressure which, according to Adler(1970), can occur with neck compression or bending over. The subject was requested to relax, and to avoid unnecessary body movements, to prevent any effects which muscular activity might have on IOP.[8]

In order to encourage the subjects to maintain attention

and fixation on the reading material, each subject was informed prior to testing that he would be given a brief quiz on the material he was about to read. Following testing, two short questions were posed in order to assure that subsequent reading material would receive similar attention from the subject. In addition, one of the examiners closely observed each subject while he was reading, so that poor attention or lack of constant fixation on the reading material could be noted.

The post-reading IOP measurements were taken as quickly as possible after the subject finished reading. In order to facilitate taking the fastest readings possilbe, readings were taken only on the right eye. Also, the reading stand was positioned close to the tonometer, so that after reading, the subject could merely swivel around and be in the proper position for IOP measurements to be made.

A small reading light was positioned so that it provided proper near point illumination for reading, as well as providing good stimulus for accommodation. Room lights were left on so that no drastic pupil changes would occur at any time during the testing procedure.

In order to avoid any experimenter bias, this study was done in double-blind fashion. The experimenter taking the tonometer readings was unaware of which lenses the subject had been wearing during the reading period.

RESULTS

Mean change in IOP for each of the 4 conditions was calculated, and these means are shown in Table I.

Table II shows the change in IOP for each subject, under each of the 4 conditions. A one-tailed analysis of variance was performed on the data, as illustrated in Table III. This table shows the steps involved in the analysis. The null hypothesis, that the differences between the means were due to chance, failed to be rejected at the .01 level.

TABLE #1

Condition	$\bar{x}$
No Read	-.129
+2.00	-.363
plano	-.377
-1.00	-.116

TABLE # II

Subjects ↓	1 Δ NR	2 Δ plano	3 Δ +2.00	4 Δ -1.00
1) BS	0	-0.67	+0.67	-0.33
2) RL	+0.67	-1.33	-0.34	0
3) DD	-0.67	+3.34	+0.66	-0.33
4) KR	-2.00	-1.34	-1.67	-1.00
5) BR	+0.67	+1.67	-2.00	-1.00
6) VS	0	-0.67	+1.00	+0.34
7) JD	-0.67	-3.67	-1.33	+1.33
8) HB	-0.33	-0.34	-5.00	-0.34
9) LC	+0.66	-1.66	+0.33	0
10) JA	-0.33	-1.00	+1.67	-1.00
11) AS	-0.33	+1.00	+1.66	0
12) AS	-0.67	+1.00	0	0
13) JS	+1.34	-1.00	-0.34	+1.00
14) BF	-0.33	-1.33	-0.67	-0.67
15) ML	+0.33	-1.00	-1.33	-0.67
16) SF	-0.67	+0.33	+0.67	+1.00
17) RG	0	-1.00	+0.33	-0.33
18) LL	-0.66	-1.00	+0.33	+0.66
19) SH	-0.66	-0.33	+0.67	-0.67
20) TS	+0.34	+0.66	-3.33	0
21) BW	+1.67	-1.33	+0.33	-0.33
22) BO	-1.66	-0.33	-0.33	-2.32
23) FB	+0.33	+1.33	-0.33	+1.00

TABLE III

k = # of Treatments = 4
n = # of Subjects = 23

Source of Variation	Degrees of Freedom	Sum of Squares (SS)	Mean Square (MS)	$F_{obs.}$ MS_{Tr}/MS_E
Treatment	k-1 4-1=3	2.38	$SS_{Tr}/(K-1)$ .1082	$\frac{.1082}{1.3665} = .079$
Error	k(n-1) 4(23-1) = 88	91.51	$SS_E/k(n-1)$ 1.3665	
Total	nk-1 (23·4)-1 = 91	124.72		

$F_{\alpha=.01} = 4.13$ $\quad F_{obs} = .079$

DISCUSSION

In the present experiment no significant differences were found in the mean intraocular pressure change for any of the investigated conditions. Therefore, it made no difference whether the subject read through a +2.00D lens, a -1.00D lens, or a plano lens, or whether the subject sat for 10 minutes without reading; all changes recorded could be attributed to chance. These results are not in agreement with the findings of Armaly and Burian (1958) or of Armaly and Rubin (1961), both of which reported significantly lower pressures during short periods of accommodation.

A number of procedural differences between those studies and the present study could perhaps account partially for this discrepancy. In those reports showing significance, different tonometers were used--a Schiotz indentation tonometer in the Armaly and Burian study and a Goldmann applanation tonometer in the Armaly and Rubin study. The Non-Contact Tonometer, which was used in the present experiment, is calibrated against the Goldmann and should in theory give similar values. Also, the repeatability of NCT findings, which has been questioned in the past, has been found to be good, providing the same sequence was followed from test to retest.[9] However, the NCT which was used in the present experiment was also available for use by some three hundred

student clinicians at the University and no doubt received some rough treatment during the duration of the study. It was noted during testing of subjects that a number of abnormally low readings was being recorded. Also, the magnitude of pressure change within each condition varied much from subject to subject in seemingly random fashion(graphs 1,2,3,4).

Another difference in procedure that is relevant concerns the fact that Armaly's measurements in both cases were obtained during accommodation, while in the present study the measurements were taken after the subject had accommodated a certain length of time. While it does not seem probable, it nevertheless is possible that the changes in IOP measured by Armaly are rapid in reversal (on the order of 5-15 seconds) and therefore were back to normal by the time tonometry readings were actually measured. The possibility that IOP change due to accommodation is a delayed reaction and, therefore, not recorded in the present study seems to be ruled out by Armaly's studies, which reported significant IOP changes only 5 minutes after accommodation began. Finally, Armaly's studies used 4.00D of accommodation, while the greatest amount of accommodation used in the present study was 3.50D . It is remotely possible that the relationship between IOP and accommodation is non-linear and that IOP is not significantly changed with less that 4.00D of accommodation.

CONCLUSION

From the data obtained in the present study it would seem that IOP would not be affected in any predictable manner by reading alone, or by reading through plus or minus lenses. The optometrist in practice, therefore, need not be concerned about nearpoint testing affecting tonometry readings, nor be concerned that patients reading while waiting to be examined will exibit abnormal pressure readings if the measurements are taken early in the exam. This of course is a cautious statement, owing to the limitations of the experimental design, and further research on the problem is indicated. It would be valuable to learn how IOP changes over a period of time (an hour or more) with measurements being taken every several minutes for the duration of the reading session. If some method could be developed whereby the NCT measurements could be taken while accommodation was still in play (as in the Armaly studies), another potential source of error could be eliminated.

There is room for much more study in the area of reading effects on intraocular pressure measurements, and it is hoped that more research will be forthcoming

FOOTNOTES

[1]Moses, Robert A., Adler's Physiology of the Eye, 5th Ed., 1970, 260.

[2]Lampert, P., and Cooper, K., The effect of exercise on intraocular pressure, American Journal of Ophthalmology 63: 1673, 1967.

[3]Marcus, et al, Effect of exercise on intraocular pressure, Investigative Ophthalmology 9(10): 749, October 1970.

[4]Armaly, M.F., and Burian, H. M., Changes in the tonogram during accommodation, Archives of Ophthalmology 60:60, July 1958.

[5]Armaly, M. F., and Rubin, M. L., Accommodation and applanation tonometry, Arch. Ophthal. 65:415, 1961.

[6]Borish, Irvin M., Clinical Refraction, 3rd Ed., 459, 1970.

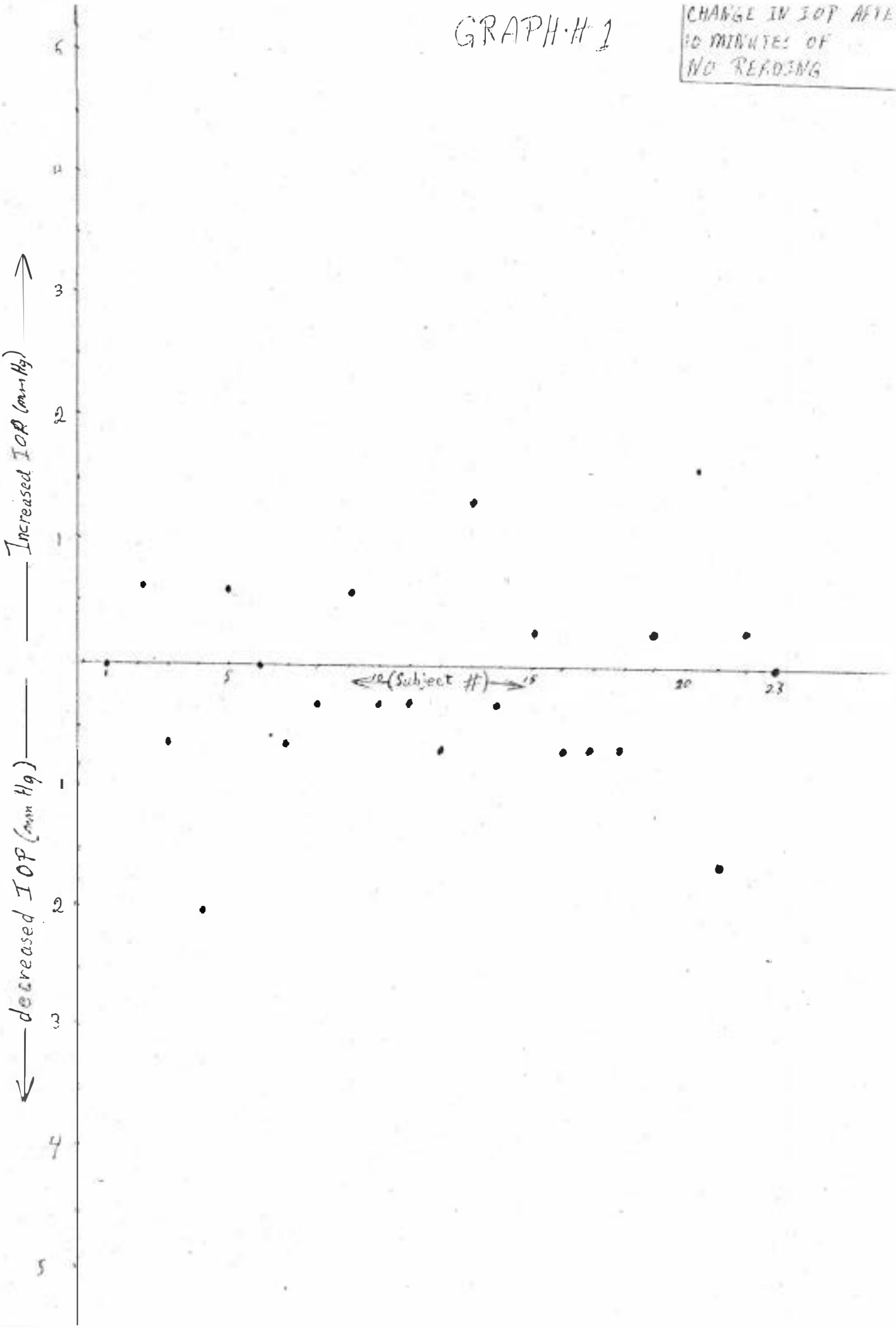
[7]Goodman, Louis S., and Gilman, Alfred, The Pharmacological Basis of Therapeutics, 5th Ed., 1970.

[8]Moses, Robert A., Adler's Physiology of the Eye, 5th Ed., 260, 1970.

[9]Robertson, Rodger D., Reading variability with procedure used in A. O.'s Non-Contact Tonometer, unpublished Doctoral thesis, April, 1970.

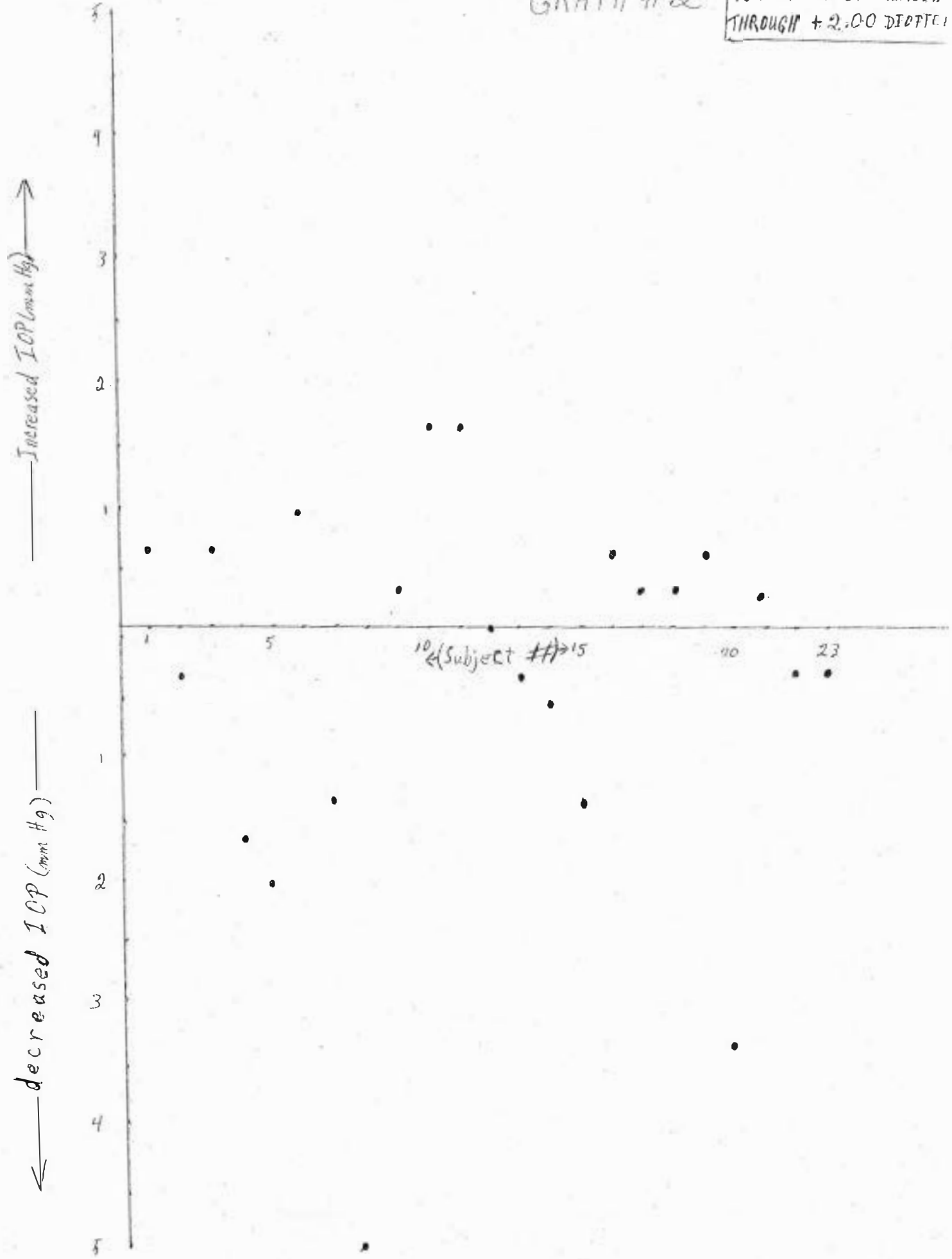
GRAPH-H 1

CHANGE IN IOP AFTE
10 MINUTES OF
NO READING



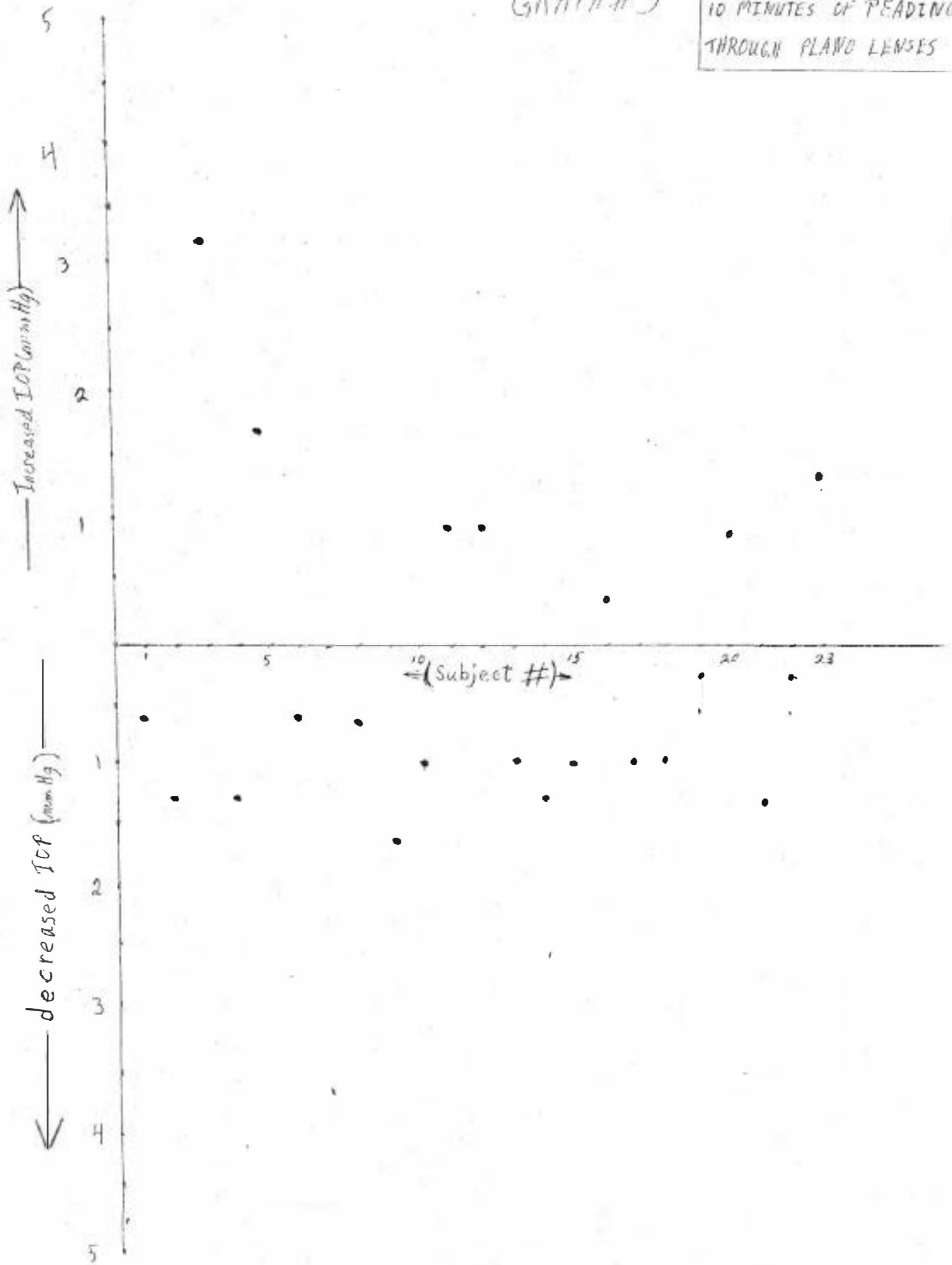
GRAPH #2

CHANGE IN IOP AFTE
10 MINUTES OF READIN
THROUGH +2.00 DIOPTE



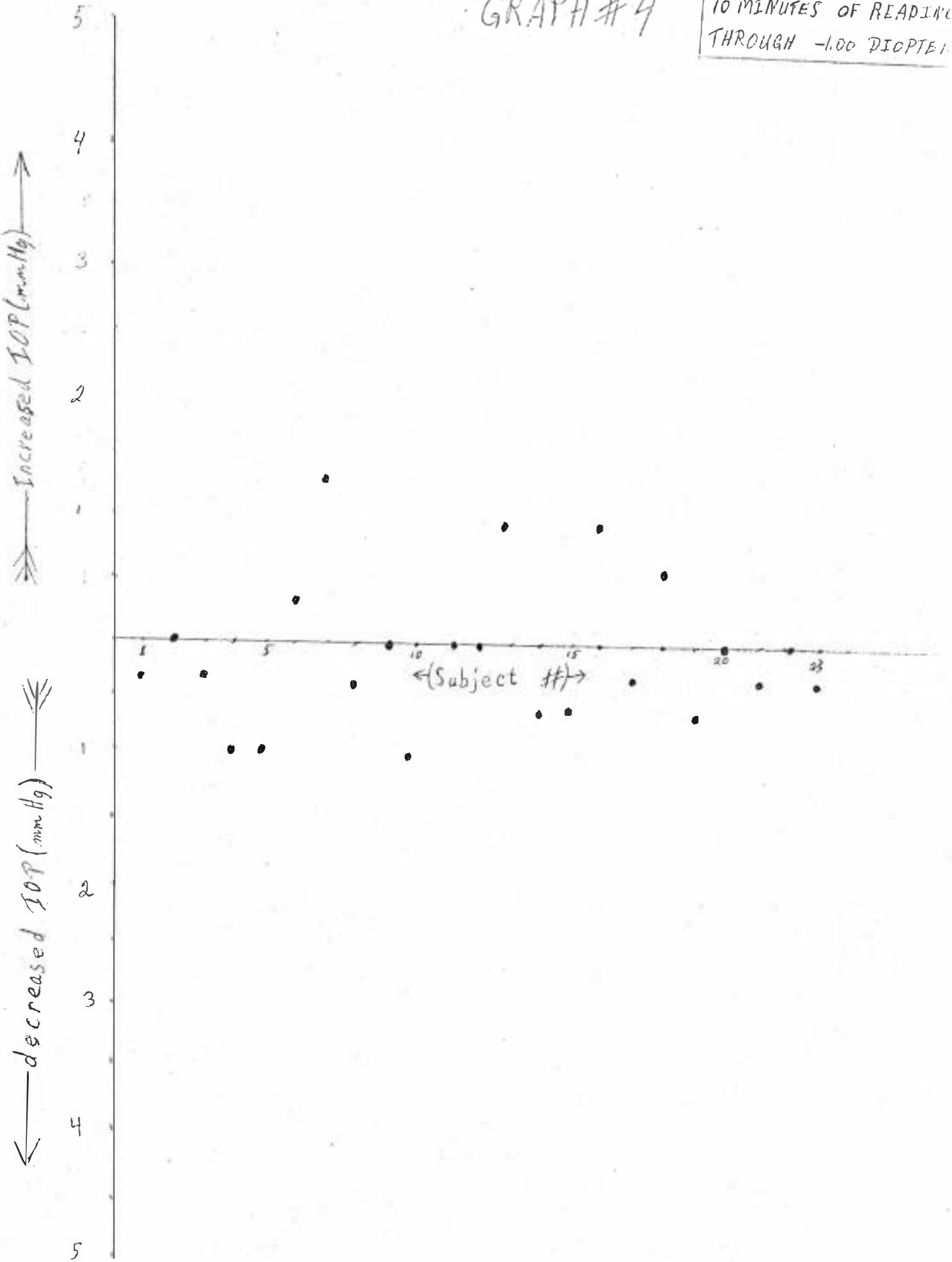
GRAPH #3

CHANGE IN IOP AFTER 10 MINUTES OF READING THROUGH PLANO LENSES



GRAPH #4

CHANGE IN IOP AFTER 10 MINUTES OF READING THROUGH -1.00 DIOPTER



REFERENCES

Armaly, M. F., and Burian, H. M. "Changes in the Tonogram During Accommodation," Archives of Ophthalmology, 60:60-69, July, 1958.

Armaly, M. F., and Rubin, M. L. "Accommodation and Applanation Tonometry," Archives of Ophthalmology, 65:415-423, 1961.

Borish, Irvin M. Clinical Refraction. 3rd Edition, The Professional Press, Incorporated, 1970.

Goodman, Louis S., and Gilman, Alfred. The Pharmacological Basis of Therapeutics. 5th Edition, New York: MacMillan Publishing Company, Incorporated, 1970.

Lampert, P., and Cooper, K. "The Effect of Exercise on Intraocular Pressure," American Journal of Ophthalmology, 63:1673, 1967.

Marcus, Daniel F., Krupin, Theodore, Podos, Steven M., and Becker, Bernard. "Effect of Exercise on Intraocular Pressure: I. Human Beings," Investigative Ophthalmology, 9(10):749, October, 1970.

Moses, Robert A. Adler's Physiology of the Eye, Clinical Application. 5th Edition, St. Louis: The C. V. Mosby Company, 1970.

Robertson, Rodger D. "Reading Variability With Procedure Used in A.O.'s Non-Contact Tonometer," Unpublished Doctoral Thesis, Pacific University College of Optometry, Forest Grove, Oregon, April, 1976.

SUBJECT RELEASE FORM

1. Institution

A) Title of Project: The Effect of Reading Through Various Lens Powers on IOP.

B) Principle Investigators: John Duffy and Hugh Brumley

C) Advisor: Dr Scott Pike

D) Location: Pacific University College of Optometry

E) Date: 1976-1977

2. Description of Project: This study is designed to monitor IOP before and after reading through various lens powers. Each subject is required to participate in three 15 minute sessions. An AO Air Puff Tonometer will be used to monitor the IOP.

3. Description of Risks: Only standard and conventional forms of optometric testing will be used in this project.

4. Description of Benifits: This study will serve to help eye-care professionals understand how intraocular pressure is affected by reading through plus and minus lenses.

5. Offer to Answer Any Inquiries: The investigators will be happy to answer any questions that you may have at any time during the course of this study.

I have read the above and understand what is involved.

Signed_____ Date_____