A VERIFICATION STUDY OF DARK ROOM RETINOSCOPY

by

Dale T. Massignan
Joseph T. Trubiroha

OUTLINE

INTRODUCTION

In an effort to assess the refractive state of a nonverbal patient two objective techniques such as retinoscopy under cycloplegia, and static retinoscopy can be used. In performing static retinoscopy, accommodation must be relaxed at infinity and distant fixation must be steady. Uncontrolled fixation which can be characteristic of young children not only makes it difficult to perform this technique but also produces an inaccurate accommodative response which will give you an incorrect refractive error.

In an effort to control the patients accommodation, the cycloplegic technique is an alternative method to determine the patient's refractive error. The cycloplegic refraction can be unreliable because of possible factors that involve the ciliary tonus values such as age, refractive error, and eye alignment. The type of cycloplegic agents, concentration, amount and amount of induced residual astigmatism[1] must also be taken into consideration. Often in cases where a cycloplegic is necessary the refractive evaluation will be based largely on retinoscopic findings. Retinoscopy may be difficult due to aberrations in the reflex with widely dilated pupils, and only the central area of the reflex should be utilized, which may be difficult. It should be brought out that one should not overlook the various ocular and local side effects of cycloplegic agents.

TECHNIQUE

In order to avoid the above mentioned handicaps, Mohindra[2] has developed an objective near-retinoscopy technique which could be used in determining the refractive error in infants and very young children. Near retinoscopy is performed with monocular fixation at a near distance of 50cm in a room with all the lights turned off, except for the retinoscope light with the patient seated facing the examiner. The patient is encouraged to fixate the light with one eye while the other eye is occluded. To ensure that fixation by the patient is maintained at a constant distance while retinoscopy is performed a string of a predetermined length of 50cm is attached to the retinoscope head while the other end is held by the patient next to the temporal orbital margin of the patient's fixating eye.

Retinoscopy is performed by neutralizing the retinal reflex in the two primary meridians of the eye by using lens bars. Wooden lens bars (a set of four bars - two with plus and two with minus dioptric power) are thought to work the best[3]. The lens bars were painted with black matte paint in order to avoid the patient's distraction when the retinoscopic light is reflected from the light wood.

The first step involves neutralizing the maximum plus or least minus power meridian.[15] The second principle meridian is then neutralized in the same manner. This provides a gross retinoscopic finding for the neutrality lens value for a fixation distance of 50cm. In order to obtain the net refraction of the eye for infinity and adjustment factor of 1.25D as determined by Mohindra in a previous study[4] is algaebrically subtracted from the spherical meridional components of the near retinoscopic technique.

The 1.25D correction factor was confirmed in a study on adult patients.[4] It is assumed from this study that a patient told to fixate the retinoscopic light at 50cm (-2.00D working distance) accommodative system will be focusing at +0.75D and not at infinity or the 50cm working distance. Because of this accommodative response, the patient is contributing -0.75D to the -2.00D working distance so that only -1.25D is needed as a correction factor instead of -2.00D.

An example of this technique would be:

Patient X

Gross near retinoscopy findings (Meridional):

OD -1.00 x045, -1.50 x135
OS -0.25 x045, +0.25 x135

To correct these above findings 1.25D is subtracted from each meridional finding thus giving:

OD -2.25 x045, -2.75 x135
OS -1.50 x045, -1.00 x135

Converting to spherical-cylindrical form

OD -2.25 = -0.50 x135
OS -1.00 = -0.50 x045

The above result being the refractive error for patient X using Mohindra's near retinoscopic technique.

PREVIOUS INVESTIGATIONS

Mohindra performed a number of studies in order to find the relationship between near retinoscopy and subjective refraction and what influence if any the accommodative system had in the -1.25D difference between the two.

One of the first or pioneer studies of the technique reported was performed on adults.[4] Twenty-seven optometry students and faculty members, age twenty to thirty-five served as subjects in the study. All subjects had their ametropia measured by subjective refraction within the preceding year. Near retinoscopy was performed with a streak retinoscope after the subject was asked to fixate the retinoscopic light in a dark room at a fixating distance of 55cm. The nonfixating eye was occluded. The gross sphere-cylinder value was calculated from these measurements. The procedure was performed on each eye for three weeks, once a week, without prior knowledge of the subjective refraction. The data was then analyzed. For the spherical findings by near retinoscopy a calculated correlation coefficient of +0.99 was found between these spherical near retinoscopy findings and the spherical component of the subjective refraction. For both hyperopes and myopes the difference between near retinoscopy across all subjects was +1.24D more plus than the subjective refraction. This 1.24D difference was accounted for by an accommodative lag. Mohindra states that this large accommodative lag is probably due to the difference in targets and measurement methods from previous studies.

An investigation done to determine if the technique could be replicated was performed by several third and fourth year optometry students. A correlation coefficient of +0.95 was found using the spherical dioptric components.[2]

An investigation of near retinoscopy was then performed on early primary grade school children.[5] The purpose of this investigation was to compare the refractive measurements obtained by near retinoscopy with those of a cycloplegic retinoscopy. There were thirty-one subjects in the study ranging from kindergarten through second grade, ages five through seven years old. Two examiners performed near retinoscopy twice on each subject using the original technique and correction number. Cycloplegic refractions were then performed on the same subjects. Correlation coefficients for the spherical components of the near retinoscopy technique and the cycloplegic retinoscopy technique were 0.831 and 0.748 respectively for the two examiners.

In a recent study[6] it has been concluded that the tonus factor of +0.75D was attributed to the resting focus of accommodation and not accommodative lag.

The dark focus or the intermediate resting state of accommodation is the state of accommodation under the normal muscle tonus, in the absence of any stimulus to accommodation and convergence?

REASON FOR THIS INVESTIGATION

This technique is being used clinically on a wide basis and because of this it was felt necessary to further investigate the procedure. An effort was made to:

I. Perform a verification study on a clinical population.

II. Deterine if the adjustment factor of -1.25D as determined by Mohindra is independent of the examiner or would each examiner or would each examiner have their own correction factor.

III. Determine if the adjustment factor of -1.25D is independent of refractive error.

IV. Investigate the basis for the -1.25D correction factor through a lieterature search.

V. Can the technique be used with reliability in a clinical setting.

METHOD

This investigation consisted of three separate components. In part one, retinoscopy was performed by each examiner on a series of schematic eyes in order to determine their level of proficiency and consistency. In part two the subjective refraction was compared to Mohindra's near retinoscopic technique by two examiners with each doing the technique on separate groups. In part three both examiners performed the near retinoscopic technique/subjective comparison on the same subjects.

EXPERIMENT I

In experiment I retinoscopy was performed by each examiner on a series of lenses before a schematic eye in order to determine their level of proficiency and consistency. An American optical schematic eye calibrated at emmetropia with a 4mm pupil was used. Twelve lenses were chosen by an observer[9] in a random fashion between +3.00D sphere and -3.00D sphere without replacement. The two examiners were not given any clues about the lenses used (e.g. color, thickness, minus or plus power).

EXPERIMENT II

Examiner one examined 49 subjects ranging in age from 8 to 30 years old with a mean age of $\overline{X}$ = 21.33 years old. The refractive range of this group was -6.75 to +3.75 diopters with a standard deviation of 2.01 and mean refraction of $\overline{X}$ = -1.21D. A total of 97 eyes were used in the study which included 16 simple myopic eyes, 50 myopic astigmats, 16 simple hyperopes, 7 hyperopic astigmats, 2 mixed astigmats and 6 emmetropes. One patient in the study was monocular, thus giving the odd number of eyes.

Examiner two performed the technique on 45 subjects whose age ranged from 5 to 37 years old with a mean age of 19.8 years. The refractice range of this group was +3.25 to -5.75 diopters with a standard deviation of 2.05 and mean refraction of $\overline{X}$ = 0.99D. The technique was performed on a total of 89 eyes of which 12 were simple myopes, 17 simple hyperopes, 38 myopic astigmats, 15 hyperopic astigmats, 3 mixed astigmats and 4 emmetropes. One patient in the study was monocular thus giving the odd number of eyes.

Both examiners duplicated the conditions required for the technique as stated by Mohindra.[3] Near retinoscopy was performed with one eye occluded in a dark environment at a distance of 50cm which was maintained by the use of string with one end tied to the retinoscope head and the other held at the temperal orbital margin of the fixating eye. Four wooden lens racks (two minus and two plus) with a range of $\pm$13.00D in half diopter steps were used. All the bars were painted with black matte paint in order to avoid distractions of the retinoscopic light off the wood. A copeland-Optec 360 Streak Retinoscope was used in the experiment.

Each examiner performed near retinoscopy on their respective subjects while they were told to fixate the light. The lens values used to neutralize the major and the minor meridians were then converted to their sphere-cylinder equivalent which respresented the gross near retinoscopic value. Each near retinoscopic neutrality value was determined without prior knowledge of the subjective refraction in that the examiner not doing the near retinoscopy performed the subjective refraction eliminating all bias in the technique. Corrected acuities of 20/20 or better were achieved by each subject through the obtained subjective refraction.

EXPERIMENT III

In experiment III, the technique was performed on 29 subjects whose age ranged from 18 to 26 years old with a mean age of $\overline{X}$ = 20.6. It was performed on a total of 57 eyes of which 10 were simple myopes, 9 simple hyperopes, 29 myopic astifmats, 3 hyperopic astigmats, 4 emmetropes and 2 mixed astigmats. Again, one patient was monocular which accounts for the odd number of eyes. All conditions were identical to the first experiment except for the fact that near retinoscopy was performed by both examiners on the same subjects without prior knowledge of the subjective refraction which was performed after the near technique.

RESULTS

In experiment number one both examiners corrected retinoscopic findings for eleven of the lenses were within ∓0.25D with one differing by ∓ 0.50.[9] It can be, therefore, assumed from these results that both examiners are good retinoscopists.

In the second experiment a correlation coefficient of 0.98 was found between the spherical findings of near retinoscopy and subjective refraction by examiner one. In both myopes and hyperopes a difference between the means of 1.19D more plus or less minus was found with near retinoscopy (standard deviation = 2.04) than with the subjective refraction (standard deviation = 2.01). (See Table I)

A correlation coefficient of 0.98 was found between the spherical findings of near retinoscopy and subjective refractions in a group number two by the second examiner. A difference of +1.17D was found between the near retinoscopy (mean standard deviation = 2.13) and the subjective refraction (mean standard deviation = 2.05). (See Table II)

Because of the wide range of refractive errors and large standard deviation of the sample, we further investigated to determine if this high correlation existed in different refractive groups. In group one Examiner one found a correlation coefficient of 0.93, correction factor ($\bar{X} - \bar{Y}$) of 1.04 and correlation coefficient of 0.97, correction factor ($\bar{X} - \bar{Y}$) of 1.22 was found for 25 hyperopic eyes and 59 myopic eyes respectively. Myopic and hyperopic eyes were drawn from the second experiment sample. The myopes ranged in refraction from -0.50D to 6.75D and hyperopes +.50 to +3.75D.

Table III depicts a further breakdown of refractive groups in respective number of eyes, slope/y intercept relation, coefficient and net difference between the technique of near retinoscopy ($\bar{X}$) and subjective refraction (Y) for examiner II which were similar to findings with examiner I. It may be apparent that the high correlation between the two techniques in both hyperopes and myopes as a group is due to the wide range of refractive types (+3.25 to -5.75D) of the subjects which may represent a statistical anomaly.[8] A non uniform slope, a recognized difference in myopes and hyperopes response, a range of correlation coefficient from 0.32 to 1.00 and a correction factor from -0.75 to -1.28 indicates a variability among set refractive groups which may be attributed to either subject or examiner variation.

In experiment III examiner variation was tested by duplication of both refractive techniques on identical subjects by both examiners. Comparisons between the two examiners of the near retinoscopy technique revealed a correlation coefficient 0.98, a slope of 1.01 and a y intercept of 0.01 all of which indicate similarity between the two examiners retinoscopic technique. However, a subtle difference in correction factors between examiner one (1.10) and examiner two (1.17) was found which is not clinically significant. (See Table IV).

DISCUSSION

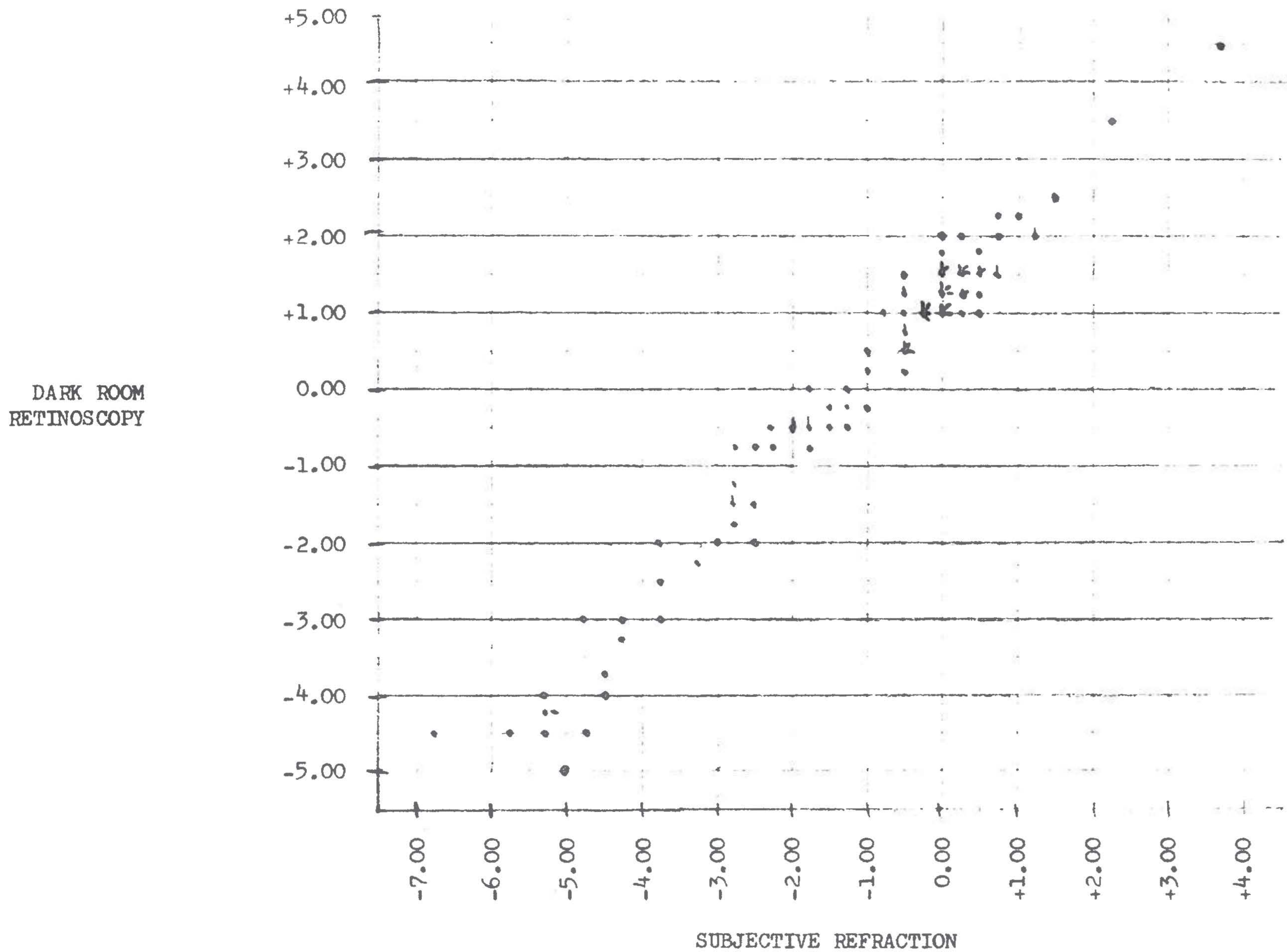
As stated earlier in the paper, an effort was made to investigate five different points. These will be discussed individually.

I. In an attempt to compare near retinoscopy to subjective refraction a correlation coefficient of 0.98 was found by both examiners in the second experiment. As stated earlier, it may be apparent that the high correlation between the two techniques in experiment number two is due to the wide range of refractive types of the subjects which may represent a statistical anomaly.[8]

II. In experiment number one, where retinoscopy was performed by both examiners on schematic eyes, a high level of proficiency and consistency was found. In experiment number three where near retinoscopy was performed by both examiners on the same subjects a correlation of 0.98 was found. It can be said that the adjustment factor is likely independent of examiner variability because we now have four people who obtained similar results (2 authors, Mohindra and Molinari).

III. Maddock, Millodot, Leaf and Johnson[10] found a lower average dioptric value of the resting point of accommodation for corrected myopes and higher average values for corrected hyperopes of approximately 0.50D. In previous studies a difference of 1.24D was found between the near retinoscopy technique

TABLE   EXPERIMENT 2   EXAMINER 1   SUBJECTIVE REFRACTION (x) vs. NEAR RETINOSCOPY



TABL I

EXPERIMENT 2 EXAMINER 2 SU TIVE REFRACTION (x) vs. NEAR RETINOSCOPY (y)

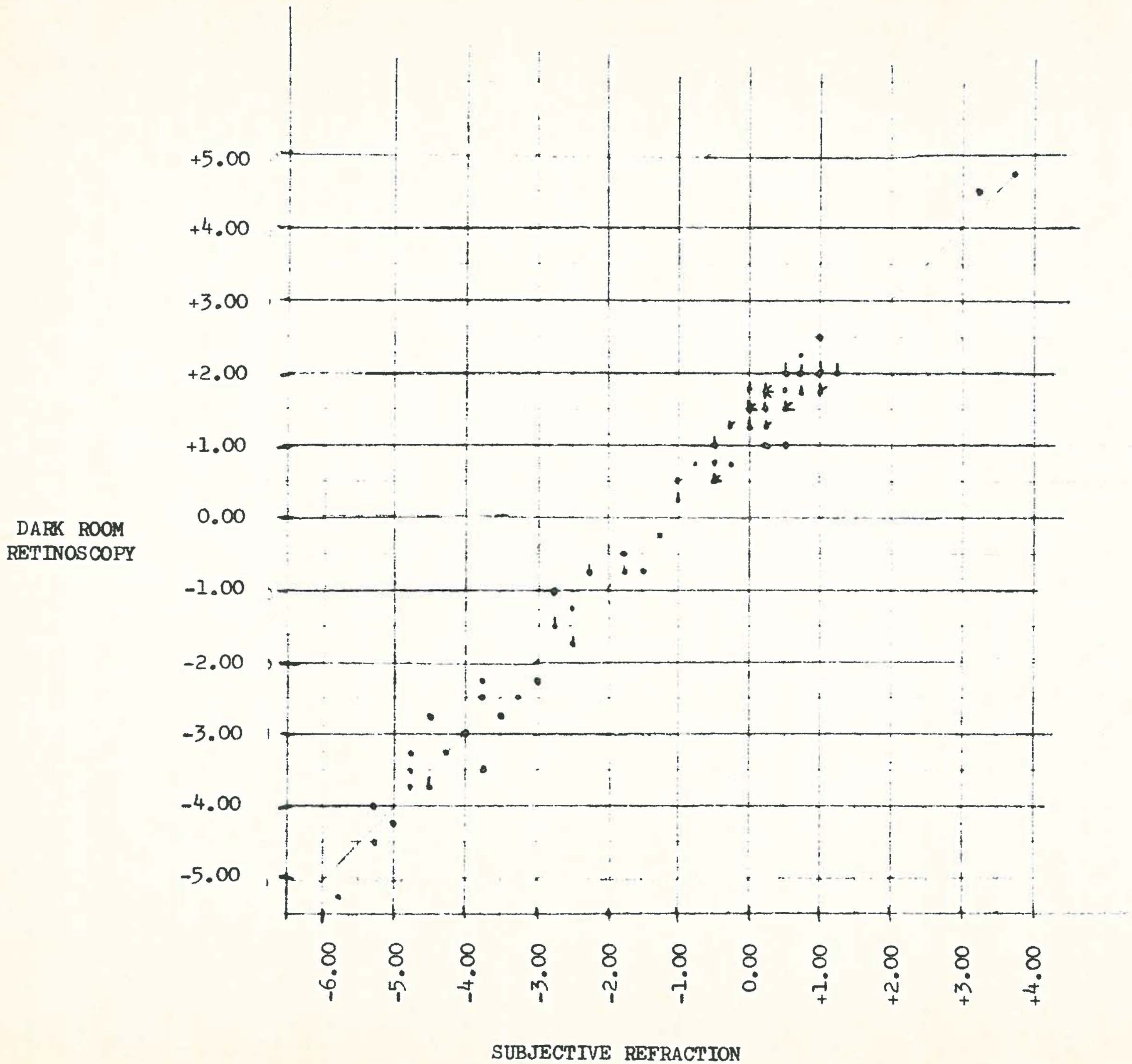
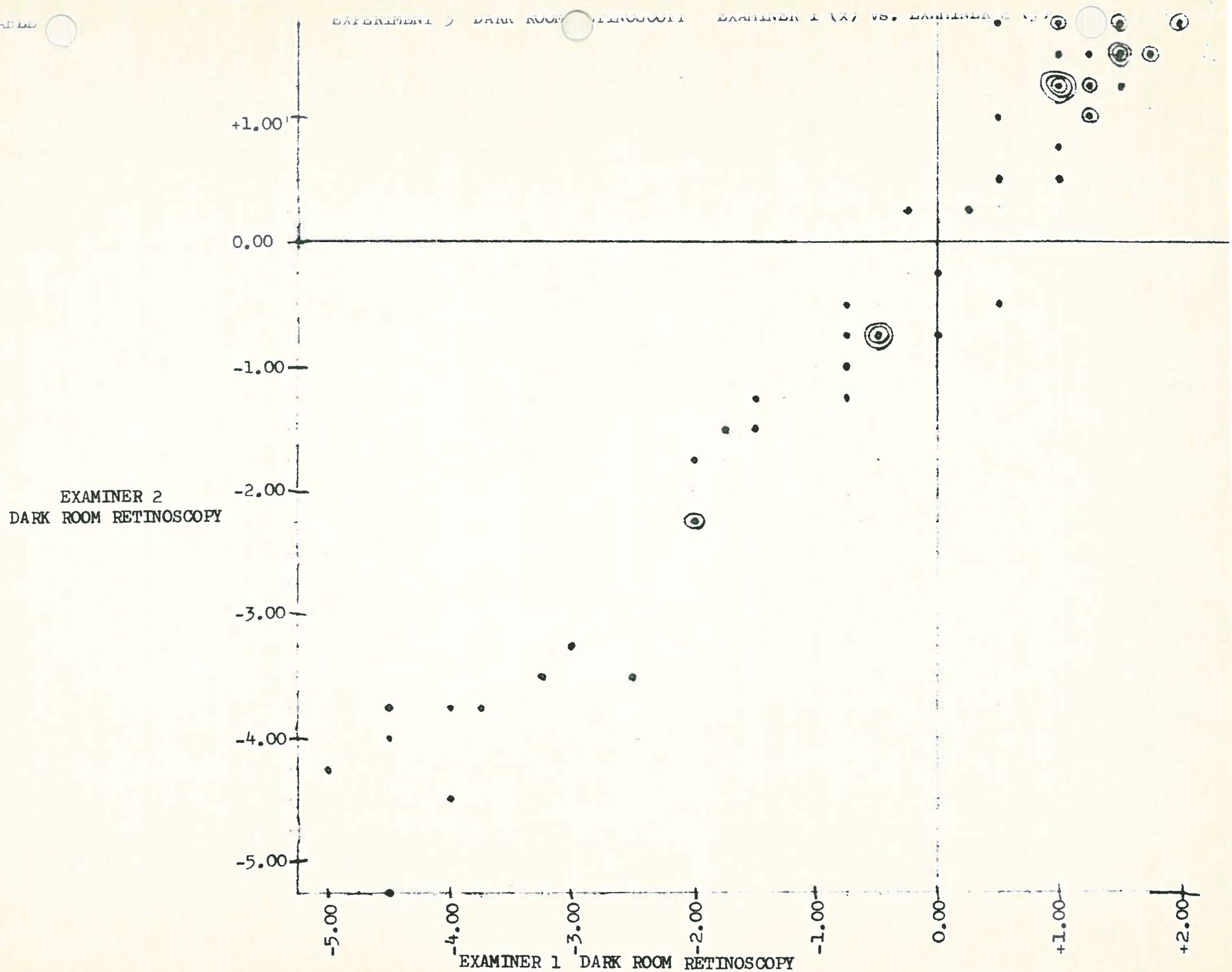


TABLE III COMPARISON OF CORRELATION COEFFICIENT, CORRECTION FACTOR IN SEPARATE REFRACTIVE GROUPS FOR EXAMINER #2

REFRACTIVE GROUPS	NUMBER OF EYES	(r)	CORRECTION FACTOR $(\bar{X}-\bar{Y})$	SLOPE/Y INTRCEPT
+0.25 to +1.00	32	0.56	-1.15D	0.65/1.34
+1.25 to +2.00	2	1.00	-0.75D	1.00/0.75
+2.25 to +3.00	0			
+3.25 to +4.00	2	1.00	-1.12D	0.50/2.88
-0.25 to-1.00	16	0.75	-1.28D	0.96/1.26
-1.25 to -2.00	5	0.69	-1.00D	0.69/0.50
-2.25 to -3.00	9	0.77	-1.25D	1.50/0.50
-3.25 to -4.00	6	0.32	-0.91D	0.56/-0.69
-4.25 to -5.00	7	0.24	-1.14D	0.46/-1.33
-5.25 to -6.00	4	0.86	-0.81D	1.47/-0.33


EXAMINER 2
DARK ROOM RETINOSCOPY
+1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-5.00
-4.00
-3.00
-2.00
-1.00
0.00
+1.00
+2.00
EXAMINER 1 DARK ROOM RETINOSCOPY

and subjective refraction for a wide range of refractive groups. Looking at individual refractive groups it was found that the assumed resting focus of accommodation was lower for myopes than for hyperopes. It is, therefore, felt that the correction factor is dependent on refractive type.

IV. In experiment number two examiner number one found a correction factor of 1.19D and examiner number two 1.17D. As can be seen the average correction factor by both examiners was similar to Mohindra's. Her correction factor of 1.25D, found using a 50cm working distance, and the residual of +0.75D was attributed to the dark focus or resting point of accommodation.[6] The dark focus or intermediate resting state of accommodation is the state of accommodation under the normal muscle tonus, in the absence of any stimulus to accommodation or convergence.[7]

In a study performed by Owens and Leibowitz the resting focus measures obtained varied over a relatively large range from 0.66 to 3.12D with a mean of 1.98D.[11]

In a later study by Owens and Leibowitz a range of 0.37 to 2.28D with a mean of 1.25D for the dark focus of accommodation was found on fourteen subjects.[12] A survey of 200 college students wearing their refractive correction, if any, indicated a range of dark focus from 0.00 to 4.00D and a mean of 1.71D.[13]

Miller has investigated the temporal stability of the dark focus of accommodation on 21 subjects over a period of two or three weeks. He concluded that the dark focus was stable even though intrasubject ranges varied from 0.08 to 2.92D over that period with a mean of 1.07D.[14] The authors feel that this above variability is clinically significant when determining an approximate refractive correction using the dark room retinoscopy technique.

A marked range and intrasubject variability in the dark focus of accommodation has been found in the above studies indicating individual variability and intrasubject variation which should be taken into account when considering the tonus adjustment value.

It is felt by this author that the above variation may be due to not only the dark focus of accommodation but also to the accommodative lag. Further investigation should be done to see if the individual accommodative lag as measured with MEM or Nott technique can be used in predicting or determining the appropriate correction factor for near retinoscopy.

It was stated that the near dark retinoscopic technique gives a useful estimate of the intermediate resting state or dark focus of accommodation which is the basis for the tonus factor in near retinoscopy as stated by Mohindra.[6] In a reported study[6] a comparison was made between near retinoscopic refractions and the same subjects intermediate resting focus of accommodation as measured with a laser optometer in an empty field. In order to find the actual refractive state during near retinoscopy, the +0.75 tonus adjustment was not applied and the findings were corrected for the working distance (-2.00D).

In order to assume that this technique (Dark room retinoscopy) is viable way to assess the dark focus of accommodation, this author feels that a study should be done where consideration is taken for the difference in accommodative response for a retinoscopic beam (0.70), and a dim empty field (1.50).[6] A comparison should be made between the accommodative response found by performing near retinoscopy with a correction factor of -2.00D and the monocular accommodative response of a moving retinoscopic beam at a distance of 50cm as measured with a laser optometer in a dark environment on the same subject.

V. It is felt that this technique is a fast, easy to perform and a somewhat reliable method for refracting nonverbal subjects without the use of drugs. However some precautions should be taken into consideration, besides the previously mentioned ones. Some discrepancies in spherical findings may occur because of inaccurate accommodative responses. This instability of the accommodative system is presumed to be more prevalent in hyperopes than myopes.[4] It would be beneficial in the future if subject variability could be a definitive factor based on other tests or findings (MEM, Nott, Refractive type, etc.). These could then be taken into consideration in adjusting for the ciliary tonus thereby making it an accurate finding without the need of subjective refraction as a check for variability as stated in an earlier paper by the original investigator.[6]

REFERENCES

1. Bergenske PD: A look at cycloplegic refractions. Wisconsin Optometric Association Journal, Vol. 24, No. 2 p. 7.

2. Mohindra I: A non-cycloplegic refraction technique for infants and young children. J. Am. Optom. Assoc. 48:518, 1977.

3. Mohindra I: Near-retinoscopy - an objective non cycloplegic refraction technique. Opt. Monthly 80: 44-47, 1980.

4. Mohindra I: Comparison of "near retinoscope" and subjective refraction in adults. Am. J. Optom. Physiol. Opt. 54: 319, 1977.

5. Mohindra I and Molinari JF: Near retinoscopy and cycloplegic retinoscopy in early primary grade school children. Am. J. Optom. Physiol. Opt. 56: 34, 1979.

6. Owens DA, Mohindra I, and Held R: The effectiveness of a retinoscope beam as an accommodative stimulus. Invest. Ophthalmol. Vis. Sci. 19: 942 - 949, 1980.

7. Schapero, Cline and Hofstetter: Dictionary of Visual Science ed. 2. Radnor, Pennsylvania: Chilton, 1968, p. 8.

8. Minium EW: Statistical Reasoning in Psychology and Education, New York, New York: John Wiley and Sons Inc., 1970, p. 191.

9. Garzia RP: Personal communication, Ferris State College of Optometry, Big Rapids, MI November 1980.

10. Maddock, Millodot, Leat and Johnson: Accommodation responses and refractive error. Invest Ophthalmol. Vis. Sci. 20: 387-391, 1981.

11. Owens DA and Leibowitz HW: The fixation point as a stimulus for accommodation. Vision Res. 15: 1161, 1975.

12. Owens DA and Leibowitz HW: Night myopia: cause and a possible basis for amelioration. Am. J. Optom. Physiol. Opt. 53: 709, 1976.

13. Leibowitz HZ and Owen DA: Anomalous myopias and the intermediate dark focus of accommodation. Science 189: 646, 1975.

14. Miller RJ: Temporal stability of the dark focus of accommodation. Am. J. Optom. Physiol. Opt. 55:447, 1978.

15. Borish IM: Clinical Refraction, Chicago, IL.: The Professional Press, Inc., 1975 p. 659.