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A comparison of objective accommodative response (as measured by a retinoscope), to the subjective accommodative response (as measured by cross cylinders), as convergence is postured inside and outside the plane of regard

Abstract

The purpose of this study was to compare the subjective accommodative posture as measured by a 20" cross cylinder to the objective accommodative posture as measured retinoscopically at 20". Also to compare the subjective accommodative posture as convergence was postured 2 meter angles (12 prism diopters) inside and outside the plane of 20" to the objective accommodative posture with the same change in convergence. It was also thought desirable to determine if the group of subjective findings were statistically predictable for the battery of objective tests.

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A COMPARISON OF OBJECTIVE ACCOMMODATIVE
RESPONSE (AS MEASURED BY A RETINOSCOPE),
TO THE SUBJECTIVE ACCOMMODATIVE RESPONSE
(AS MEASURED BY CROSS CYLINDERS), AS CON-
VERGENCE IS POSTURED INSIDE AND OUTSIDE
THE PLANE OF REGARD

Original Research
presented to the Faculty of
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by

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and

Jerry L. Adams

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SERVING AS SUBJECTS FOR THIS STUDY.

J. E. H.

F. L. A.

PURPOSE

The purpose of this study was to compare the subjective accommodative posture as measured by a 20" cross cylinder to the objective accommodative posture as measured retinoscopically at 20". Also to compare the subjective accommodative posture as convergence was postured 2 meter angles (12 prism diopters) inside and outside the plane of 20" to the objective accommodative posture with the same change in convergence. It was also thought desirable to determine if the group of subjective findings were statistically predictable for the battery of objective tests.

RELATED STUDIES

In a recent study it was found that as a hyperopic patient views a standard Snellen target set at 25 feet, the pupillary reflex as seen with the retinoscope, changed with the alteration of convergence by the use of a prism bar.

It was found that with the introduction of increasing amounts of base out prism, the amount of observed "with" motion decreased. A neutral appeared, and then an "against" motion began. Prism base in was introduced by the same procedure and the measurable amount of with or hyperopic motion increased.¹

This study proved that there is an objective accommodative shift as convergence is re-postured.

1. Skeffington A.M. "The Totality of Vision," American Journal of Optometry Vol. 34 (May, 1957), pp. 247;

APPARATUS

Bausch & Lomb Greens' Refractor

American Optical Ful-Vue Retinoscope

Standard cross-grid chart used at
20" test distance.

Standard reduced Snellen Chart.

PROCEDURE

I. TECHNIQUE OF TESTING

The refractor was adjusted to the subjects' 20 inch pupillary separation.

A near cylinder testing technique at 20 inches was performed to establish the astigmatic condition of each subject. This cylinder correction was utilized through the entirety of the study.

A 20 inch monocular cross cylinder was performed to establish the anisometric condition of each subject. This anisometric correction was then utilized through the entirety of the study.

Using the aforementioned astigmatic and anisometric factors as constants, only the right eye (S.D.) was recorded.

The illumination incident was that of dim (i.e., the shield of the near illumination turned upward.)

With the subjective testing routine, cross cylinders minus axis 90.

were in place. Plus spheres were introduced by 0.25 diopter steps until the vertical lines of the cross grid target were reported as darkest. Then plus was reduced in 0.25 diopter steps until it was reported the target was seen as equal. If reversal occurred the lenses that left the vertical lines the darkest were recorded.

With 12 prism diopters in place, the identical procedure was followed. Both Base In and Base Out prism were used.

With the objective testing routine plus spheres were introduced in 0.25 diopter steps until the pupillary reflex was seen to be decidedly "against". Plus spheres were then reduced until first evidence of neutrality was observed.

The identical procedure was followed for 12 prism diopters of Base In and 12 prism diopters of Base Out prism in place.

II. INSTRUCTIONS TO SUBJECTS

The number of subjects tested by the investigators was twenty. Below is an outline of the instructions given each subject.

It should also be mentioned at this time that each subject was checked, prior to the testing, to insure that he could maintain binocularity as the 12 prism diopters of Base In and Base Out prism was introduced.

A. INSTRUCTIONS USED FOR SUBJECTIVE TESTING WITH THE CROSS CYLINDERS.

The standardized instructions used were, "Please report when you see the vertical lines the darkest and most distinct." When the subject reported the vertical lines the darkest, the investigator instructed, "Please report when you see the horizontal lines the darkest."

B. INSTRUCTIONS USED FOR OBJECTIVE TESTING

The standardized instructions used were, "Looking at the letters on the front of my instrument, continue to read the smallest line as possible."

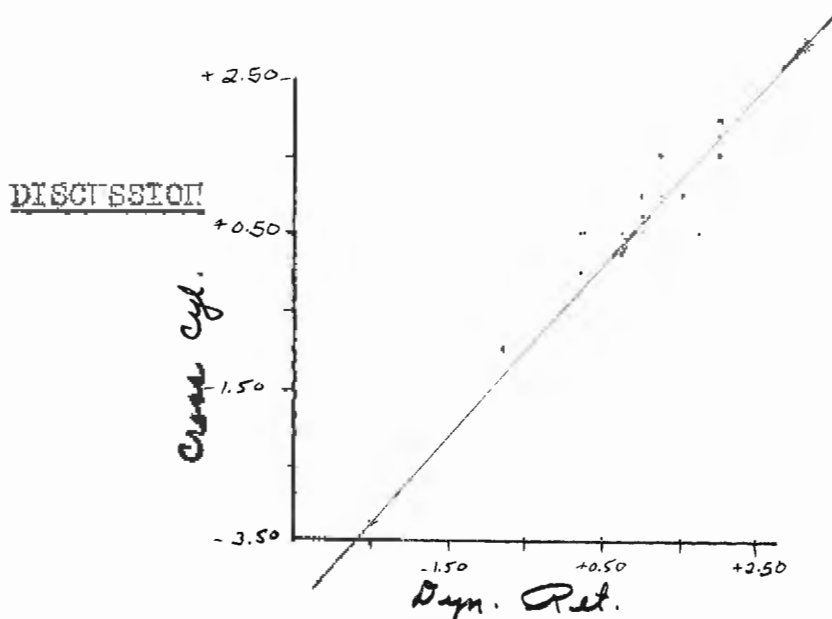


FIGURE I. SCATTER-DIAGRAM OF 20 INCH CROSS CYLINDER PLOTTED AGAINST DYNAMIC RETINOSCOPY GIVING A SLOPE OF APPROXIMATELY ONE TO ONE

In regard to Figure I, raw scores range from $+2.00$ to -2.50 for the Dynamic retinoscopy, and $+2.00$ to -3.25 for the 20 inch cross cylinder.*

In the frequency distributions** of the differences of raw scores (corrected,) the following statistics were found:

Mode--- $+0.75$ Diopters
 M_D ---- 0.263 Diopters
 σ_{MD} ---- 1.086 Diopters
 t ----- 1.08 Diopters
 P less than .1

* Table Number I in Appendix.

** Table Number II in Appendix.

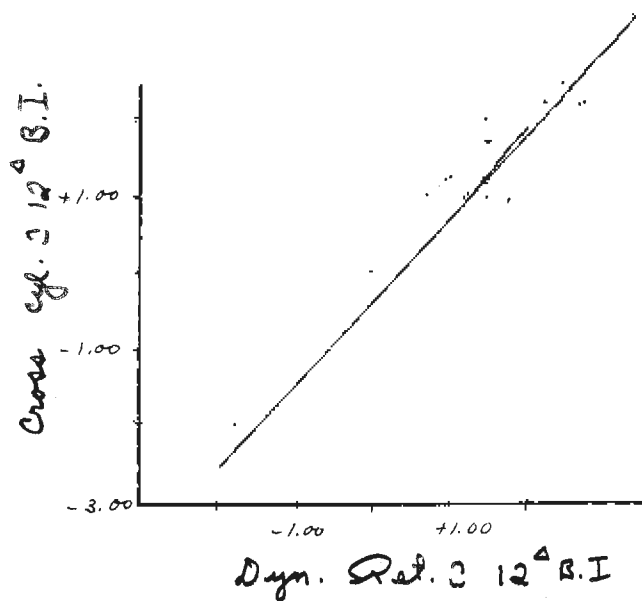


FIGURE II. SCATTER-DIAGRAM OF 20 INCH CROSS CYLINDER COMBINED WITH BASE IN PRISM OF 12 PRISM DIOPTERS PLOTTED AGAINST DYNAMIC RETINOSCOPY COMBINED WITH 12 PRISM DIOPTERS BASE IN PRISM

In regard to Figure II, raw scores ranges from ± 2.75 to $- 1.75$ for the dynamic retinoscopy, and ± 2.50 to $- 2.75$ for the 20 inch cross cylinder.*

In the frequency distribution** of the differences of raw scores (corrected) the following statistics were found:

Mode---- ± 0.75 Diopters
 M_D ----- 0.15 Diopters
 σ_{MD} ----- 1.19 Diopters
 t ----- 0.562 Diopters
 P less than .1

* Table Number III in Appendix.
 ** Table Number IV in Appendix.

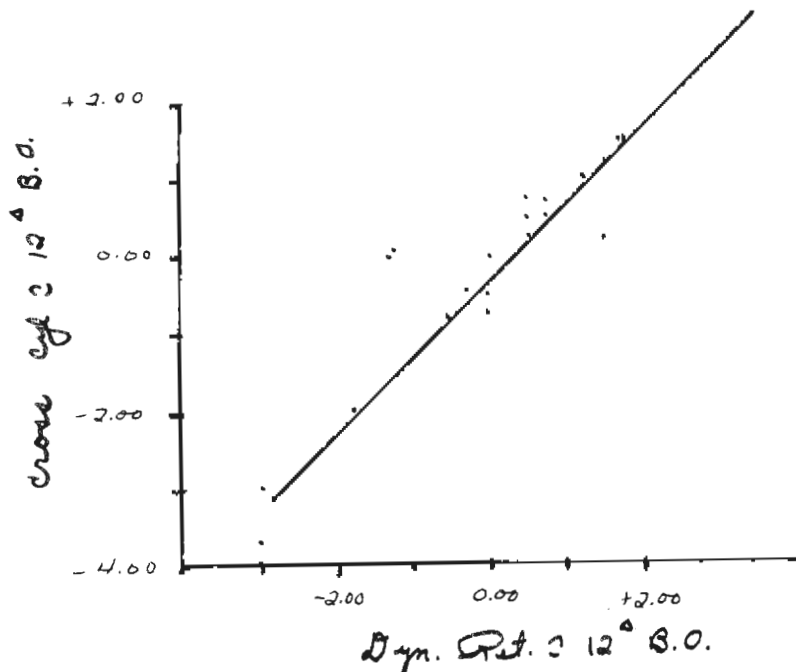


FIGURE III. SCATTER-DIAGRAM OF 20 INCH CROSS CYLINDER COMBINED WITH 12 PRISM DIOPTERS BASE OUT PRISM PLOTTED AGAINST DYNAMIC RETINOSCOPY COMBINED WITH 12 PRISM DIOPTERS BASE OUT PRISM

In regard to Figure III raw scores range from ± 1.75 to -3.00 for dynamic retinoscopy, and ± 1.50 to -3.75 for 20 inch cross cylinder.*

In the frequency distribution** of the difference of raw scores (corrected) the following statistics were found:

Mode--- ± 1.25 Diopters
 Md----- 0.09 Diopters
 GMD---- 2.25 Diopters
 t----- 0.179 Diopters
 P less than .1

* Table V in Appendix.
 **Table VI in Appendix.

DISCUSSION

In view of the statistical work performed, all three comparisons obtained a P value of less than .1 which means there is no significant difference between objective and subjective accommodative response as convergence is postured inside and outside the plane of regard.

SUPPLEMENTARY STUDIES

A study could be made between the interaction of the accommodative and convergent systems and the ratio thereof.

A study could be made between the objective and subjective accommodative response as a subject is viewing a 20 foot target. In creasing amounts of Base In and Base Out prism could be used, and the objective and subjective accommodative response checked before target blurs or breaks.

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APPENDIX
ILLUSTRATIVE MATERIALS

TABLE NUMBER I

Subj.	#5	C.C.	#5 - C.C.	Correction Factor / 0.50
1	/ 1.00	/ 1.00	000	/ 0.50
2	/ 1.75	/ 0.50	/ 1.25	/ 1.75
3	/ 1.25	/ 1.50	- 0.25	/ 0.25
4	/ 0.75	/ 0.50	/ 0.25	/ 0.75
5	/ 2.00	/ 1.50	/ 0.50	/ 1.00
6	/ 1.50	/ 1.00	/ 0.50	/ 1.00
7	/ 1.00	/ 0.50	/ 0.50	/ 1.00
8	/ 1.25	/ 1.00	/ 0.25	/ 0.75
9	- 2.50	- 3.25	/ 0.75	/ 1.25
10	/ 0.75	/ 0.25	/ 0.50	/ 1.00
11	/ 1.00	/ 0.75	/ 0.25	/ 0.75
12	- 0.75	- 1.00	/ 0.25	/ 0.75
13	/ 0.75	/ 0.25	/ 0.50	/ 1.00
14	/ 2.00	/ 1.75	/ 0.25	/ 0.75
15	/ 0.25	/ 0.50	- 0.25	/ 0.25
16	/ 2.00	/ 1.75	/ 0.25	/ 0.75
17	/ 2.00	/ 2.00	000	/ 0.50
18	- 2.00	- 2.25	/ 0.25	/ 0.75
19	/ 0.25	000	/ 0.25	/ 0.75
20	/ 0.25	/ 0.50	- 0.25	/ 0.25

TABLE NO. PPM II

	F	d	fd	fd ²
+1.75	1	6	6	36
	0	5	0	0
+1.25	1	4	4	16
	4	3	12	36
+0.75		8	2	16
	3	1	3	3
+0.25		3	0	0
	20		41	123

$$M_D = +.25 - (.25 \frac{41}{20})$$

$$M_D = .263 \quad M_D = .763 - .50 \text{ cam factor}$$

$$\sigma_{n_D} = \frac{.25}{20} \sqrt{20(123) - (41)^2}$$

$$\sigma_{n_D} = .659$$

$$S_{\bar{D}} = \frac{S_D}{\sqrt{N}} = \frac{.659}{\sqrt{20}}$$

$$S_{\bar{D}} = .147$$

$$t = \frac{\bar{D}}{S_{\bar{D}}} = \frac{.263}{.147}$$

$$t = 1.79$$

$p =$ is less than .1

\therefore there is no significant difference in the Dyn Rot and Cross Cyl. both at 20 inches

TABLE NUMBER III

Subj.	#5 () B.I.	C.C. () B.I.	#5 - C.C.	Correction Factor \neq 0.50
1	\neq 1.50	\neq 1.25	\neq 0.25	\neq 0.75
2	\neq 1.75	\neq 1.00	\neq 0.75	\neq 1.25
3	\neq 1.50	\neq 2.00	- 0.50	0000
4	\neq 1.50	\neq 1.25	\neq 0.25	\neq 0.75
5	\neq 2.25	\neq 2.25	000	\neq 0.50
6	\neq 1.50	\neq 1.75	- 0.25	\neq 0.25
7	\neq 1.50	\neq 1.00	\neq 0.50	\neq 1.00
8	\neq 1.50	\neq 1.25	\neq 0.25	\neq 0.75
9	- 1.75	- 2.75	\neq 1.00	\neq 1.50
10	\neq 1.25	\neq 1.00	\neq 0.25	\neq 0.75
11	\neq 1.50	\neq 1.25	\neq 0.25	\neq 0.75
12	000	000	000	\neq 0.50
13	\neq 1.00	\neq 1.25	- 0.25	\neq 0.25
14	\neq 0.75	\neq 1.00	- 0.25	\neq 0.25
15	\neq 2.75	\neq 2.25	\neq 0.50	\neq 1.00
16	\neq 2.75	\neq 2.25	\neq 0.50	\neq 1.00
17	\neq 2.50	\neq 2.50	000	\neq 0.50
18	- 1.75	- 2.00	\neq 0.25	\neq 0.75
19	\neq 1.00	\neq 1.25	- 0.25	\neq 0.25
20	\neq 0.75	\neq 1.00	- 0.25	\neq 0.25

TABLE NUMBER IV

	f	d	fd	fd ²
+1.50	1	6	6	36
	1	5	5	25
+1.00	3	4	12	48
	6	3	18	54
+0.50	3	2	6	12
	5	1	5	5
0	1	0	0	0
	20		52	180

$$M_D = 0 + .25 \frac{52}{20}$$

$$M_D = .65 - .50 \text{ corr. factor}$$

$$M_D = .15$$

$$S_{M_D} = \frac{.25}{20} \sqrt{20(180) - (52)^2}$$

$$S_{M_D} = .374$$

$$S_{\bar{D}} = \frac{S_D}{\sqrt{N}} = \frac{.374}{\sqrt{20}}$$

$$S_{\bar{D}} = .0836$$

$$t = \frac{\bar{D}}{S_{\bar{D}}} = \frac{.15}{.0836}$$

$$t = 1.785$$

$$P = \text{is less than .1}$$

\therefore there is no significant difference in Dayn. Ret. $\approx 10^4$ BI and cross eye $\approx 10^4$ BI both at 20 inches

TABLE NUMBER V

Subj.	#5 () B.O.	C.C. () B.O.	#5 - C.C.	Correction Factor \neq 1.00
1	\neq 0.50	\neq 0.75	- 0.25	\neq 0.75
2	\neq 1.50	\neq 0.25	\neq 1.25	\neq 2.25
3	\neq 0.75	\neq 0.75	000	\neq 1.00
4	000	- 0.75	- 0.75	\neq 0.25
5	\neq 1.75	\neq 1.50	\neq 0.25	\neq 1.25
6	\neq 1.25	\neq 1.00	\neq 0.25	\neq 1.25
7	\neq 0.50	\neq 0.25	\neq 0.25	\neq 1.25
8	\neq 0.50	\neq 0.50	000	\neq 1.00
9	- 3.00	- 3.75	- 0.75	\neq 0.25
10	000	000	000	\neq 1.00
11	\neq 0.75	\neq 0.50	\neq 0.25	\neq 1.25
12	- 1.75	- 2.00	\neq 0.25	\neq 1.25
13	- 0.50	- 0.75	\neq 0.25	\neq 1.25
14	\neq 1.50	\neq 1.25	\neq 0.25	\neq 1.25
15	000	- 0.50	- 0.50	\neq 0.50
16	\neq 1.75	\neq 1.50	\neq 0.25	\neq 1.25
17	\neq 1.75	\neq 1.50	\neq 0.25	\neq 1.25
18	- 3.00	- 3.00	000	\neq 1.00
19	- 0.75	000	- 0.75	\neq 0.25
20	- 0.25	- 0.50	\neq 0.25	\neq 1.25

TABLE NUMBER VI

	f	d	fd	d ²
+2.25	1	8	8	64
	2	7	0	0
+1.75	0	6	0	0
	1	5	5	25
+1.25	10	4	40	160
	4	3	12	36
+ .75	1	2	2	4
	0	1	0	0
+ .25	3	0	0	0
	20		67	289

$$M_D = +.25 + .25 \frac{67}{20}$$

$$M_D = 1.09 - \text{corr. factor } 1.00$$

$$M_D = .09$$

$$S_{M_D} = \frac{.25}{20} \sqrt{20(289) - (67)^2}$$

$$S_{M_D} = .45$$

$$S_{\bar{D}} = \frac{S_D}{\sqrt{N}} = \frac{.45}{\sqrt{20}}$$

$$S_{\bar{D}} = .1000$$

$$t = \frac{\bar{D}}{S_{\bar{D}}} = \frac{.09}{.1002}$$

$$t = .899$$

$p =$ is less than .1

\therefore there is no significant difference in Dyn Rod 212⁴ B.O. and cross cyl = 12⁴ B.O. both at 20 inches.