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The effect of orientation of retinal configuration upon accommodation and convergence

Ken R. Brost
Pacific University

Ray G. Mans
Pacific University

Jack B. Shepherd
Pacific University

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Abstract

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C.B. Pratt

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THE EFFECT OF ORIENTATION OF RETINAL CONFIGURATION UPON ACCOMMODATION AND CONVERGENCE

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KEN R. BROST

RAY G. MANS

JACK B. SHEPHERD

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DR. C.B. PRATT

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INTRODUCTION

When the image of an object point falling on the retina is not conjugate to the object point, a blur circle is formed and an accommodative response is initiated. The larger the blur circle formed the greater the response. As we know, the use of the pinhole influences the size of the blur circle because most all but the paraxial rays are prevented from entering the eye. The result is that the accommodative response is greatly reduced.

Further to the fact that the accommodative response can be influenced by restricting the area of illumination entering the eye it is hypothesized that accommodation can also be influenced by employing certain targets that bear specific orientation to certain restricted areas of illumination.

To clarify this postulation let us consider the foregoing in more detail. Suppose that instead of restricting the area of illumination by a pinhole we employ a slit which we can think of as an elongated pinhole. Under this condition the non-paraxial rays from target detail whose negative vergence is at right angles to the slit direction (after passing through a non-conjugating lens) will be restricted from entering the eye by the edges of the slit. In this case there would be less blur of the retinal image resulting in minimum accommodative response. The non-paraxial rays from target detail whose negative vergence is in the direction of the slit will not be restricted from entering the eye by the edges of the slit. This would result in no reduction of blur of the retinal image and the accommodative response would occur.

For a practical example, suppose that through a horizontal slit we view a block target composed of thin black parallel lines separated by a white space of approximately the same dimension as the width of one of the black parallel lines. Suppose the target is positioned with the lines vertical. The negative vergence from the vertical detail is primarily in the horizontal direction and as previously explained the non-paraxial rays are not restricted from entering the eyes by the slit. The result would be an accommodative response. On the other hand if the target was positioned with the lines horizontal the negative vergence is primarily in the vertical direction. Under this situation, as previously explained, the slit will restrict the paraxial rays from entering the eye and the result will be minimal accommodative response.

To test this hypothesis, 30 subjects were each examined under four different conditions. Each subject was presented with the following: (1) a horizontal lined target; (2) a vertical lined target; (3) the horizontal lined target viewed through a horizontal slit; and (4) the vertical lined target viewed through the same horizontal slit. Under each condition accommodative responses were noted using several lens powers. It is hypothesized that under the condition of viewing the horizontal lined target through a horizontal slit, the accommodative response (and the convergence response) will be significantly less than under the other three conditions.

APPARATUS

The testing apparatus consisted of two monocularly presented targets separated by a black septum. One of the targets was black lines on a white background with an angular subtense equal to a 20/120 Snellen designation. These lines could be presented either horizontally or vertically, before the right eye. The other target consisted of the lower half of a standard 45-135° cross-cylinder near-point card, presented to the left eye. There was a horizontal separation of 41mm and vertical separation of 23mm between the center of the line target and center of cross-cylinder target.

The testing apparatus was placed on the Bausch and Lomb phoropter at 40 cm. A stenopaic slit was made from electrical tape and placed horizontally on the +0.12D lens on the right occluder bank of the phoropter. A nearpoint light was adjusted so as to have 3 times the intensity on the right side as the left. It was positioned so that equal reflected light from the target plane passed through each lens port to the subject's right and left eyes when the slit was positioned before the patient's right eye. All data was gathered using this apparatus (see photos) in room C-1 in the Optometry Clinic here at Pacific University.

PROCEDURE

1. The patient was seated in the examination chair and instructed to remove any spectacle correction.
2. The phoropter was adjusted for the patient's near pupillary distance.

3. The reduced Snellen card was placed on the near point rod at 40cm and the near point light was adjusted to illuminate the letters evenly.
4. The patient was instructed to call the 20/20 acuity letters on the reduced Snellen card.
5. We obtained the results for a monocular negative relative accommodative test (21_m--by adding plus monocularly until the 20/20 letters were blurred out, then we reduced the plus until the first perception of two-thirds of the 20/20 letters). These were the starting lenses for all patients.
6. With these monocular negative relative accommodative lenses in place, the near astigmatic correction of each patient was determined by a near cylinder test. (Pratt Near Cylinder Test)
7. With this near cylindrical correction in the phoropter, a monocular near cross cylinder, accommodative posture test (14A) was performed.
8. With the 14A and the near astigmatic correction placed in the phoropter, the testing apparatus was introduced at 40cm. Four different conditions were presented to each subject's right eye inthe following order: (1) Horizontal target; (2) Vertical target; (3) Horizontal target and horizontal slit; and (4) Vertical target and horizontal slit.
9. The four different conditions were performed using the same method:
   A) The near point light was positioned so the illumination on the right target was three times that on the left, and was used only with the horizontal slit in place. When the slit was not

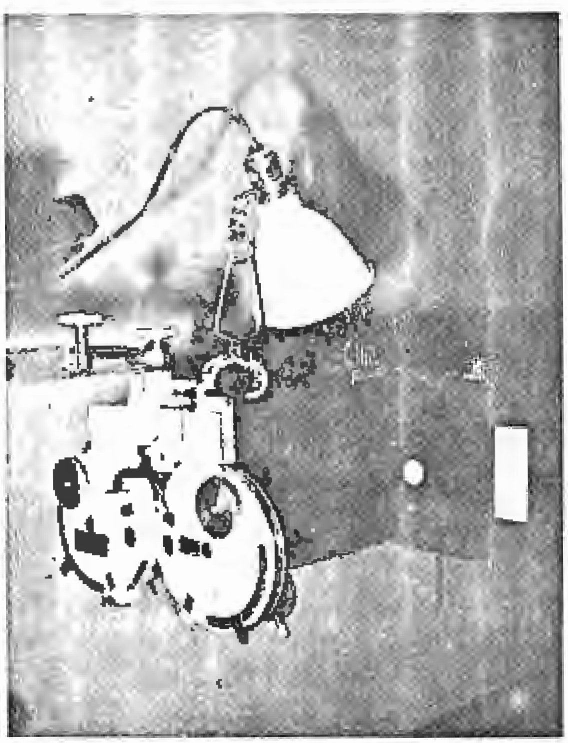
in place, full room illumination (29 foot candles) was used. Therefore, right and left eyes had equal target illumination for each condition tested.

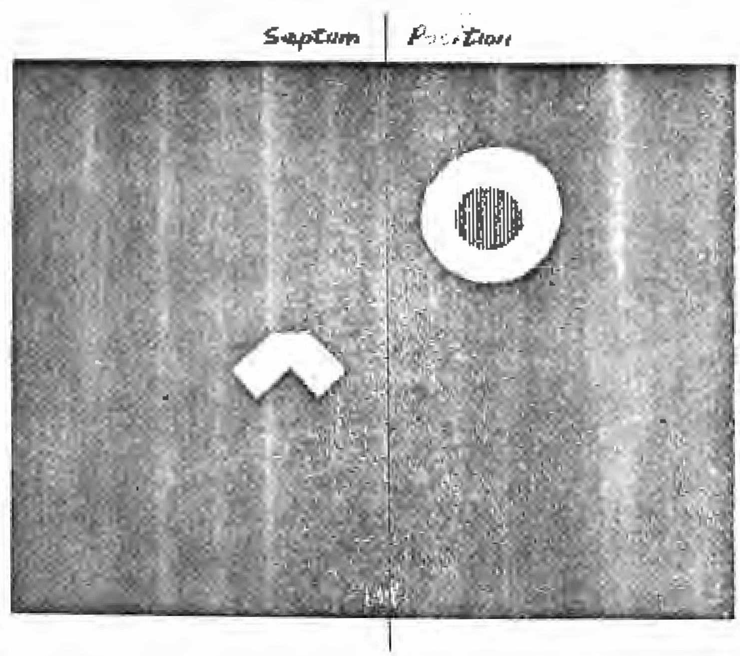
B) The following lens sequence was used for each condition: 14A, 14A+1.00, 14A, 14A-1.00, 14A-2.00, 14A-3.00, 14A-2.00, 14A-1.00, and 14A.

C) Before each new accommodative measurement, the rotary prism of the left eye was used in aligning the two targets vertically. This represented the convergence posture for each accommodative stimulus, and was left in place.

D) A corresponding accommodative posture was measured on the left eye for each lens placed before the right eye, for each condition.

ILLUSTRATION OF APPARATUS





DATA

1. Accommodative
2. Convergence
3. Statistical
4. Graphical

RECORDING FORM

NAME AGE 21R (OD) (OS) NEAR CYL (OD) (OS)14B (OD) (OS)

HORIZONTAL TARGET			VERTICAL TARGET			HORIZONTAL TARGET w/ SLIT			VERTICAL TARGET w/ SLIT		
OD	PHORIA	OS	OD	PHORIA	OS	OD	PHORIA	OS	OD	PHORIA	OS
14B			14B			14B			14B		
14B+1.00			14B+1.00			14B+1.00			14B+1.00		
14B			14B			14B			14B		
14B-1.00			14B-1.00			14B-1.00			14B-1.00		
14B-2.00			14B-2.00			14B-2.00			14B-2.00		
14B-3.00			14B-3.00			14B-3.00			14B-3.00		
14B-2.00			14B-2.00			14B-2.00			14B-2.00		
14B-1.00			14B-1.00			14B-1.00			14B-1.00		
14B			14B			14B			14B		

NAME AGE 21R (OD) (OS) NEAR CYL (OD) (OS)14B (OD) (OS)

HORIZONTAL TARGET			VERTICAL TARGET			HORIZONTAL TARGET w/ SLIT			VERTICAL TARGET w/ SLIT		
OD	PHORIA	OS	OD	PHORIA	OS	OD	PHORIA	OS	OD	PHORIA	OS
14B			14B			14B			14B		
14B+1.00			14B+1.00			14B+1.00			14B+1.00		
14B			14B			14B			14B		
14B-1.00			14B-1.00			14B-1.00			14B-1.00		
14B-2.00			14B-2.00			14B-2.00			14B-2.00		
14B-3.00			14B-3.00			14B-3.00			14B-3.00		
14B-2.00			14B-2.00			14B-2.00			14B-2.00		
14B-1.00			14B-1.00			14B-1.00			14B-1.00		
14B			14B			14B			14B		

DIFFERENCE FROM MEAN Ap OF Ar AT THE CORRESPONDING As

	Subject	GM	KB*	RM	ED	BD	DF	RB	GI	DR	LL	DN	KB	JJ	TB
	Mean $14A_p$	+1.56	+0.74	+2.03	+2.01	+1.62	+1.57	-0.05	+1.08	+0.93	+1.48	+2.10	+1.98	+1.92	-2.60
H	+1.00	+0.94	+0.76	+0.72	+0.49	+0.50	+0.18	+0.30	+0.77	+0.32	+0.77	+0.27	+0.52	+0.70	+0.85
H	$14A_p$	-0.23	+0.01	+0.09	+0.03	-0.04	-0.07	+0.13	-0.04	-0.06	+0.27	-0.10	-0.19	+0.08	+0.43
H	-1.00	-0.94	-0.74	-0.53	-0.95	-0.37	-0.57	+0.05	-0.96	-0.75	-0.23	-0.48	-0.42	-1.11	-0.21
H	-2.00	-1.31	-1.61	-1.03	-1.28	-1.12	-0.70	-0.76	-1.52	-1.05	-1.11	-0.98	-0.98	-1.30	-0.52
H	-3.00	-2.31	-2.24	-1.66	-2.28	-2.12	-1.07	-1.95	-2.45	-1.18	-1.48	-1.48	-1.36	-1.17	-0.65
V	+1.00	-0.06	+0.76	+0.59	+0.49	+0.62	+0.07	+0.30	+0.54	+0.57	+0.52	+0.15	+0.52	+0.83	+0.85
V	$14A_p$	-0.15	+0.01	+0.14	+0.07	+0.05	-0.07	-0.07	+0.09	+0.07	+0.10	-0.06	+0.10	+0.03	+0.31
V	-1.00	-0.50	-0.86	-0.22	-0.51	-0.37	-0.45	-0.45	-0.96	-0.31	-0.61	-0.35	-0.48	-0.80	-0.33
V	-2.00	-1.38	-1.86	-1.03	-1.14	-1.12	-0.57	-1.32	-1.45	-0.81	-0.98	-0.98	-0.61	-1.55	-0.94
V	-3.00	-2.81	-2.74	-1.91	-2.26	-1.87	-0.57	-1.82	-2.20	-1.43	-1.73	-1.48	-1.48	-3.17	-1.15
H S	+1.00	+0.94	+0.01	+0.34	-0.01	+0.63	+0.18	+0.30	+0.77	+0.32	+0.27	+0.52	+0.39	+0.45	+0.23
H S	$14A_p$	+0.11	-0.07	-0.07	-0.14	+0.05	-0.03	+0.05	+0.21	+0.01	-0.48	+0.06	+0.01	-0105	-0.31
H S	-1.00	-0.69	-0.49	-0.28	-0.33	-0.37	-0.20	-0.07	-0.21	-0.18	-0.73	-0.29	-0.30	-0.42	-0.65
H S	-2.00	-1.31	-0.99	-1.16	-0.95	-0.87	-0.32	-0.70	-0.96	-0.68	-1.11	-0.73	-0.61	-1.24	-1.02
H S	-3.00	-1.81	-1.49	-1.91	-1.26	-1.62	-0.82	-1.57	-1.33	-0.93	-2.23	-1.23	-1.23	-1.92	-1.15
V S	+1.00	+0.19	+0.11	+0.34	+0.49	+0.63	-0.07	-0.07	+0.54	+0.32	+0.77	+0.65	+0.39	+0.33	+0.10
V S	$14A_p$	+0.27	+0.01	-0.16	+0.03	-0.04	-0.16	-0.12	-0.04	-0.01	+0.10	+0.11	+0.05	-0.05	-0.40
V S	-1.00	-0.63	-0.74	-0.78	-0.45	-0.62	-0.32	-0.38	-0.40	-0.31	-0.36	-0.48	-0.48	-0.61	-0.90
V S	-2.00	-1.19	-0.86	-1.53	-1.03	-1.37	-0.32	-1.20	-1.20	-0.68	-1.36	-0.85	-1.05	-1.61	-1.15
V S	-3.00	-1.81	-1.49	-2.40	-1.76	-1.87	-1.07	-1.82	-1.95	-0.43	-1.98	-1.10	-1.73	-2.79	-1.40

Sign Convention: + = Relaxation (Negative Accommodation)

- = Stimulation (Positive Accommodation)

H = Horizontal Target

V = Vertical Target

S = Horizontal Slit in Place

DIFFERENCE FROM MEAN A_p OF A_r AT THE CORRESPONDING A_s

	Subject	DB	KM	GG	GV	BP	RR	DH	OC	LF	BN	PN	GT	MM	AK
	Mean $14A_p$	+2.17	-1.42	-1.54	+0.46	+0.34	+2.10	+1.18	+3.21	+2.26	+2.55	+2.51	+0.25	-0.86	-0.11
H	+1.00	-0.42	+0.17	+0.29	+0.17	+0.53	+0.65	+0.44	+0.54	+0.61	+0.20	-0.01	+0.50	+0.86	+0.36
H	$14A_p$	-0.13	+0.08	-0.13	-0.04	+0.03	-0.31	+0.02	+0.04	+0.03	+0.08	-0.05	+0.08	+0.36	+0.07
H	-1.00	-0.49	-0.55	-0.27	-0.46	-0.34	-1.23	-0.24	-0.71	-0.70	-0.49	-0.58	-0.37	-0.45	-0.45
H	-2.00	-0.92	-0.83	-0.58	-0.92	-0.52	-2.72	-0.81	-1.46	-1.33	-0.55	-0.45	-1.00	-1.07	-0.82
H	-3.00	-0.92	-1.45	-0.71	-1.33	-0.84	-2.60	-0.81	-1.96	-1.14	-0.30	-2.01	-1.25	-2.14	-1.14
V	+1.00	+0.33	+0.30	+0.17	+0.04	+0.66	+0.77	+0.32	+0.54	+0.49	+0.20	+0.36	+0.50	+0.36	+0.36
V	$14A_p$	+0.03	-0.09	+0.08	-0.05	+0.30	+0.31	-0.10	+0.04	-0.18	+0.03	-0.03	0.00	-0.14	-0.01
V	-1.00	-0.17	-0.64	-0.46	-0.46	-0.22	-0.92	-0.37	-0.59	-0.75	-0.49	-0.33	-0.37	-0.82	-0.26
V	-2.00	-0.17	-0.95	-0.71	-0.83	-0.34	-1.47	-0.87	-1.21	-1.39	-0.74	-0.89	-0.75	-1.45	-0.64
V	-3.00	-0.42	-1.95	-1.21	-0.96	-0.59	-2.47	-1.06	-1.96	-2.26	-1.05	-0.89	-1.25	-2.01	-0.89
H S	+1.00	-0.17	+0.05	+0.04	+0.29	+0.16	+0.65	+0.32	+0.04	+0.11	+0.07	+0.11	+0.50	+0.61	+0.23
H S	$14A_p$	0.00	-0.01	-0.08	-0.13	-0.24	-0.06	+0.08	-0.21	+0.11	-0.22	-0.01	-0.08	+0.10	-0.05
H S	-1.00	-0.42	-0.39	-0.14	-0.58	-0.65	-0.79	-0.44	-0.59	-0.08	-0.62	+0.06	-0.25	-0.64	-0.39
H S	-2.00	-0.45	-1.20	-0.08	-0.58	-0.46	-1.29	-0.75	-1.21	-0.76	-0.49	-0.01	-0.25	-1.14	-0.82
H S	-3.00	-0.92	-2.20	-0.46	-0.83	-0.46	-1.73	-1.06	-1.71	-1.01	-0.80	-0.26	*****	-1.39	-1.51
V S	+1.00	+0.08	+0.17	+0.29	+0.54	+0.41	+1.02	-0.06	+0.54	+0.49	+0.20	+0.24	+0.50	+0.86	-0.01
V S	$14A_p$	+0.08	+0.03	+0.09	+0.04	-0.09	+0.06	-0.02	+0.12	+0.03	+0.07	+0.09	0.00	-0.14	-0.01
V S	-1.00	-0.17	-0.76	-0.14	-0.21	-0.46	-0.67	-0.37	-0.46	-0.58	-0.55	+0.17	-0.25	-0.89	-0.45
V S	-2.00	-0.55	-1.33	-0.21	-0.34	-0.84	-0.73	-0.93	-1.21	-0.89	-1.05	-0.01	-0.37	-1.76	-0.70
V S	-3.00	-0.92	-2.08	-0.46	-0.46	-1.59	*****	-0.93	-1.96	-1.64	-1.18	-0.01	*****	-2.14	-0.89

Sign Convention: + = Relaxation (Negative Accommodation)

\- = Stimulation (Positive Accommodation)

H = Horizontal Target

V = Vertical Target

S = Horizontal Slit in Place

DIFFERENCE FROM MEAN C_p OF C_r AT CORRESPONDING A_s

	Subject	GM	KB	RM	ED	BD	DF	RB	GI	DR	LL	DN	KB	JJ	TB	DB
	Mean C_p	1so	5so	6so	3so	6so	6so	2xo	8so	12s	1xo	3so	θ	7so	12s	6so
H	+1.00	-3	-7	-4	-2	-2	-2	-1	-2	-3	-4	-1	-3	-7	-6	-3
	$14A_p$	0	-2	0	0	0	+1	0	-1	+1	+1	0	0	+1	-2	-1
	-1.00	+7	+2	+3	+5	+3	+1	+4	+6	+5	+2	+2	+7	+8	+2	+1
	-2.00	+13	+7	+7	+10	+6	+3	+8	+8	+11	+9	+5	+13	+11	+6	+11
	-3.00	+23	+9	+9	+13	+10	+4	+14	+10	+14	+17	+9	+16	+15	+10	+16
V	+1.00	-3	-3	-3	-3	-2	-1	-2	-3	-1	-3	-3	-5	-5	-4	-4
	$14A_p$	0	0	+1	0	+1	0	0	+2	0	-1	0	+1	0	-1	-1
	-1.00	+8	+4	+5	+5	+3	+1	+2	+7	+5	+5	+2	+8	+8	+4	+6
	-2.00	+14	+10	+11	+6	+2	+5	+10	+10	+11	+5	+14	+14	+10	+14	+10
	-3.00	+15	+13	+12	+13	+8	+4	+10	+15	+16	+15	+9	+20	+21	+12	+19
H S	+1.00	+2	+2	-3	-2	0	-2	-1	-3	0	-1	-3	-2	-4	+3	-2
	$14A_p$	0	+2	-1	0	0	-1	+1	0	0	+2	-1	0	-1	+2	+1
	-1.00	+3	+3	+3	+4	+2	+1	+4	+1	+3	+6	-1	+3	+5	+4	+6
	-2.00	+12	+8	+8	+8	+6	+2	+8	+5	+11	+9	0	+6	+9	+8	+13
	-3.00	+15	+15	+11	+10	+8	+2	+14	+7	+14	+15	+2	+13	+17	+10	+19
V S	+1.00	-3	+1	-2	-2	0	-1	-1	-2	-1	-2	-3	-3	-5	-2	-1
	$14A_p$	0	0	0	-1	+1	+1	-1	0	0	0	-1	0	+1	+2	0
	-1.00	+6	+5	+2	+4	+4	+2	+5	+3	+7	+4	0	+6	+8	+3	+8
	-2.00	+18	+9	+7	+8	+7	+3	+6	+7	+11	+7	+13	+14	+15	+8	+14
	-3.00	+27	+15	+11	+11	+8	+2	+6	+8	+16	+12	+5	+20	+22	+10	+18

Sign Convention: + = Stimulation (Positive Convergence) in Prism Diopters

- = Relaxation (Negative Convergence) in Prism Diopters

H = Horizontal Target

V = Vertical Target

S = Horizontal Slit in Place

DIFFERENCE FROM MEAN C_p OF C_r AT CORRESPONDING A_s

	Subject Mean C_p	KM 5so	GG 4so	GV 9so	BP 7so	RR 1so	DH 1so	OC 9so	LF 7so	BN 4so	PN 8so	GT 8so	MM 9so	AK 13s	KH 2so
	+1.00	-3	-1	-2	-2	-5	-1	-5	-3	-2	-6	-4	-5	-1	-2
H	$14A_p$	-2	+1	-1	+1	-2	0	-1	+1	-1	-1	0	-1	0	0
	-1.00	+2	+4	+3	+5	+2	+4	+5	+5	+4	+4	+4	+3	+5	+3
	-2.00	+6	+4	+5	+7	+9	+7	+8	+10	+10	+9	+5	+8	+12	+5
	-3.00	+9	+6	+6	+11	+13	+11	+15	+13	+13	+12	+12	+13	+16	+6
	+1.00	-1	0	-2	-2	-4	-1	-5	-2	0	-4	-2	-4	-5	-1
	$14A_p$	+1	+1	-1	0	-2	+1	-2	+1	+2	+2	-1	-1	-1	+1
V	-1.00	+5	+4	+3	+4	+3	+3	+5	+5	+3	+3	+2	+4	+2	+4
	-2.00	+9	+8	+5	+6	+8	+6	+7	+10	+7	+9	+6	+8	+10	+4
	-3.00	+11	+9	+7	+9	+11	+9	+13	+14	+10	+14	+12	+11	+14	+6
	+1.00	-2	0	-1	-1	-3	-1	-1	-2	0	0	-2	-5	-1	-2
	$14A_p$	+1	0	0	-1	+1	-1	+2	-2	+1	0	0	0	+3	0
H	-1.00	+4	+1	+2	+3	+1	+3	+2	+3	0	+2	+2	+3	+5	+1
S	-2.00	+6	+2	+1	+3	+5	+2	+6	+8	+6	+3	+5	+7	+9	+4
	-3.00	+10	+4	+2	+4	+9	+7	+9	+9	+11	+8	+12	+8	+10	+6
	+1.00	-1	-1	-1	-2	-1	-2	-1	-5	0	+2	+1	-5	-3	-1
	$14A_p$	-1	-1	0	0	+1	0	+2	-2	0	-1	+1	0	-1	0
V	-1.00	+4	0	+1	+2	+5	+1	+8	+2	+3	0	+2	+5	+5	+3
S	-2.00	+10	+2	+4	+2	+9	+3	+10	+8	+6	+8	+4	+7	+9	+4
	-3.00	+13	+4	+6	+9	+13	+5	+13	+13	+12	+9	+9	+9	+15	+6

Sign Convention: + = Stimulation (Positive Convergence) in Prism Diopters

- = Relaxation (Negative Convergence) in Prism Diopters

H = Horizontal Target

V = Vertical Target

S = Horizontal Slit in Place

STATISTICAL DATA FOR ACCOMMODATION

	CONDITION	MEAN	STANDARD DEVIATION	STANDARD ERROR	VARIANCE
H	+1.00	+.468	.297	.055	.088
	$14A_p$	+.009	.161	.026	.026
	-1.00	-.546	.291	.054	.085
	-2.00	-1.033	.450	.083	.202
	-3.00	-1.489	.608	.113	.369
V	+1.00	+.438	.247	.046	.061
	$14A_p$	+.020	.130	.024	.017
	-1.00	-.494	.220	.041	.048
	-2.00	-.982	.400	.074	.160
	-3.00	-1.594	.726	.135	.528
HS	+1.00	+.300	.257	.048	.066
	$14A_p$	-.046	.146	.027	.021
	-1.00	-.391	.221	.041	.049
	-2.00	-.788	.360	.067	.130
	-3.00	-1.285	.508	.096	.258
VS	+1.00	+.343	.287	.054	.083
	$14A_p$	-.034	.121	.022	.015
	-1.00	-.467	.238	.044	.057
	-2.00	-.934	.430	.080	.185
	-3.00	-1.449	.661	.127	.436

STATISTICAL DATA FOR CONVERGENCE

	CONDITION	MEAN	STANDARD DEVIATION	STANDARD ERROR	VARIANCE
H	+1.00	-3.172	1.713	.317	2.933
	$14A_p$	-.276	.996	.185	.993
	-1.00	+3.828	1.794	.333	3.219
	-2.00	+8.034	2.680	.497	7.177
	-3.00	+11.552	4.231	.787	17.899
V	+1.00	-2.690	1.490	.276	2.222
	$14A_p$	+.103	1.113	.206	1.239
	-1.00	+4.241	1.864	.345	3.475
	-2.00	+8.586	3.100	.575	9.608
	-3.00	+12.069	3.927	.727	15.424
H S	+1.00	-1.300	1.664	.308	2.769
	$14A_p$	+.310	1.105	.204	1.221
	-1.00	+2.690	1.692	.314	2.864
	-2.00	+6.207	3.244	.601	10.527
	-3.00	+9.690	4.481	.832	20.079
V S	+1.00	-1.621	1.678	.310	2.815
	$14A_p$	0.000	.926	.171	.857
	-1.00	+3.690	2.392	.444	5.722
	-2.00	+7.690	3.992	.741	15.936
	-3.00	+11.241	5.661	1.050	32.047

STATISTICAL COMPARISONS

CONDITION TO CONDITION	ACCOMMODATION "T"	CONVERGENCE "T"
H TO V	.77314	1.50468
H TO HS	3.56254 *	4.19470 *
H TO VS	.98413	.74803
V TO HS	3.14795 *	5.44885 *
V TO VS	.61135	2.20134
HS TO VS	3.04205 *	3.12131 *

Significant "T" value to the .01 level = 2.763

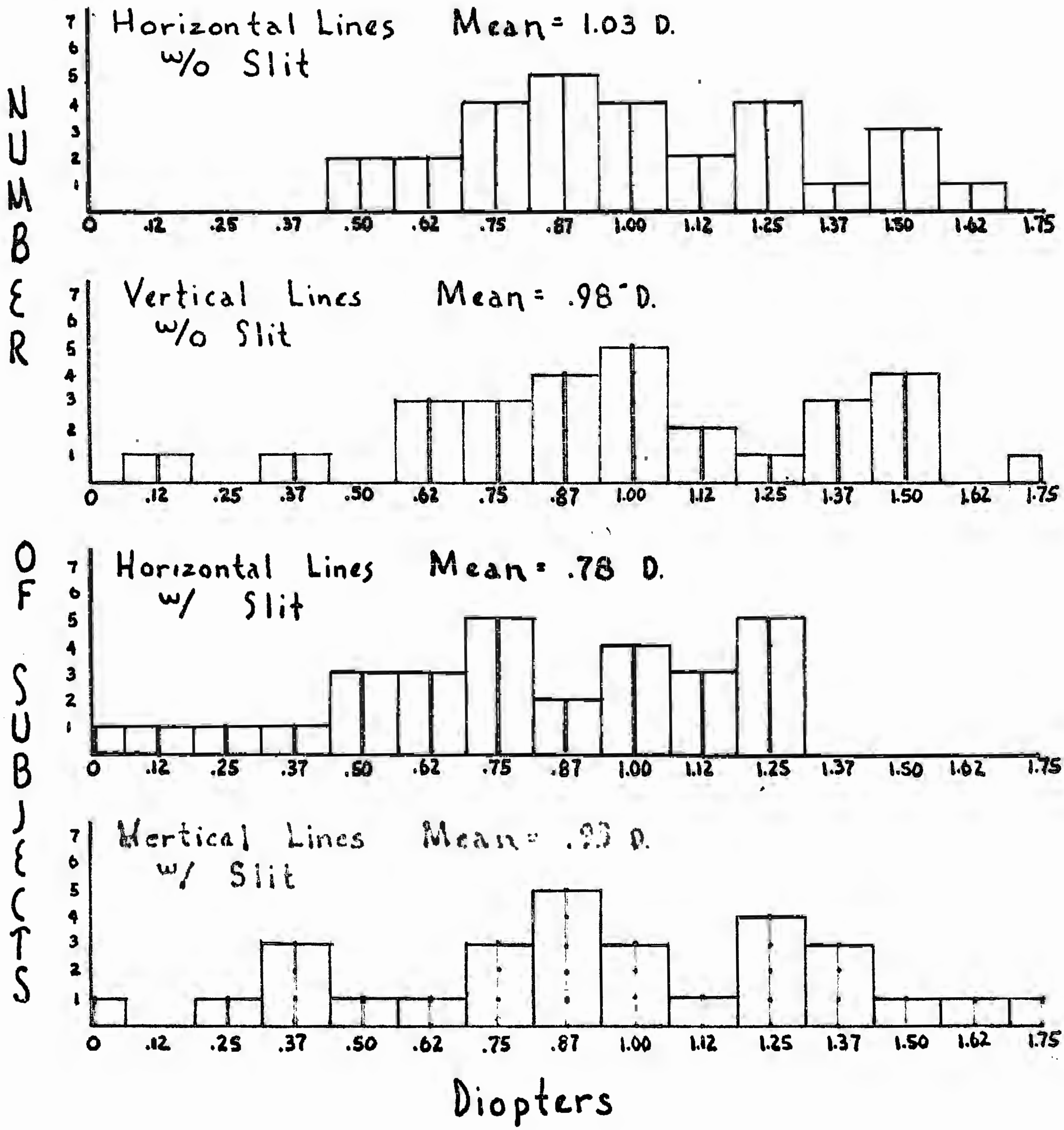
H = Horizontal Target

V = Vertical Target

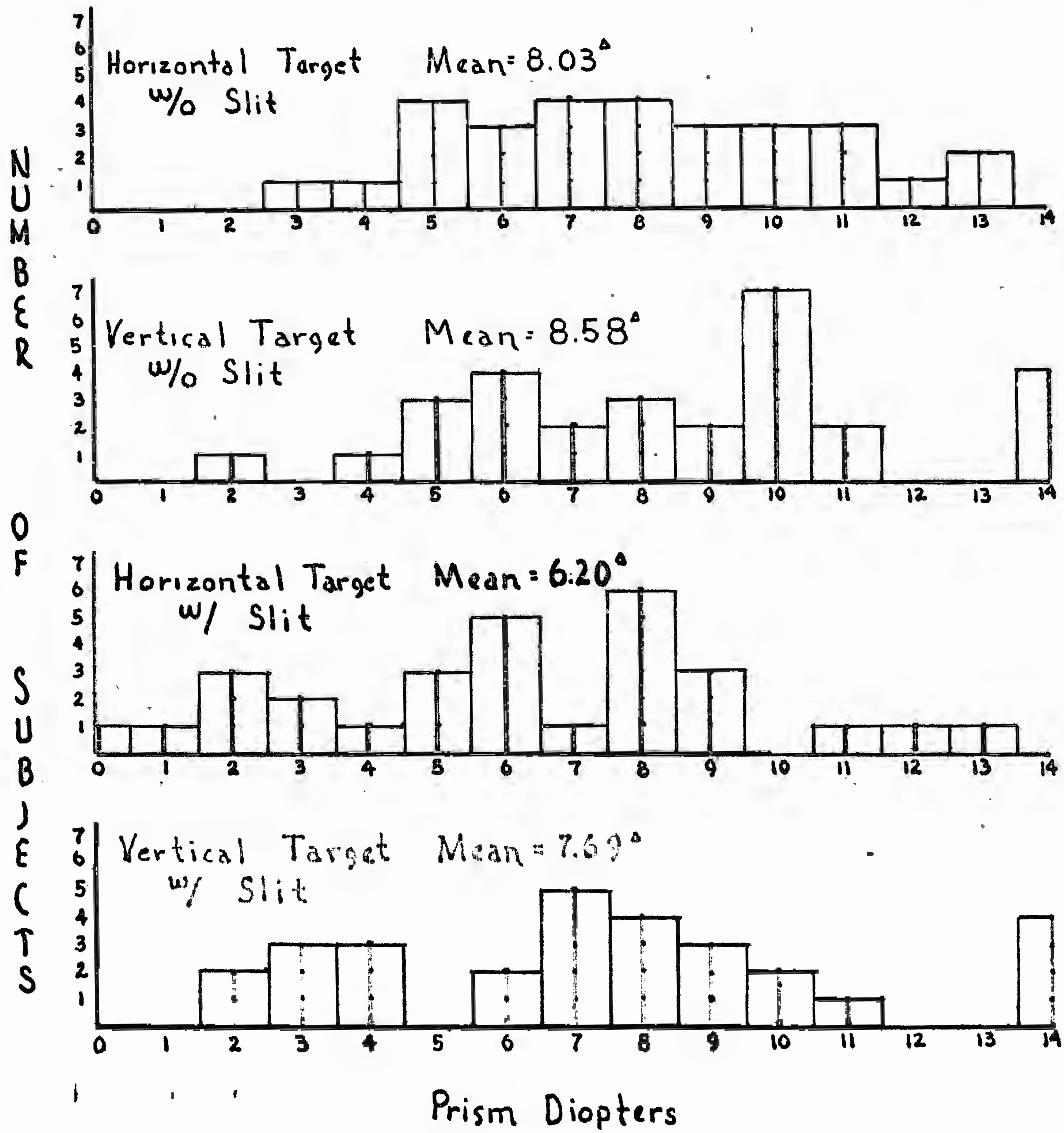
S = Horizontal Slit in Place

* = Significant Findings

Frequency Distribution of Accommdative Respones at -2.00 Diopter Stimulus Level



Frequency Distribution of Convergent Respones at -2.00 Diopter Stimulus Level



three conditions where the non-paraxial rays were not restricted from forming a large retinal blur circle. Considering the relatively gross target, (20/120), this accommodative response of 50% is 70% of the response usually elicited by targets 20/20 in detail. At the -2.00D stimulus level, the average mean accommodative response was .986D. In the condition where the paraxial rays were restricted, the consensual accommodative response was approximately 40% that of the accommodative stimulus. At the -2.00D stimulus level, the mean consensual accommodative response was .788D.

Considering the interaction of accommodation and convergence, the convergence activity was also decreased in the condition with the reduction of the accommodative response and was maintained at a consistently higher level in the other three conditions of the higher accommodative response. Statistical evaluation of the data also showed the aforementioned hypothesis to be proven correct to the .01 level.

It must be noted that all the subjects were between 22 and 31 years of age and all were optometry students. This may have been a biasing factor. The subjects may be assumed to have active accommodative and convergence systems of average or above average facility. The data indicates the manner with which normal subjects react.

If this study were to be redone or expanded, there are several appropriate suggestions one might consider. Further testing could involve a vertical slit rather than a horizontal slit and results compared. Also, one may randomly vary the order of presentation of conditions between subjects to act as a control for fatigue factors. Different angular subtense of lines may be employed.