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A clinical investigation of suppression behavior and its measurement in strabismus and amblyopes

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A clinical investigation of suppression behavior and its measurement in strabismus and amblyopes

Abstract

A clinical investigation of suppression behavior and its measurement in strabismus and amblyopes

Degree Type

Thesis

A Clinical Investigation
Of Suppression Behavior And Its
Measurement In Strabismics
And Amblyopes

This thesis is submitted as
partial requirement for the Doctor
of Optometry degrees of Robert Gander
and Morris Kuhlman.

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ACKNOWLEDGMENTS

We would like to express our thanks and appreciation to Dr. Clifford Schor and Dr. Niles Roth for their advice and help. We would also like to express our appreciation to all the subjects, past and future, for putting up with the inconvenience and trauma (headache) we caused them.

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INTRODUCTION

For their 1975 O.D. thesis project, Gordon Woods, Daniel Jacks and Larry Robertson developed an apparatus for measuring the size of suppression scotomas in strabismics and amblyopes. The description of their apparatus is enclosed in this paper (see Equipment and Apparatus).

Woods, et al, were only able to test this equipment on one subject. The findings suggested promise as a tool in the search for the mechanism of suppression. Our study involved the testing of five additional subjects to attempt to gather and analyze data to determine if this tool could in fact be used to investigate the mechanism of suppression.

Suppression

Suppression is an adaptation commonly found with strabismics. The size of the suppression is frequently used clinically to determine the degree or severity of the suppression response.

In the laboratory, different stimulus conditions have been arranged to elicit a suppression response. These different conditions have demonstrated the potential for several different suppression mechanisms. Could one of these types of suppression mechanisms be responsible for the suppression behavior in strabismics and/or amblyopes? Or could there be an interplay of these mechanisms that results in this response? Possibly one mechanism is responsible for suppression at one time and set of conditions, and another mechanism works for another set of conditions in the natural environment. We hoped the Woods apparatus would help us find more clues to answer these questions.

Psychophysical Studies

The simultaneous presentation of two dissimilar contours of corresponding points on the retina can trigger suppression. Inhibitory interactions of this type are said to be resulting from retinal rivalry. This response can be elicited to corresponding areas not just points. These areas or zones are referred to as contralateral suppression fields (CSF's). At the fovea the CSF is about 14" of arc. In the periphery this zone gets larger, much as the size of Panum's fusional areas.

Suppression results from the simultaneous presentation of similar contours to corresponding retinal areas in each eye. This type of contour interaction results in the inhibitory response known as lateral masking.

Both of these types of suppression involve simultaneous contour interaction that is the condition the strabismic (and normal) system must deal with in the day-to-day visual invironment. One or both of these mechanisms may come to play in the strabismic suppression response. Important variables that influence each of these mechanisms include retinal image size, contour density, contrast, color and motion.

HYPOTHESIS

Our purpose in this study was to investigate the mechanism of suppression, utilizing the apparatus developed by Woods, et al. Our basic assumption was that this mechanism is triggered by the retinal rivalry and/or lateral masking. We further assumed that using the Woods apparatus, the degree of suppression would be reflected by the size of the scotomas.

Our hypothesis then was if lateral masking is the mechanism of the suppression response in strabismics and/or amblyopes, then we expect greater suppression scotomas with similar contours or gratings oriented with 20° of each other than with dissimilar contours. Conversely, if retinal rivalry is the mechanism of suppression, then the orientations greater than 20° from each other would show the greatest suppression.

Gratings of different frequencies were used systematically to determine if this was an important variable in the study. If we were to pick a "poor" frequency, perhaps we could not demonstrate the mechanism at this frequency but could for other frequencies.

EQUIPMENT AND APPARATUS

Our purpose is to investigate suppression zones in strabismic individuals. To do this, it is necessary to have an instrument which operates in as near normal conditions as possible. We designed our apparatus to function as closely to this ideal as possible.

The dominance of one eye over the other can be influenced by retinal image size, contour density, contrast, luminance, color, motion, and contour separation. Therefore, we tried to control as many of these as possible. Image size was controlled by the use of an adjustable aperture. Contour density was one of the experimental variables which was controlled by the use of gratings with variable spatial frequencies. Contrast was not controlled but was limited to the photographic quality of the grids used. Color difference was avoided with the use of polarizing filters for dissociation. Luminance was controlled by the use of neutral density filters. Contour separation was limited again by the photographic reproduction of the gratings.

Our fixation pattern for the dominant eye was projected onto the screen opposite the subject (see Figure II). The grids were placed on slides which could be easily interchanged for frequency variations, and rotated for orientation changes (see Figure III). Various frequencies were obtained by placing one of seven grids in position and the overhead projector at a particular (marked) floor position (see Table I).

The deviating eye's pattern was projected onto the screen by the B & L Autoplot. The Autoplot had been modified to project one of these grids at a time. The following formula may be used to calculate the number of lines per inch which are required in the grid in order to yield the desired spatial frequency. This assumes a screen to Autoplot distance of one meter. Each grid was of the same orientation (90 degrees). This target was movable by the nature of the Autoplot mechanism, and allowed the suppression zone to be explored.

Cycles/Degree x 16 = Cycles/Inch
(Needed at one　　(Cycles required
meter distance)　　on projected grid)

(for example: to obtain a 4 cy/degree grid to the deviating
eye, 4 cy/degree x 16 = 84 cycles/inch on
projected grid.)

The screen was a special projection screen designed for use with polarized light, one side of which is frosted and the other smooth. The smooth side is toward the overhead projector and the frosted side is placed toward the subject and the Autoplot projector.

A zero setting, compensating planimeter was used to measure the area of each suppression scotoma. The most sensitive arm setting was used and the following conversion factor yields square centimeters (cm^2). Each scotoma was measured three or four times. These readings were averaged, then multiplied by the conversion factor. "

For arm setting of 4:
Planimeter reading (average x .0334 = cm^2

PROCEDURE

Our experiment was divided into three steps. In Step I, relative orientation remained constant as the gratings were kept parallel to each other and vertical. Three spatial frequencies were used as the independent variables. In Step II, one of the independent variables was degrees from parallelism. In this experiment there were three separate blocks of tests. One using gratings of 2 cy./deg., one of 4 cy./deg., and one of 8 cy./deg. In Step III, the independent variable was spatial frequency of the mask using the 2, 4 and 8 cycle/degree targets. The rest of the procedure was identical to that developed by Woods, et al.

"During each session, the subject was seated at the Autoplot with his chin on the chin rest. A trial lens frame with polarized lenses was placed over the subject's habitual correcting lenses. The subject was asked to turn the polarized lens before his preferred eye until the Autoplot disappeared. This was done while the non-preferred eye was occluded. Then, while the preferred eye was occluded, the polarized lens was turned before the non-preferred eye until the overhead projected target disappeared. This completed the dissociation.

To locate the area of the suppression scotoma, a vertical and horizontal Vernier alignment was performed. This marked the corres-

Figure II

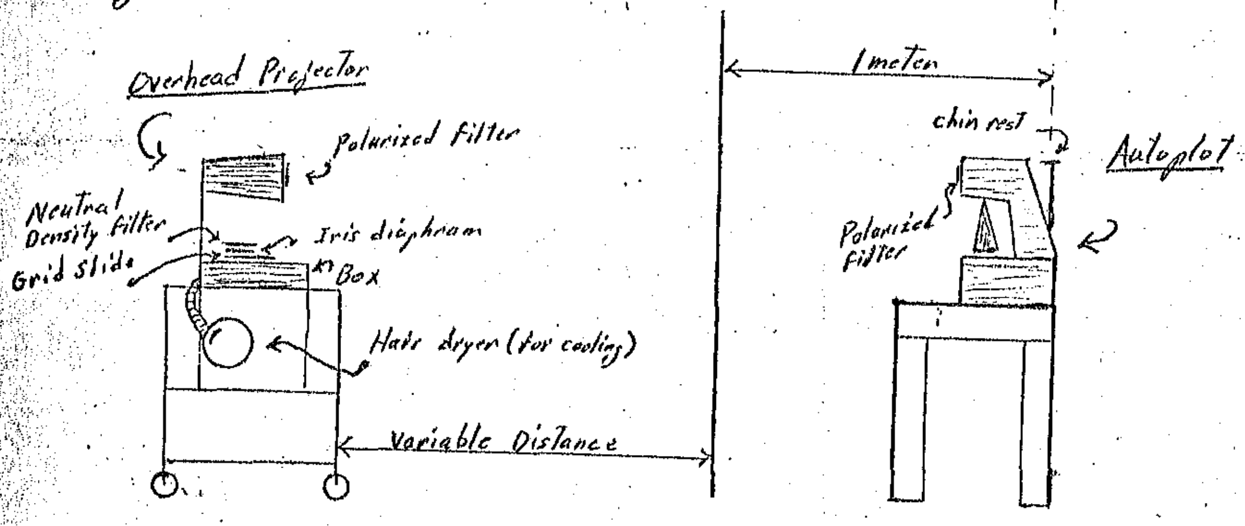
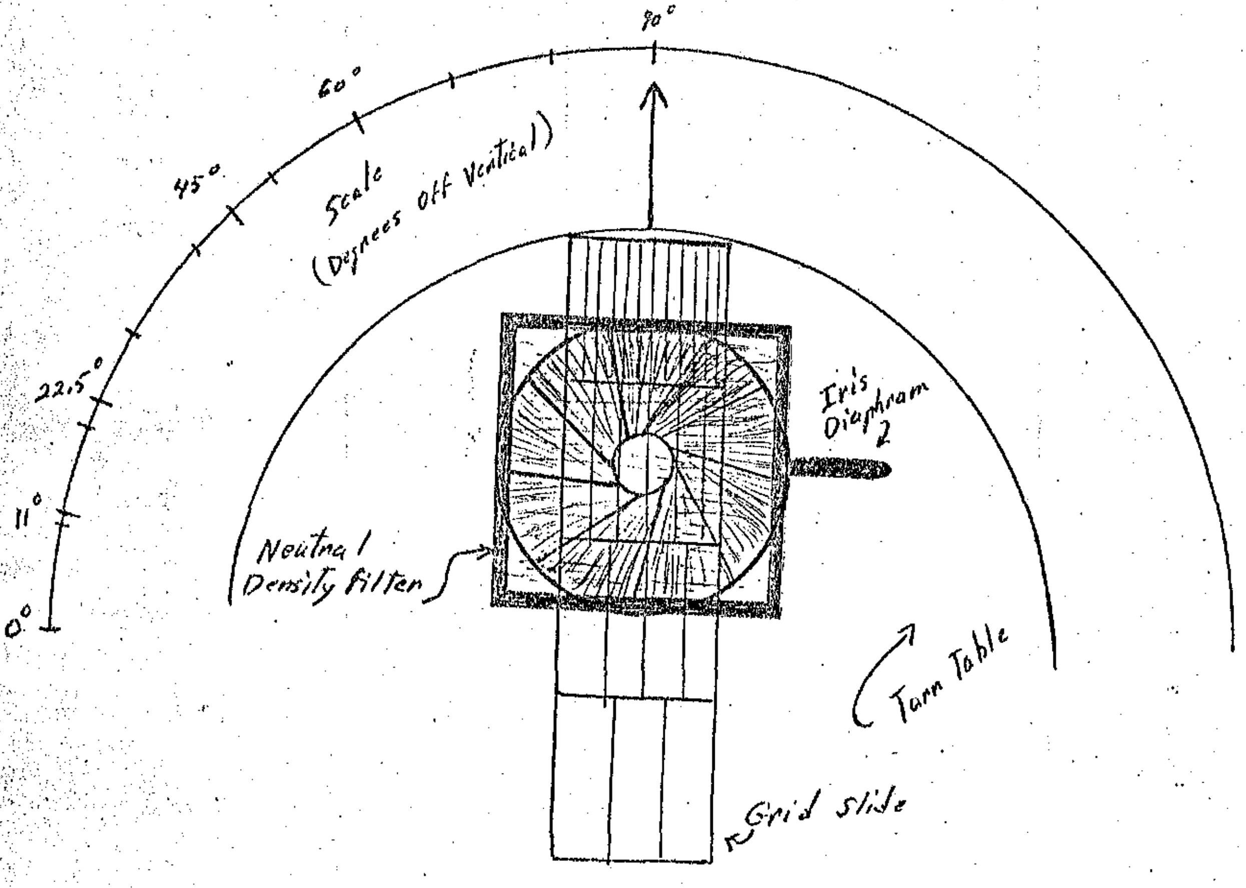


Figure III



ponding retinal points at the subjective angle of squint. This would be the diplopia point in normal retinal correspondence (NRC) or zero measure point in anomalous retinal correspondence (ARC).

The target provided by the overhead projector was established by placing the proper grid in place and positioning the projector at the marked floor position relative to the screen. (See Table I or Table II). One person was required for this maneuver, while another watched from the Autoplot side of the screen to determine the focus. Once the focus is refined, target (spot) size is adjusted by superimposing the Autoplot target over the overhead projected target. The Autoplot subtends an angle of 1.25 degrees which corresponds to 22 mm at a distance of one meter. The overhead projectionist then adjusts the iris diaphragm until the target sizes are equal. At this point, neutral density filters are placed over the grids on the overhead projector to balance the luminance of the overhead target with the Autoplot target. Focus, target size and luminance adjustments were required each time the projector to screen distance was changed. Orientation may be varied by rotation of the slide to the proper position. Spatial frequency changes of the Autoplot target is accomplished by simply turning the dial until the proper grid aperture is in place. No further adjustment is necessary for this instrument.

During testing, the subject was told to be alert to any eye pain or headaches. We found that eye pain in the non-dominant eye generally preceeded the headache. When eye pain was noticed, testing was discontinued. If continued, as in the early testing procedure, a headache of several hours duration was caused.

The suppression scotoma was plotted from non-seeing to seeing to prevent the possible collapse of the scotoma. We found that it was necessary to move toward the lateral edges of the scotoma and wait for suppression to occur. This may indicate deeper suppression at the lateral edges of the scotoma. It was also noticed that the plotting of the scotoma required slow and steady movement of the Autoplot target. We determined that one person should take all the readings for each particular subject. This eliminated measuring errors caused by differing technique."

RESULTS

Step I

In this experiment, orientation was constant and frequency was varied equally for the mask and measuring targets. With spatial frequency and orientation identical for both the mask and target, no consistent result was found among all five subjects. Subjects G.W. and R.Y. had a drop in both the area and vertical diameter of the suppression with the finest grating (8 cy/deg.). R.Y. had a sizeable increase at 4 cy/deg. in vertical diameter but a reduction in total area. Subjects P.S. and B.O. displayed similar patterns with an increase in suppression in both diameter and area with the finest grating after a decrease in suppression from the coarsest to the intermediate frequency. P.S. and B.O. showed inverse patterns to that of R.Y. and G.W. With finer gratings subject D.V. had more suppression in the vertical dimension but showed less suppression in the total area.

Step II

In this experiment suppression areas were plotted as a function of relative orientation of two different gratings. Fine, intermediate and coarse gratings were used.

Subject P.S. suppressed in a larger area for the perpendicular than the parallel orientation for all gratings. This effect was not consistent for all the orientations in between. Suppression increased then decreased in an inconsistent fashion. That is, when the suppression area increased for the finer grating it might decrease, stay the same, or increase for the other gratings in that orientation. This was also true for the data on vertical diameter which did not even show a consistent relationship with the area measurements as one might expect.

Subject R.Y. had small changes in the size of the suppression areas for the 0° and 90° settings for all gratings. For the finest and coarsest gratings there were slightly larger suppression areas and for the intermediate grating there was a small decrease. However, while the size of the area was relatively stable for the extreme gratings, the intermediate grating produced a much larger suppression area for the 11°, 22.5°, 45° and 60° orientations. This pattern was also found with the vertical measurements. No data was graphed for the vertical measurement of the coarser gratings as the initial fixation points were not recorded. Generally smaller areas were recorded for the coarser gratings.

The data on subject D.V. revealed one pattern where there was greater suppression and one where there was less suppression with the 90° orientation than the parallel and one where there was only a small change. The intermediate orientations show no consistent relationship between the different gratings. Again it was generally found that the coarser grating produced smaller suppression areas and diameters although the intermediate grating produced the largest suppression areas. The coarser grating had less suppression with the 90° orientation, the intermediate grating produced more suppression with the 90° orientation than the parallel and the finer grating produced a small decrease for the 90° orientation.

Subject B.O.'s data displays an unusual peaking of the largest suppression area in the 45° orientation but only for the coarser gratings. There is more suppression with this grating in the 90° position. Both the finer gratings showed slightly less suppression for the 90° position. No prominent relationship was found between gratings or among the orientations with the same grating. The vertical diameter was fairly consistent with the area suppressed for B.O. No consistent relationship could be seen between the coarser and finer gratings here.

With subject G.W., the largest difference between the 0° and 90° settings was with the fine grating. Here there was more suppression for the orthogonal than with the parallel orientation. The intermediate showed less change but in the same direction and the coarse grating showed about the same amount of suppression for these two orientations. With G.W., the finer targets produced greater suppression areas. Except for a peak in the vertical dimension of the suppression area for the 22.5° setting with the coarse grating, the vertical and area measurements produced a somewhat similar graphical pattern.

Between the subjects there appears no common patterns other than the generally smaller suppression areas for the coarse grating with R.Y. and D.V. Nearly every type of pattern had a contradictory pattern by another subject and frequently within the same subject. Inconsistencies seemed to be the rule rather than the exception.

Step III

In the third and final step of this procedure, again there was disappointingly no qualitative trend in suppression as a function of mask frequency. Subject B.O. showed an expected increase in suppression area at 0 octaves difference between the test probe and mask stimulus at 2 cy/deg. The vertical diameter, on the other hand, did not correlate with the area and instead remained virtually unchanged for this same frequency. For a test frequency of 4 and 8 cy/deg. there were no noteworthy trends as the data remained scattered for the vertical diameter as well as the area. The least amount of suppression was actually found in the 0 to +0.5 octaves difference in frequency.

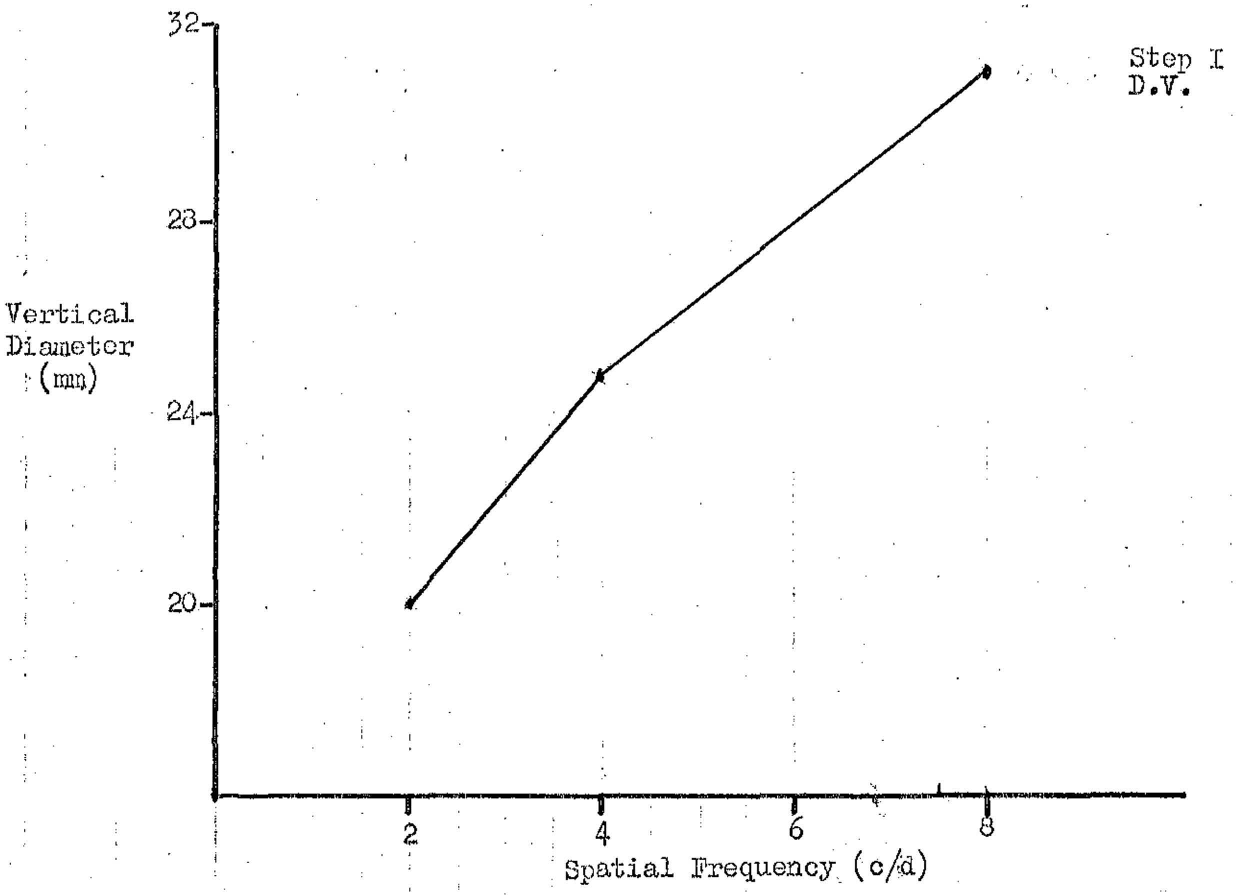
R.Y. showed similar responses for 2 cy/deg. for the area measurements but the vertical diameter this time followed the area. No significant trends could be demonstrated at this time.

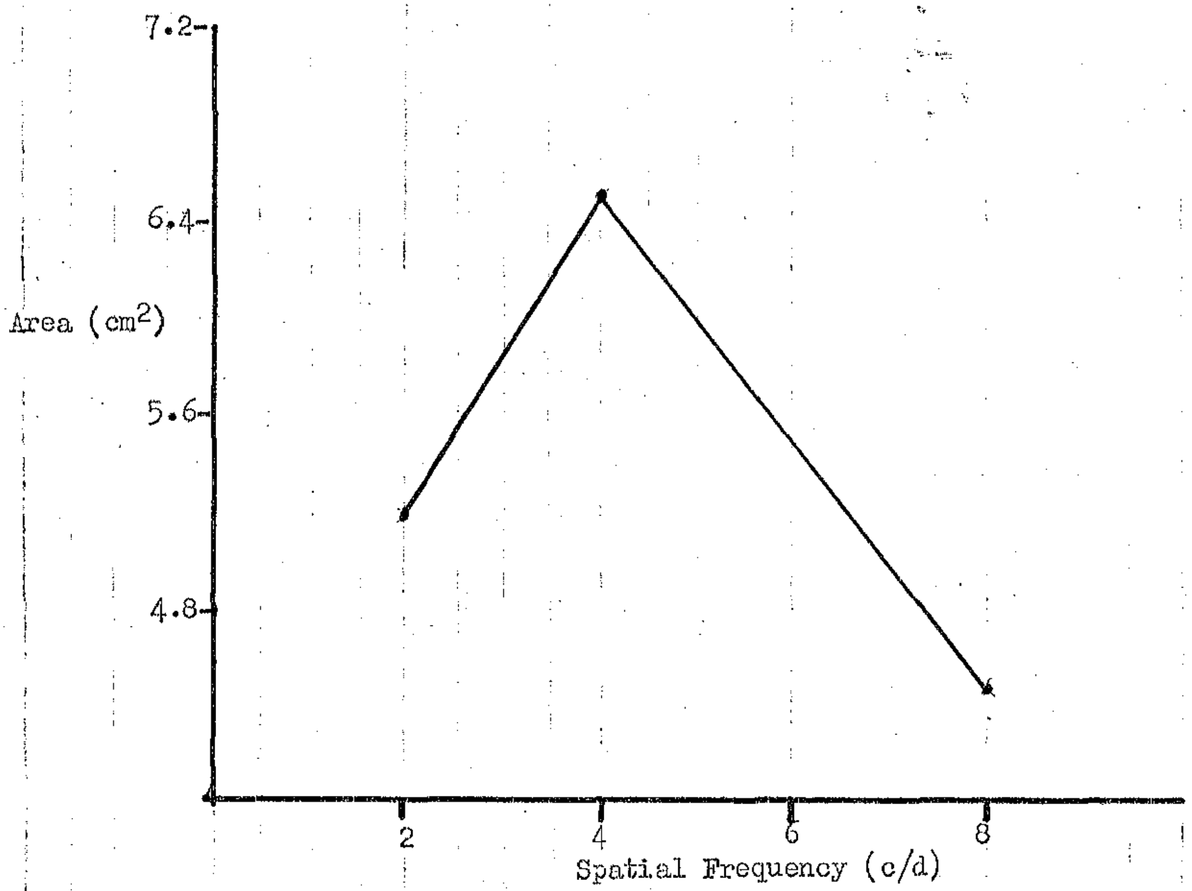
P.S. demonstrated no significant variation when changing frequencies of the probe gratings. There was a general rise in suppression area (which was not totally indicated however in the vertical diameter) as the mask was increased in frequency with respect to the test probe.

D.V.'s results were a complete scatter. The graphs reveal undulating patterns without correlation or predictability. Suppression seemed to not change a great deal overall. The vertical diameter did somewhat follow the area but only further revealed an already obvious randomness.

G.W. also showed a stable pattern without overwhelming variation. As the suppression increased slightly when the targets became similar at the 8 cy/deg. test frequency, so did the suppression decrease for the 4 cy/deg. test frequency, while the 2 cy/deg. underwent but little change. The vertical diameter revealed a similar pattern and thus can be given the same description.

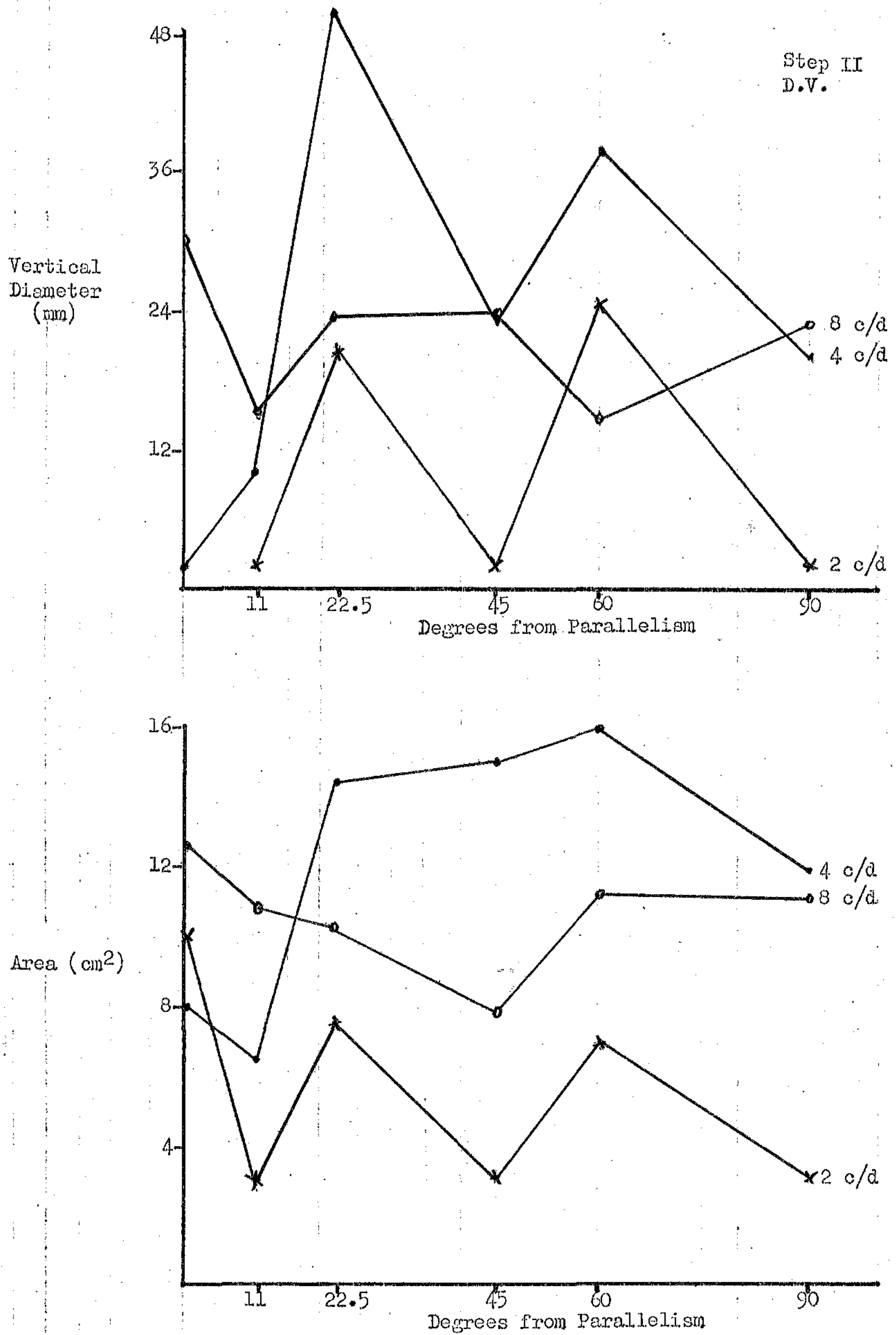
The results of the third step include one similarity between the suppression of B.O. and R.Y. Both show an expected increase as the test and mask became similar with respect to frequency. This occurred for the 2 cy/deg. test frequency only as the 4 and 8 cy/deg. gratings were almost reversed. Only in R.Y. however did the vertical diameter relate to the area measured. In all of the remaining data there was no trend or consistency with suppression as a function of test frequency or as a function of differences in frequency between the test and mask stimulus.



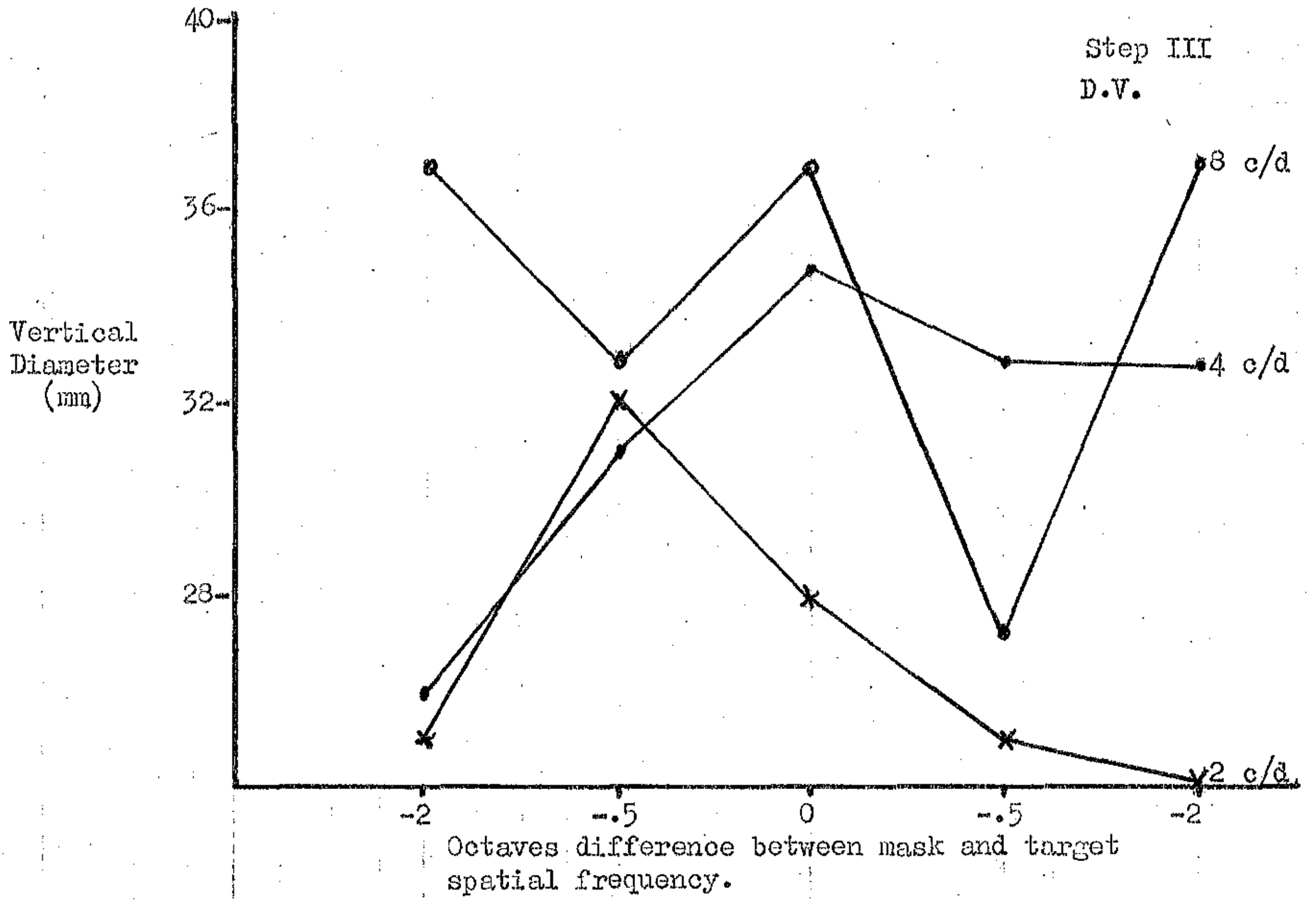


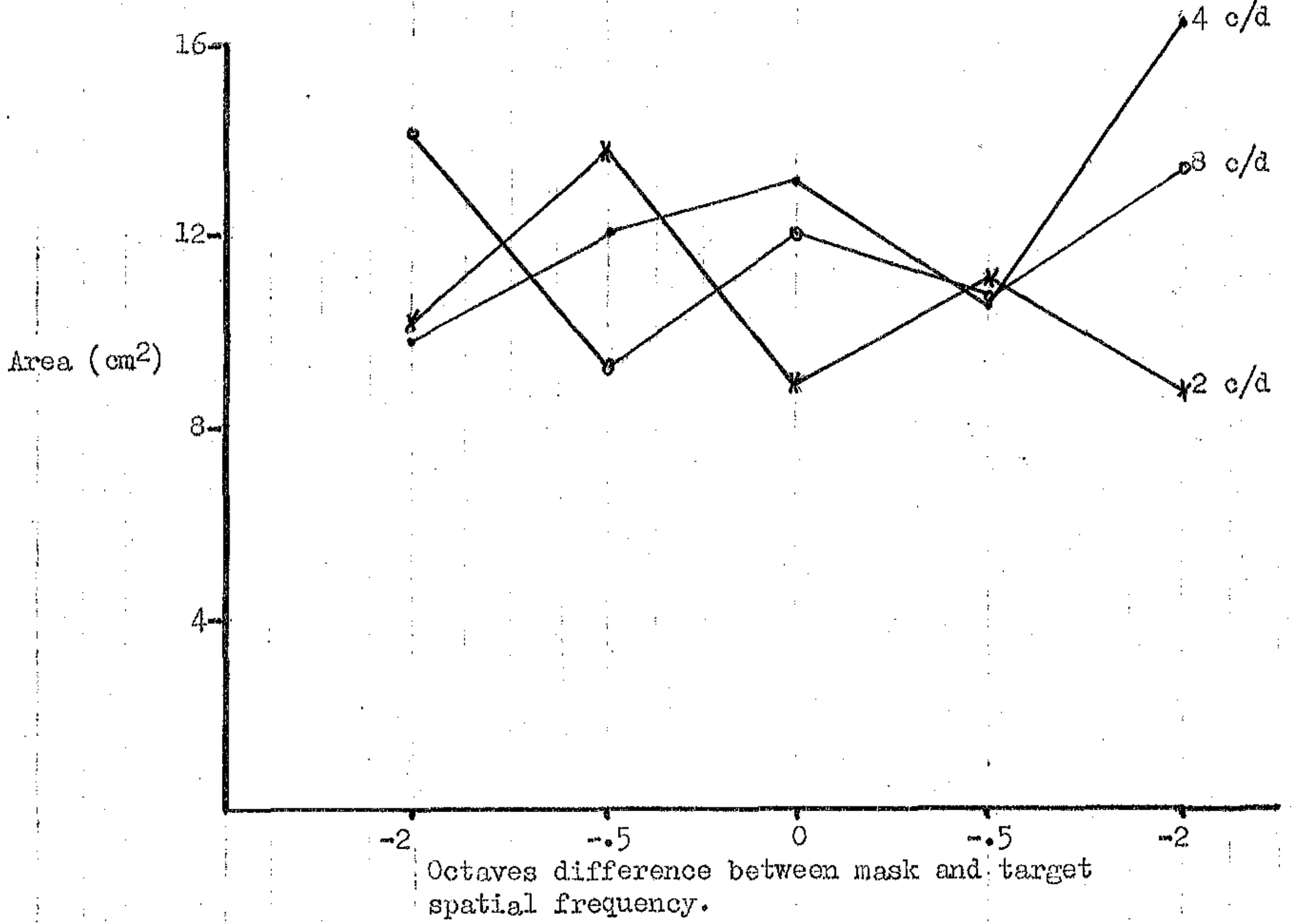
Target frequency and orientation is the same before each eye.

Simultaneous Contrast



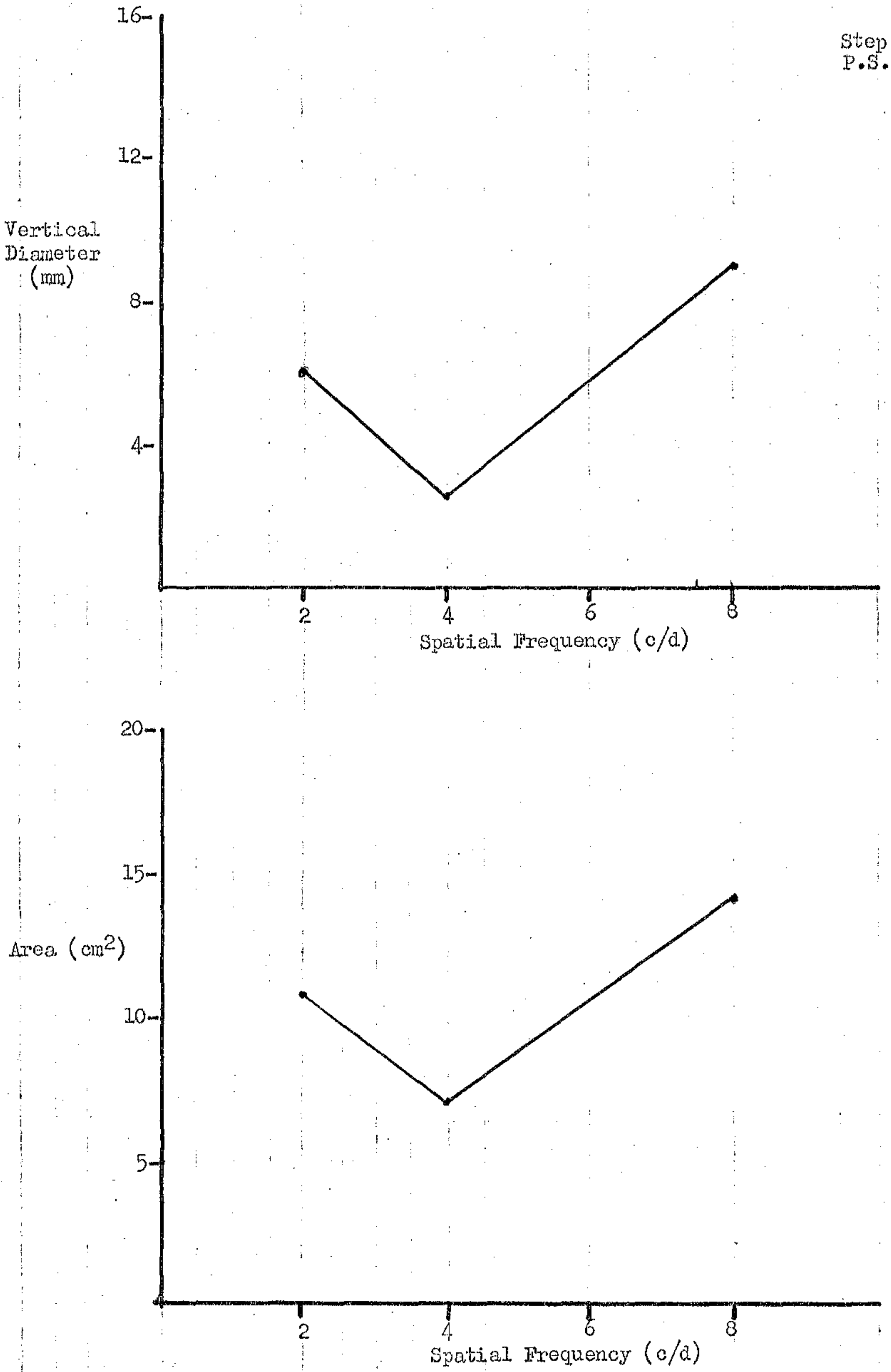
Target frequency the same before each eye
Fixation target varied in orientation
Simultaneous contrast to retinal rivalry stimuli





Target orientation remains constant
Fixation target frequency varied before each eye
Lateral Masking

Step I
P.S.



Target frequency and orientation is the same before each eye.

Simultaneous Contrast

TABLE I

Suppression area (A) and its vertical diameter (V.D.) of a test probe of vertical gratings of 2, 4 and 8 cy./deg. presented to the deviating eye. The mask stimulus consists of parallel gratings of equal frequencies and are presented to the fixing eye.

Suppression		Spatial Frequency of Test Probe					
Area in mm. V.D. in cm^2	Subject	2		4		8	
		A	V.D.	A	V.D.	A	V.D.
Test probe frequency equals the mask frequency	D.V.	5.18	20	6.4	25	4.4	31
	P.S.	1.06	6	0.68	2.5	1.38	9
	G.W.	0.87	14	0.94	15	0.74	11
	R.Y.	3.44	13	2.43	19	2.05	4
	B.O.	13.8	67	4.3	29	7.7	45

TABLE II - PROCEDURE

Step I	Same frequency, same orientation
Step II	Same frequency, vary orientation
Step III	Vary frequency, same orientation

Cond.		Frequency Autoplot	Frequency Overhead	Orientation Overhead	Orientation Autoplot	Grid # and Floor Pos. Overhead
Step) I)	1	2 c/d 0.5	2 c/d	Vertical	Vertical	3/IV
	2	4 c/d 2	4 c/d	"	"	7/I
	3	8 c/d 12	8 c/d	"	"	9/XII
		Block I				
Step) II)	4	2 c/d	2 c/d	90° off vert.	"	3/IV
	5	"	"	60° "	"	"
	6	"	"	45° "	"	"
	7	"	"	22.5° "	"	"
	8	"	"	11° "	"	"
	9	"	"	0° "	"	"
		Block II				
	10	4 c/d	4 c/d	90° "	"	7/I
	11	"	"	60° "	"	"
	12	"	"	45° "	"	"
	13	"	"	22.5° "	"	"
	14	"	"	11° "	"	"
	15	"	"	0° "	"	"
		Block III				
	16	8 c/d	8 c/d	90° "	"	9/XII
	17	"	"	60° "	"	"
	18	"	"	45° "	"	"
	19	"	"	22.5° "	"	"
	20	"	"	11° "	"	"
	21	"	"	0° "	"	"
		Block IV				
Step) III)	22	2 c/d	0.50 c/d	Vertical	"	1/I
	23	"	1.34 "	"	"	3/VI
	24	"	2.00 "	"	"	3/IV
	25	"	3.00 "	"	"	4/IV
	26	"	8.00 "	"	"	9/XII
		Block V				
	27	4 c/d	1.00 "	"	"	2/VI
	28	"	2.68 "	"	"	4/VII
	29	"	4.00 "	"	"	7/I
	30	"	6.00 "	"	"	9/IX
	31	"	16.00 "	"	"	10/IX
		Block VI				
	32	8 c/d	2.00 "	"	"	3/IV
	33	"	5.36 "	"	"	7/XI
	34	"	8.00 "	"	"	9/XII
	35	"	12.00 "	"	"	10/XII
	36	"	32.00 "	"	"	10/XIV
		Block VII				
	37	2 c/d Block VIII	8 c/d	90° off vert.	"	9/XII

Table II

Suppression of a test probe consisting of vertical gratings of 2, 4, and 8 c/d presented to the deviating eye by a mask of spatial frequencies equal to that of the test probe but of varied orientations of 90, 60, 45, 22.5, 11, and 0 degrees from parallelling the test probe. The mask is presented to the fovea of the fixing eye.

Mask Orientation (deg. from parallel)

Suppression A=Area (cm^2) V.D.= Vertical Diameter (mm)	Subject	90		60		45		22.5		11		0	
		A	V.D.	A	V.D.	A	V.D.	A	V.D.	A	V.D.	A	V.D.
Test Probe Freq. (2 c/d)	D.V.	3.5	ND	6.8	25	3.5	ND	7.3	20	2.7	ND	8.8	ND
	P.S.	0.21	ND	00.48	6	0.45	5	0.46	2	0.47	5	0.77	7
	G.W.	1.00	17	0.77	16	1.00	16	0.94	15	0.87	15	0.94	16
	R.Y.	4.00	ND	2.60	ND	2.70	ND	2.70	ND	3.50	ND	2.30	ND
	B.O.	9.40	31	0.90	22	16.50	45	2.20	19	5.50	21	4.50	38
Test Probe Freq. (4 c/d)	D.V.	11.9	19	15.9	38	15.0	23	13.6	49	6.6	14	7.9	ND
	P.S.	0.41	5	0.37	6	0.41	5	0.58	7	0.86	6	0.80	9
	G.W.	0.70	17	0.60	12	0.92	15	0.96	21	0.82	15	0.78	13
	R.Y.	2.70	20	12.60	45.	15.60	64	16.00	62	9.5	51	10.00	16
	B.O.	3.20	9	4.70	19	1.40	7	3.20	10	5.5	12	3.50	19
Test Probe Freq. (8 c/d)	D.V.	11.2	23	11.2	27	7.8	24	9.2	23	11.4	27	12.2	30
	P.S.	0.13	7	0.78	7	0.61	4	0.86	6	0.74	7	0.58	4
	G.W.	0.57	13	0.53	13	0.60	11	0.53	12	0.43	12	0.80	14
	R.Y.	9.50	35	7.9	33	6.70	34	6.70	48	6.00	30	8.00	40
	B.O.	2.20	16	2.0	16	1.00	8	3.00	14	4.70	23	3.30	8

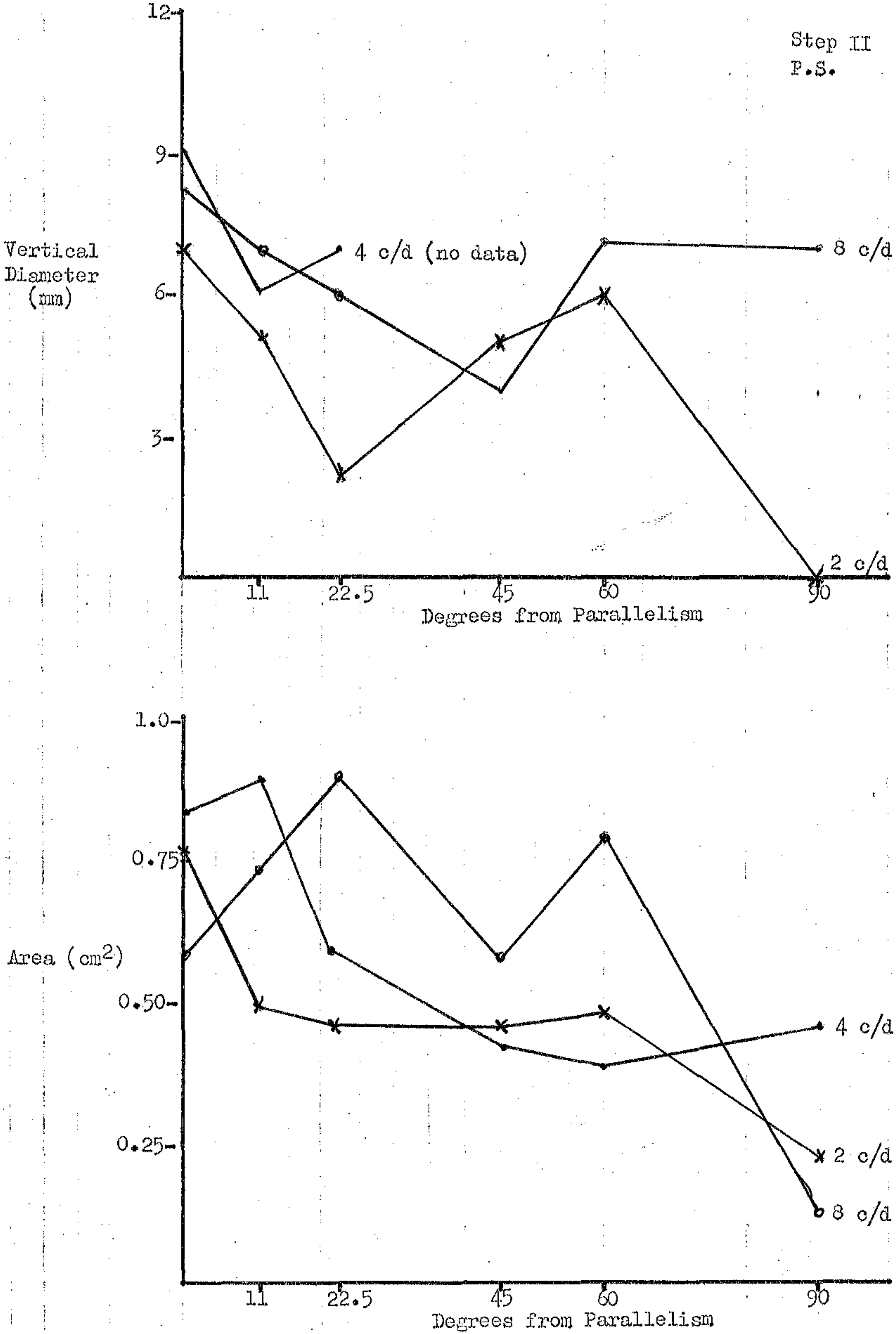
Table III

Suppression area (A) and its vertical diameter (V.D.) of a test probe of vertical gratings of 2, 4, and 8 c/d presented to the deviating eye. The mask stimulus consists of parallel gratings which differ from the test probe by -2, -0.5, 0, -2, and -0.5 octaves.

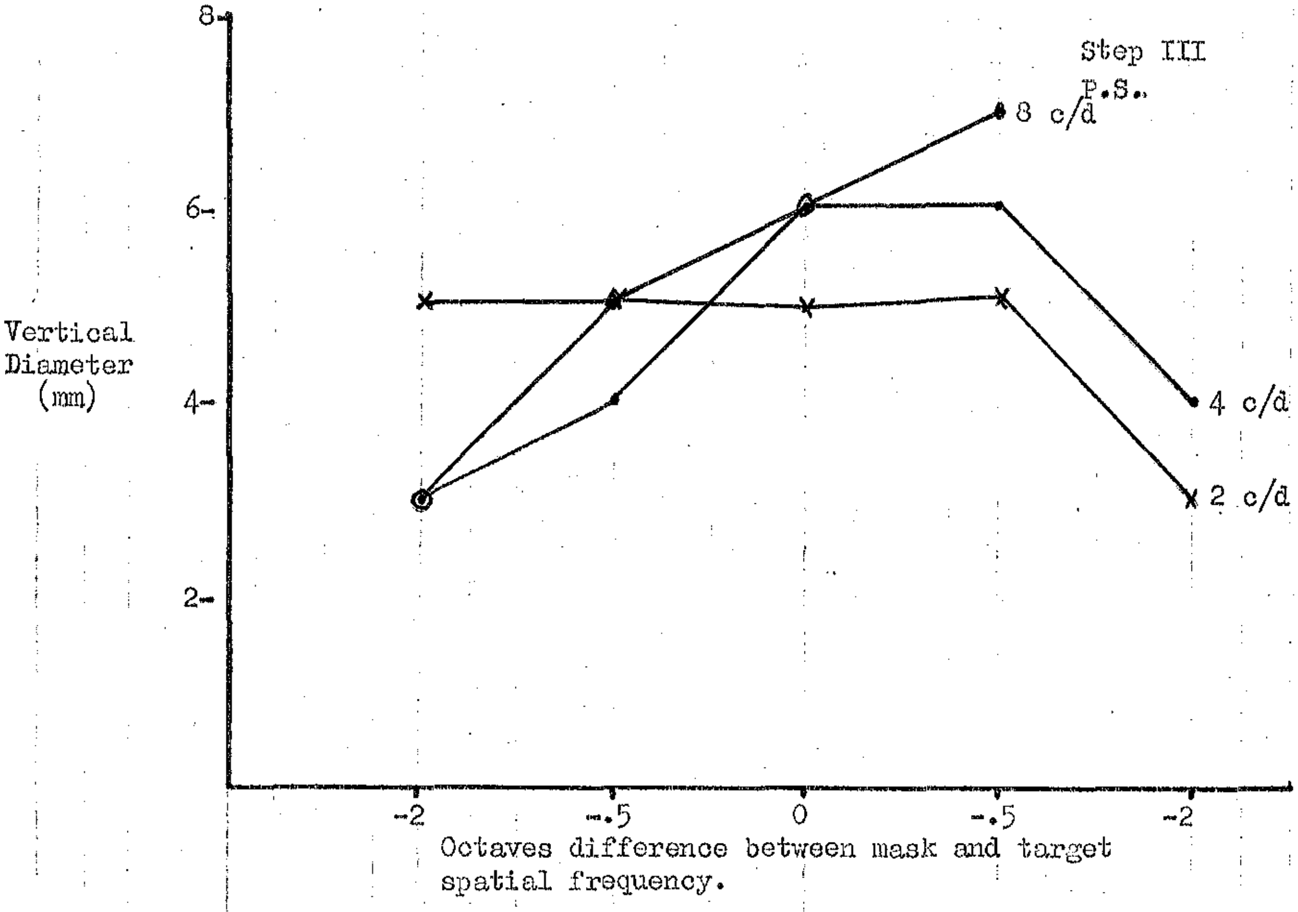
Suppression

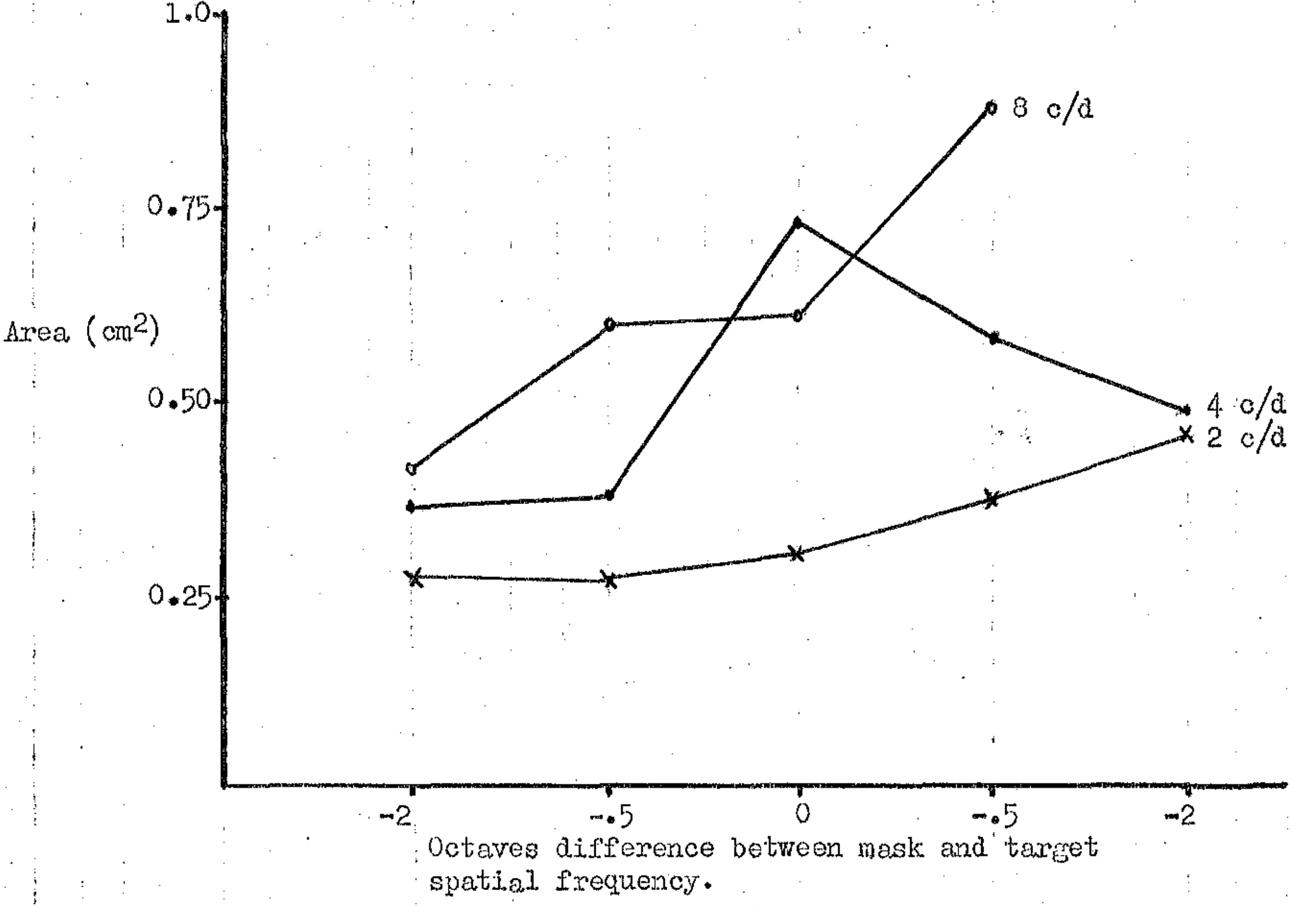
Difference in mask frequency from test probe frequency in octaves.

Area in mm. V.D. in cm^2	Subject	-2		-0.5		0		-0.5		-2	
		A	V.D.	A	V.D.	A	V.D	A	V.D.	A	V.D.
Test Probe Freq. 2 c/d	D.V.	10.10	25	13.90	32	8.9	28	11.0	25	8.8	24
	P.S.	0.28	5	0.29	5	0.31	5	0.37	5	0.40	3
	G.W.	0.47	12	0.36	13	0.40	12	0.35	12	0.42	11
	R.Y.	3.50	33	5.20	42	15.80	57	9.40	54	2.70	23
	B.O.	5.30	ND	4.00	9	6.00	9	2.50	9	2.60	11
Test Probe Freq. 4 c/d	D.V.	9.70	26	12.00	31	13.10	34	10.60	33	16.4	33
	P.S.	0.34	3	0.37	4	0.72	6	0.60	6	0.47	4
	G.W.	0.64	13	0.67	12	0.40	10	0.50	10	0.67	12
	R.Y.	7.20	37	8.00	34	5.90	29	3.90	27	1.90	22
	B.O.	0.40	9	2.90	8	0.30	5	1.37	12	0.47	9
Test Probe Freq. 8 c/d	D.V.	14.20	37	9.10	33	12.00	37	10.30	27	13.4	36
	P.S.	0.40	3	0.57	5	0.60	6	0.87	7	ND	ND
	G.W.	0.31	11	0.34	11	0.42	10	0.29	9	0.30	9
	R.Y.	4.10	28	6.30	24	4.70	25	7.50	45	6.00	30
	B.O.	0.96	9	1.24	9	0.80	6	0.41	7	2.54	20

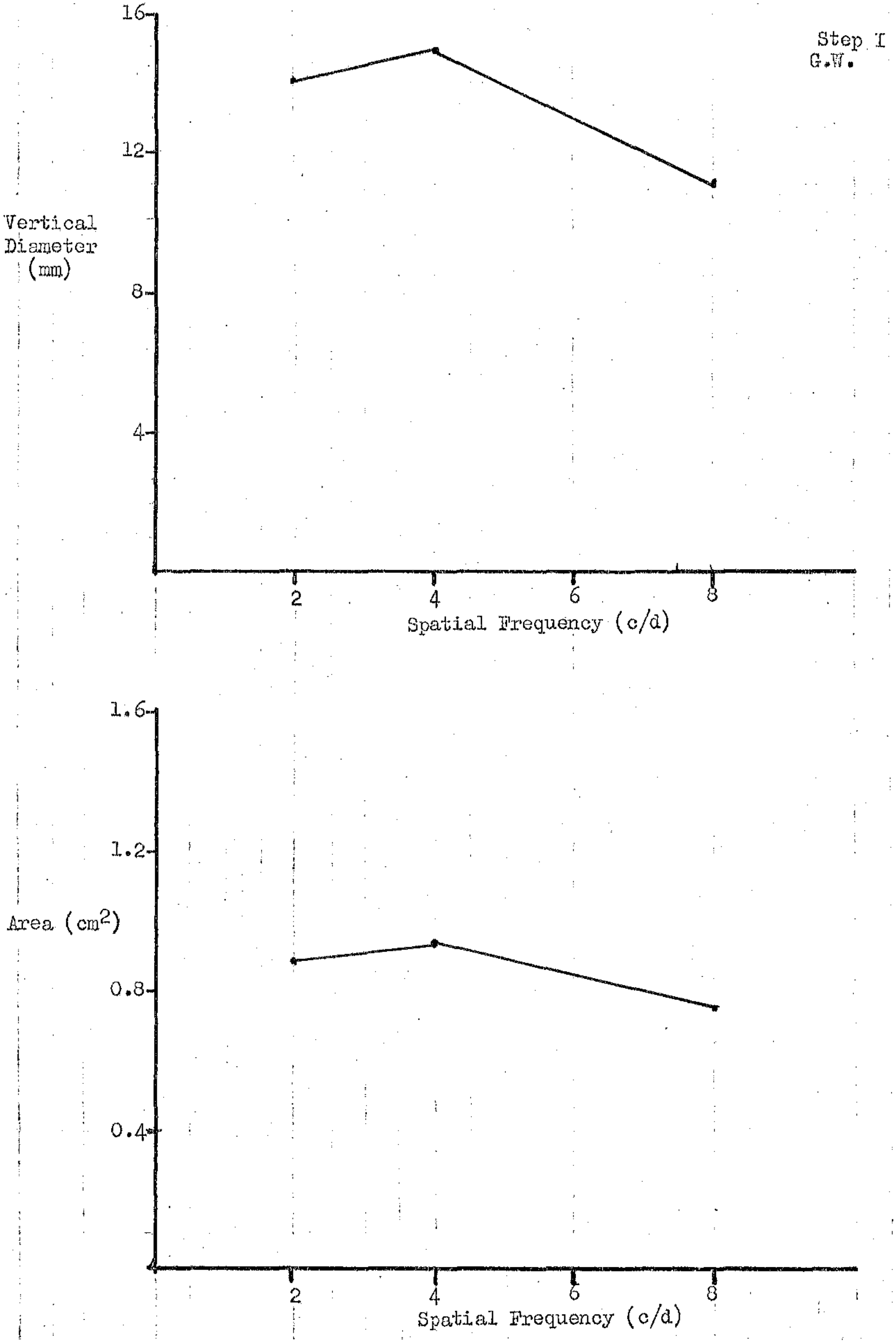


Target frequency the same before each eye
Fixation target varied in orientation
Simultaneous contrast to retinal rivalry stimuli



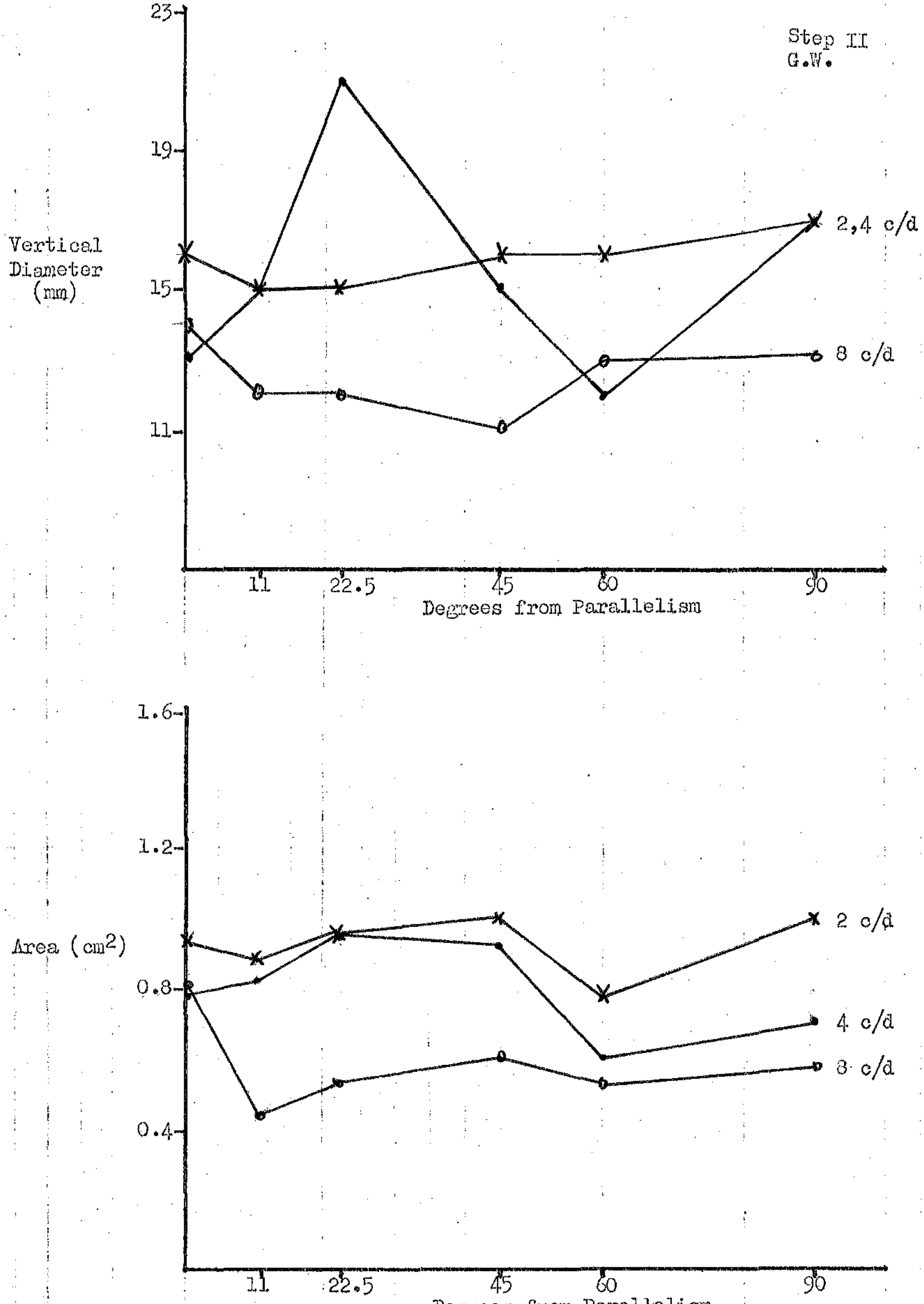


Target orientation remains constant
Fixation target frequency varied before each eye
Lateral Masking



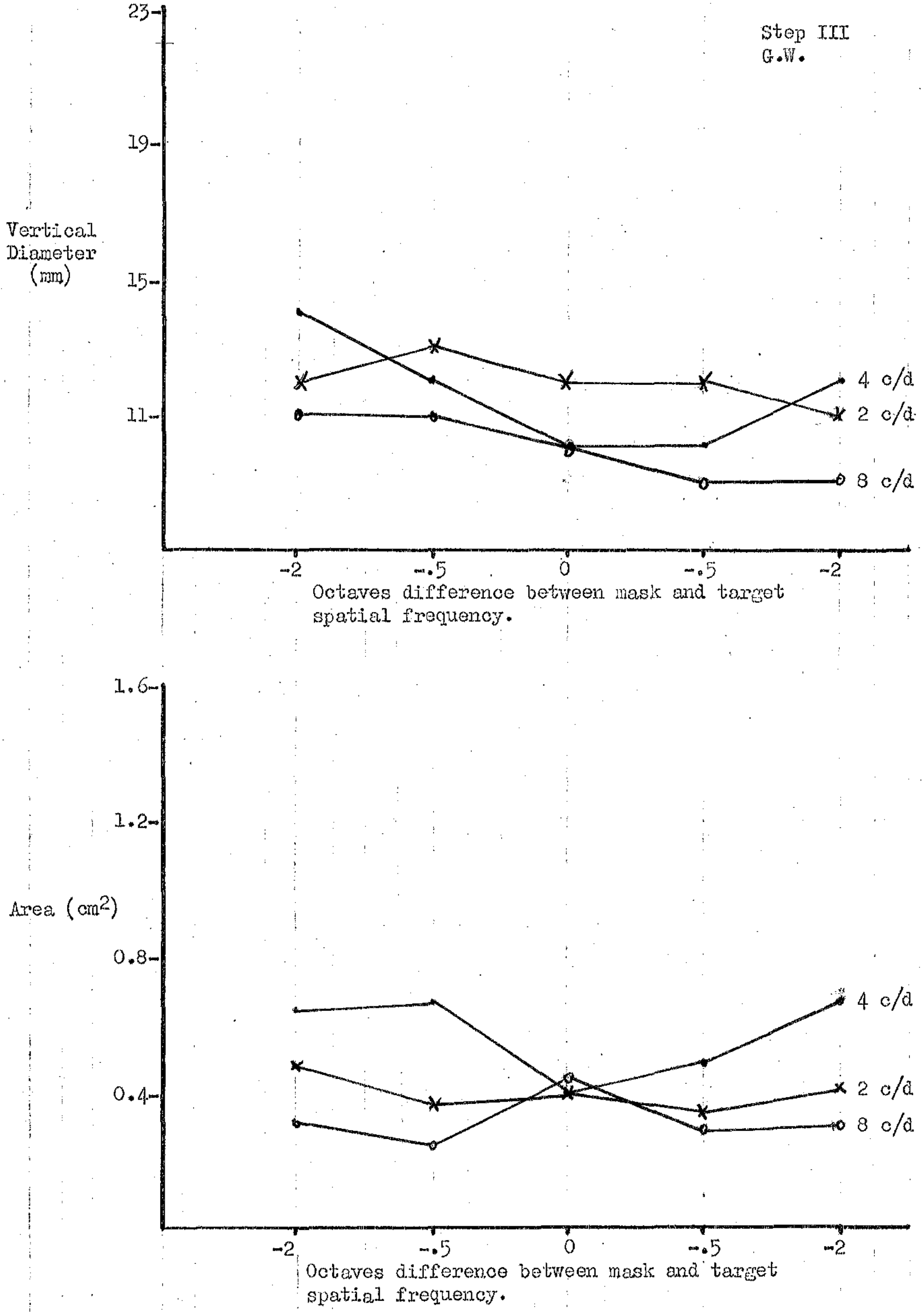
Target frequency and orientation is the same before each eye.

Simultaneous Contrast



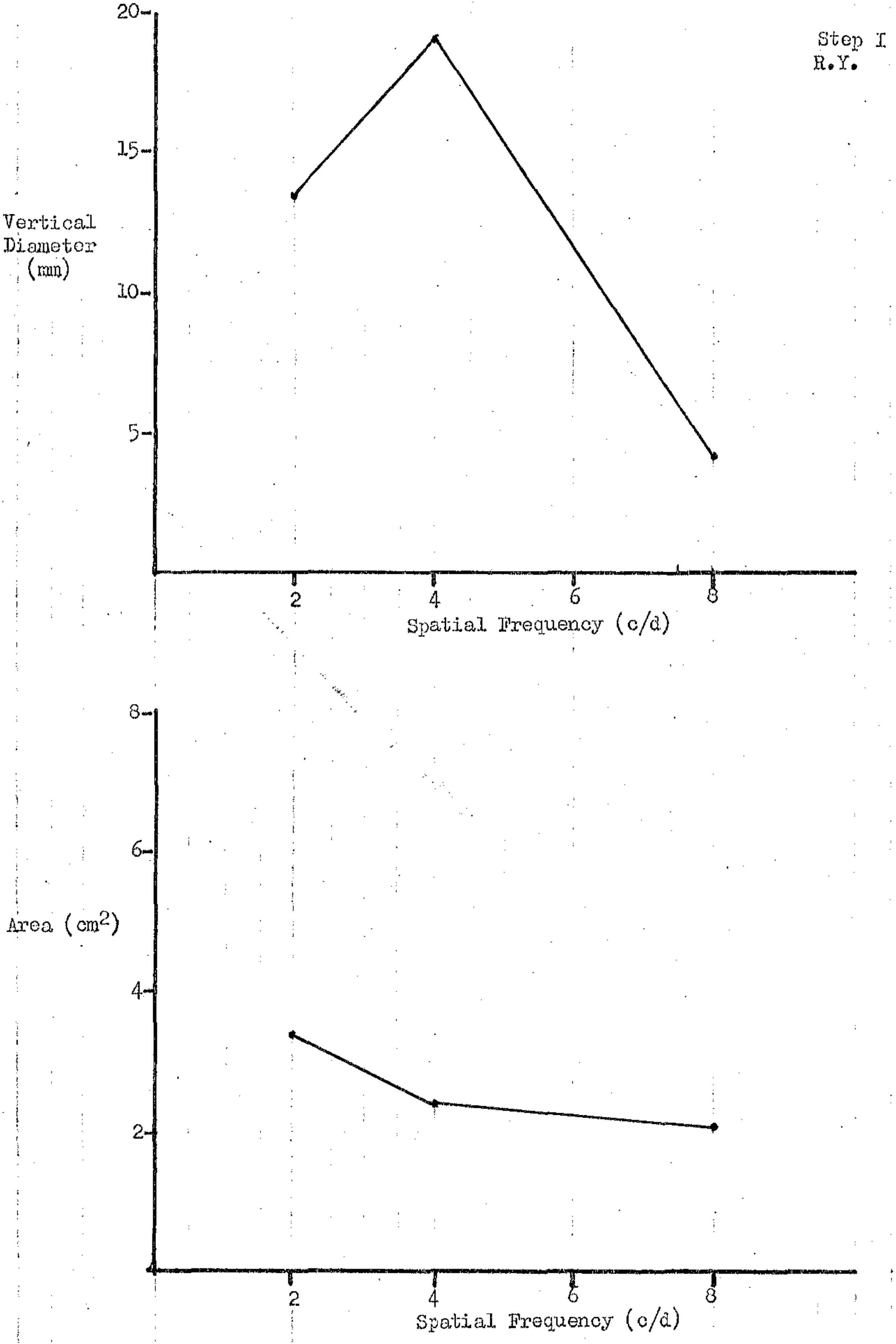
Target frequency the same before each eye
Fixation target varied in orientation
Simultaneous contrast to retinal rivalry stimuli

Step III
G.W.



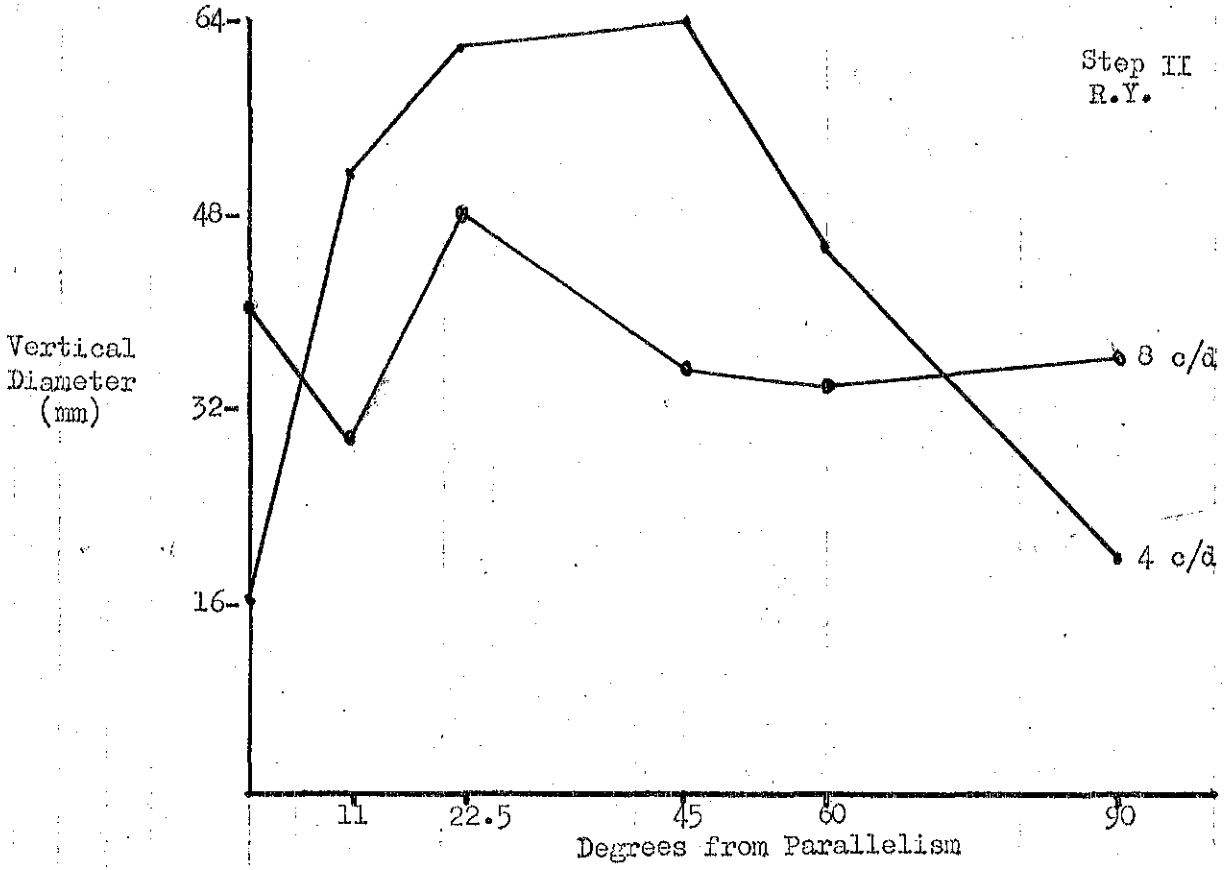
Target orientation remains constant
Fixation target frequency varied before each eye

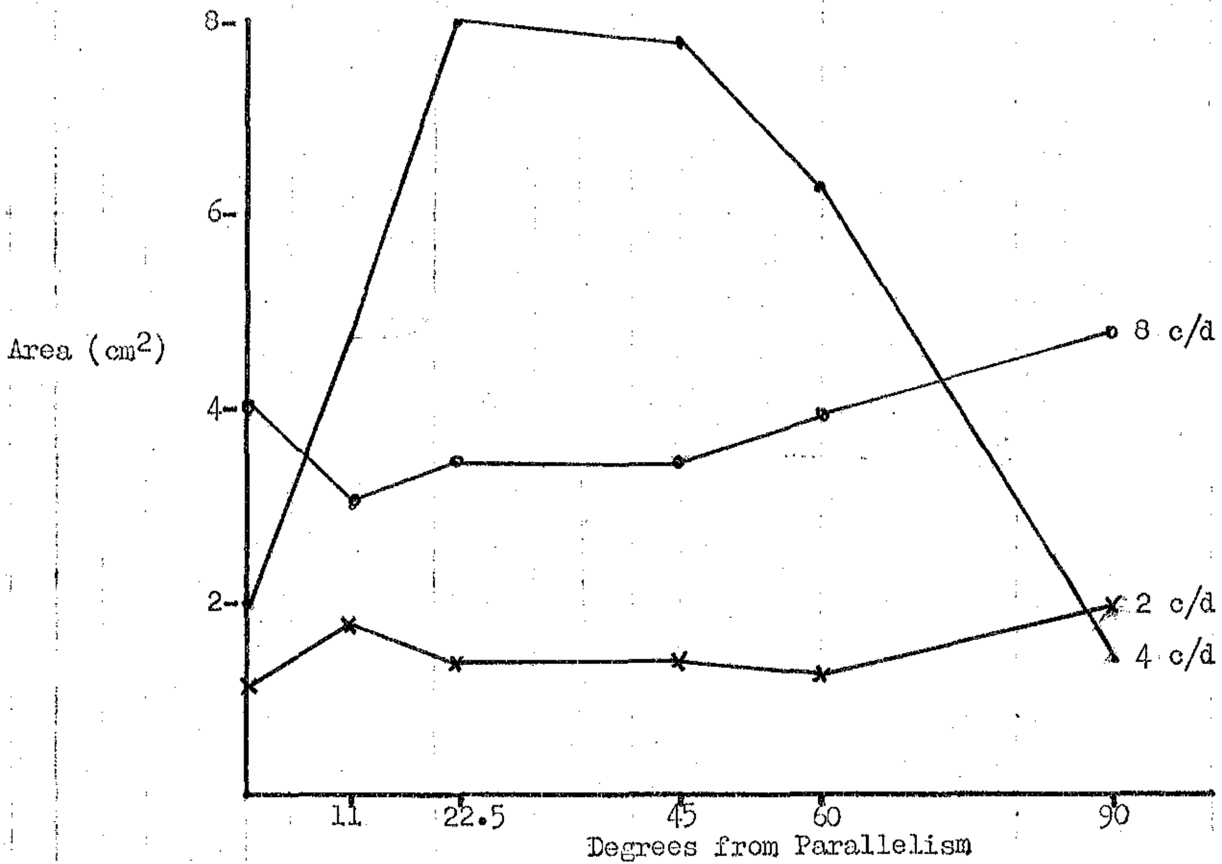
Lateral Masking



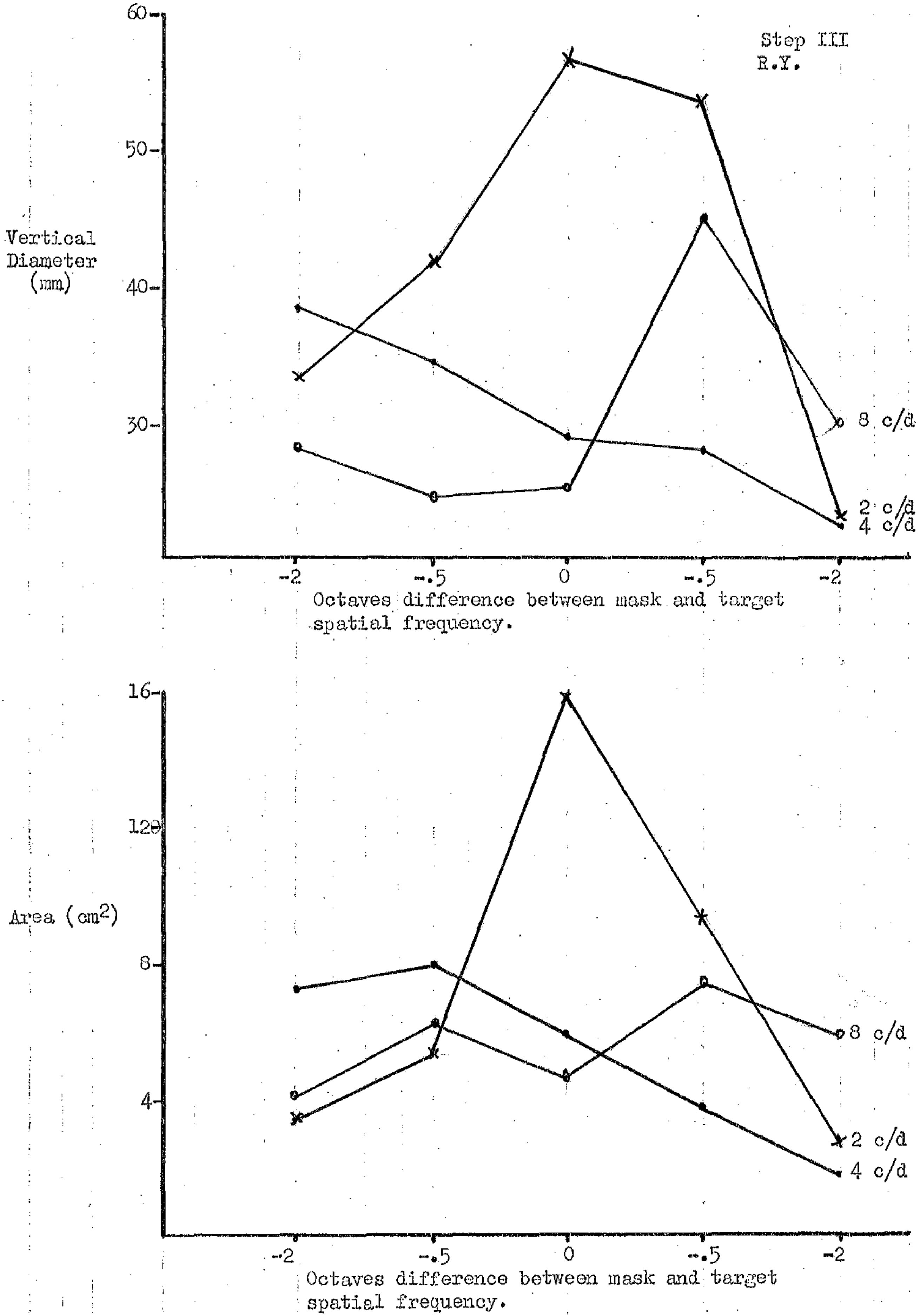
Target frequency and orientation is the same before each eye.

Simultaneous Contrast



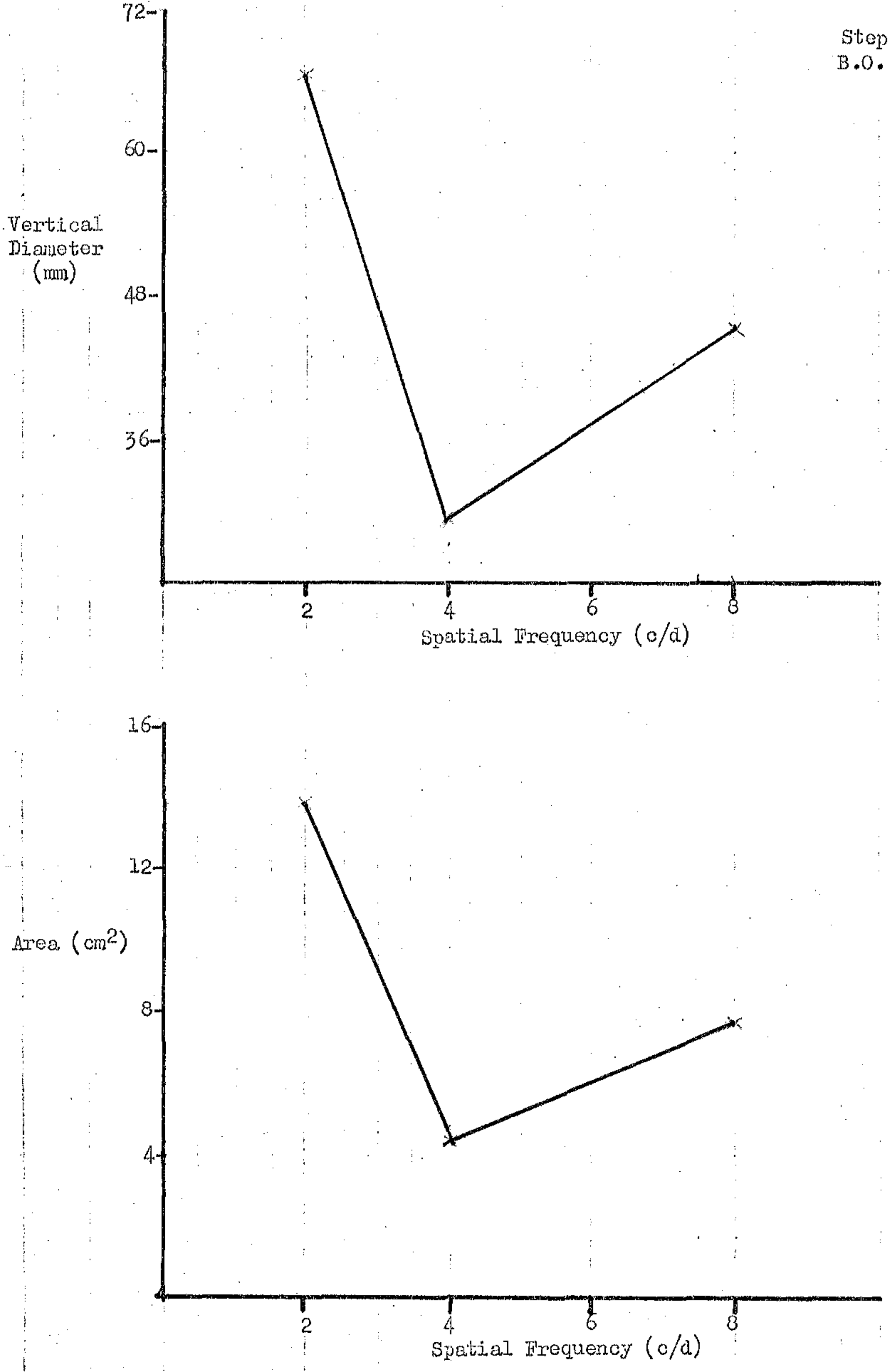


Target frequency the same before each eye
Fixation target varied in orientation
Simultaneous contrast to retinal rivalry stimuli



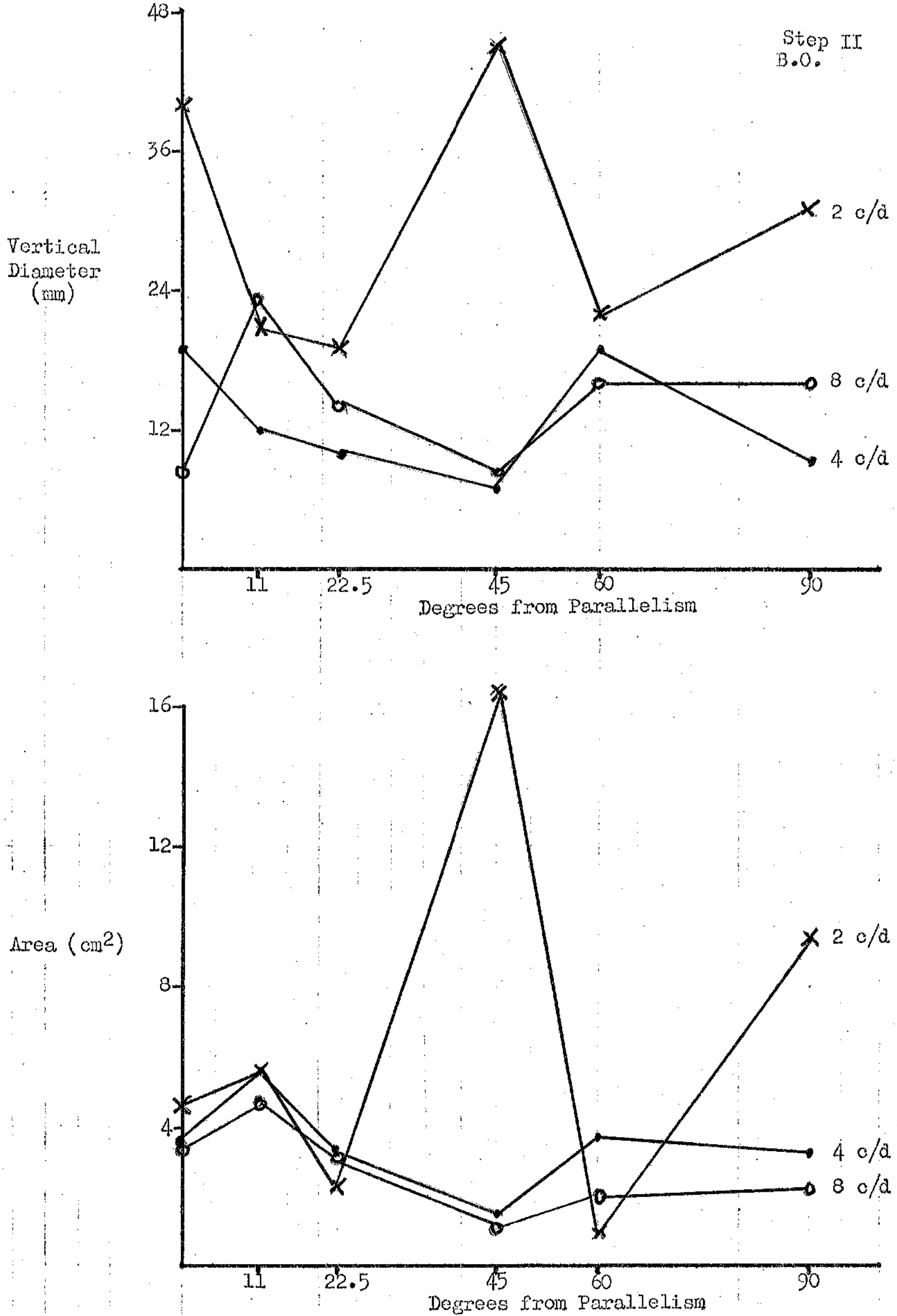
Target orientation remains constant
Fixation target frequency varied before each eye
<u>Lateral Masking</u>

Step I
B.O.



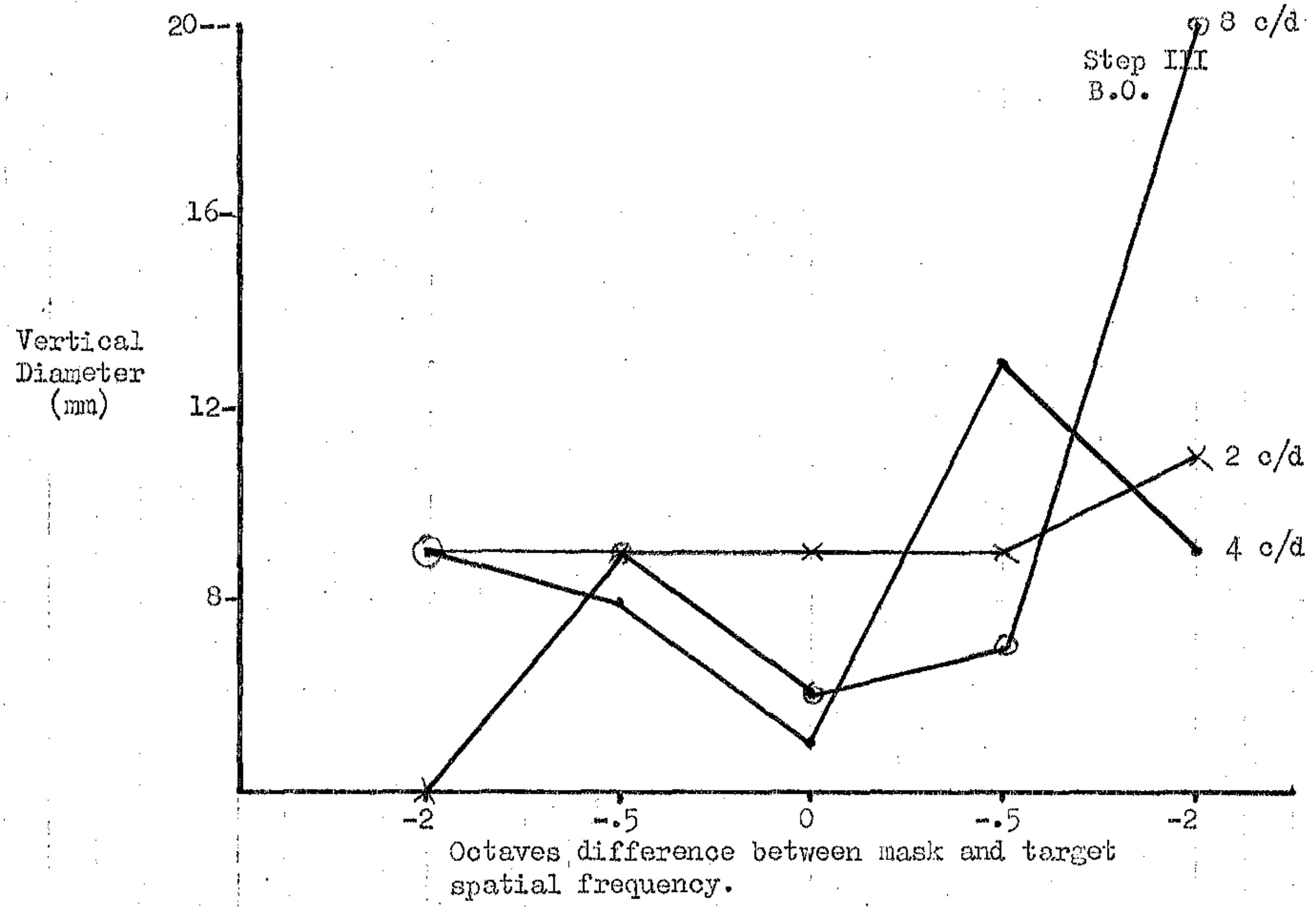
Target frequency and orientation is the same before each eye.

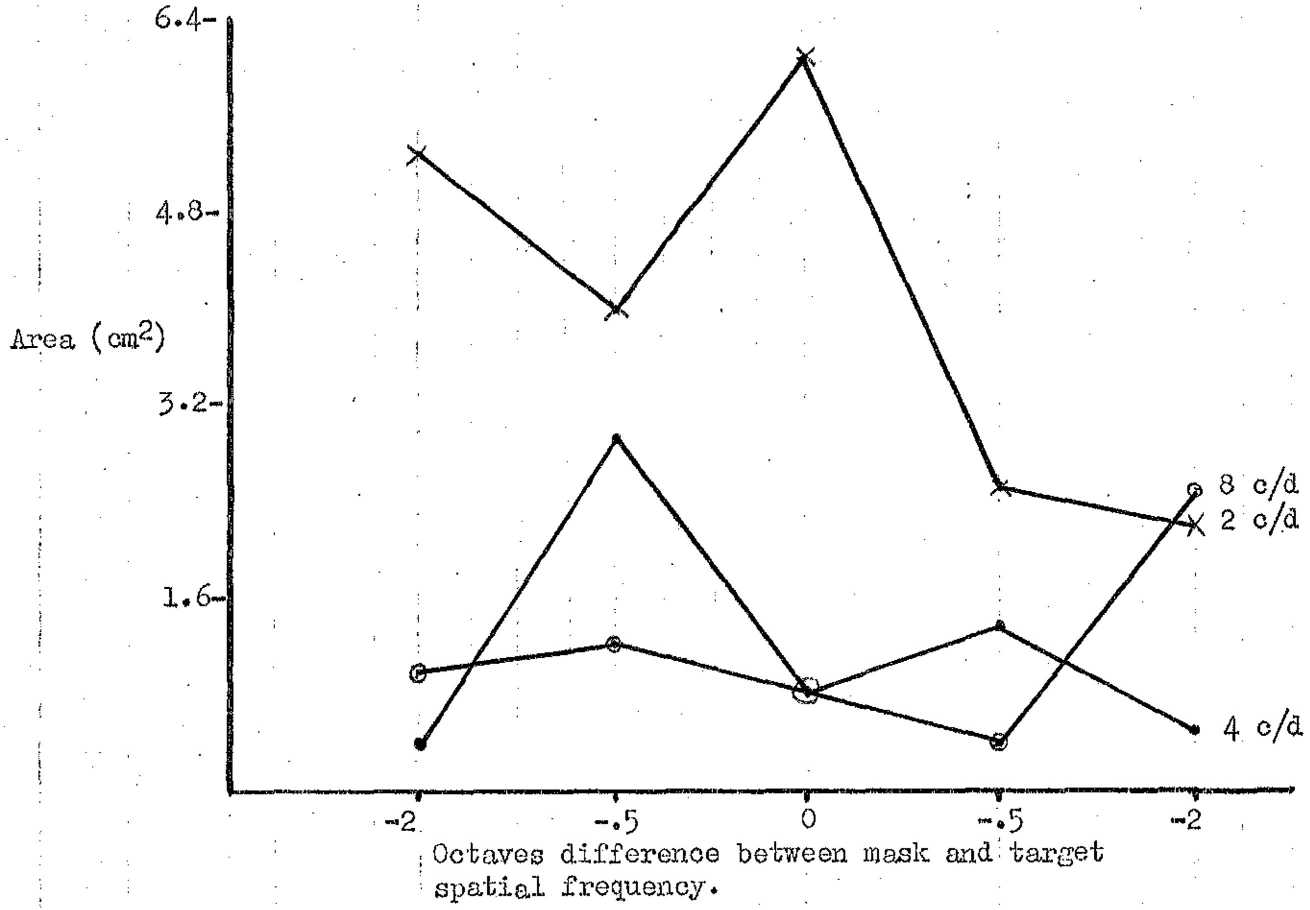
Simultaneous Contrast



Target frequency the same before each eye
Fixation target varied in orientation
Simultaneous contrast to retinal rivalry stimuli

B.O.





Target orientation remains constant.
Fixation target frequency varied before each eye

Lateral Masking

CONCLUSION

The data from this experiment was generally quite random and unpredictable. All of the data required constant criteria and was gathered over a three-hour period for each of the five subjects. The procedural design attempted to forego such problems as practice effect, illumination, subjective variability, inaccurate fixations, and fatigue. The data indicates the possibility that some of these variables are still actively contributing to errant findings.

In the first step, it initially seems that the findings may represent two groups of subjects. One group shows a peak in suppression area at 4 cy/deg. and the other a dip in suppression at 4 cy/deg. In each group, however, we find one exotrope and one amblyopic esotrope. Although there are two apparent groups of data, we cannot predict which subjects belong to which group. Furthermore, these groups and their members do not show such association in subsequent steps of this experiment.

In step two, three subjects showed - as expected - a decrease in suppression with coarser mask gratings. One, however, did the opposite and showed an increase. We can only deduce from this that there is yet too little data or that the procedure cannot adequately control the variables which yet go unchecked.

Step three continues to display a disappointing randomness. The vast spectrum of patterns present themselves from both subject to subject as well as within each individual there is no consistency in suppression trends.

The present technique is not capable of precise and unbiased suppression measurement. The randomness cannot support any hypothesis about suppression area as a function of frequency, orientation, and similarity of test and mask frequencies. Although we expect less suppression with coarser gratings, greater obliqueness and increased disimilarity it was not predictable from the data.

COMMENTS AND SUGGESTIONS

There were many difficulties in attempting to use this apparatus for this hypothesis. One of the problems lies in the limitations of the apparatus. During the experiments, subjects noted leaks in the filters that made the suppression response difficult to monitor. Further, as the gratings were moved into the periphery of the screen aberrations were produced making the details blur and reducing contrast. This particular fact was compounded by the decreased sensitivity of the peripheral retina to fine detail.

Further limitations on this technique were set by our inability to control the various physiological and psychological variables that influence suppression. For instance, by plotting the blind spots before and after each plotting, a shift in fixation was noted. This shift would distort the size and shape of the suppression areas.

Other factors that influence suppression and that we could not control include state of restedness, ability to control suppression, and practice effects of working with a technique that tended to break down suppression with prolonged exposure.

All these factors together led the investigators to suspect there would be better avenues to explore in the search for the suppression mechanism.