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CHANGES IN FORM VISUAL FIELDS IN READING DISABLED CHILDREN PRODUCED BY SYNTONIC (COLORED LIGHT) STIMULATION.

PAPER PRESENTED TO THE COLLEGE OF SYNTONIC OPTOMETRY

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ABSTRACT:

Previous clinical reports have suggested that visual field sizes are abnormal in children who are classified as reading disabled. The present study measured form and color visual fields for a total of 22 children. Nine of the children read at least two grades or more below their chronological placement and were placed into an Experimental Group. Four children were placed into Control Group 1. The remaining children, who were handicapped in reading but who were not significantly behind in their reading placement, were placed into a vision therapy program designed to treat General Binocular Dysfunction problems (control group 2). The children in the Experimental Group were exposed to colored lights of specified frequencies, while the 4 children in Control Group 1 were exposed to plain white light, and the remaining 9 children received only vision therapy for an equivalent duration. Significant form field size changes were measured in the children who received the colored light treatment, while the vision therapy control group had no significant form field size changes. Associated behavioral changes were noted in the Experimental group.

Introduction

The use of color light in optometric therapy has been in progress for over 50 years. Using specific filters, optometrists have given successful treatment to thousands of patients with a great variety of diagnosed problems. Such successful treatment has led practitioners to ask the following types of questions.

Why do optometrists use colored lights? What types of visual problems do they treat? What does light do in the visual system and in the body? Is there scientific evidence that purports that specific light frequencies have an effect on human physiology?

In the 1920's and 30's much interest was generated by people such as Loeb, Henning, and Spitler in the use of light therapy for the treatment of optometric problems. Light had been used to treat many problems previously such as colds, hay fever, sinusitis, goitre, constipation and other physical ailments. Since these conditions are outside of the scope of optometric practice their treatment by use of light therapy was discouraged by ethical practitioners.

Henning, one of the pioneers in the use of light therapy, used the term chrome-orthoptics to describe the process. Using Dr. Leob's classification of color, he prescribed color treatments for thousands of patients. Henning's method was based on the fact that polychromatic light is not focused as a single point on the retina. Since spectral colors are each focused at a different point, according to their wavelengths, the accommodative apparatus of the eye was thought to be influenced by which color was focused on the fovea. By noting that certain prisms and lenses also stimulate or inhibit accommodation, he had a direct correlation between the use of optical devices and the use of light of specific colors. Henning used light therapy, lenses, and standard orthoptic treatment with his patients. He also realized that vision is not a separate physiological entity in the body, but that it is intimately connected to the total person. He believed that chrome-orthoptics treated more than just the symptoms of the visual system; it also effected the autonomic nervous system which produced behavioral changes in his patients.

Recognizing the need to establish light therapy in the optometric community, Spitler helped found the College of Syntonic Optometry and became the prime instigator in organizing and training optometrists in the use of colored light for optometric therapy.

Syntonics in optometry has been used for such treatments of such conditions as myopia, strabismus, amblyopia, headaches, visual fatigue, reading problems, and general binocular dysfunctions. Thousands of clinical cases have been presented over the years to show the results of light therapy. Clinically, according to some practitioners, the use of syntonics has been proven an effective form of therapy in the optometric office. But what scientific evidence is there to show that light of certain frequencies effects humans, and what is the method of entry of this light into the body?

Scientific Data

A whole body of knowledge has been developed regarding the effects of light on plants and animals. Wurtman (1975) reported that, along with food, air, and water, sunlight is the most important survival factor for human life. The formation of vitamin D on the skin, control of endocrine systems, timing of biological clocks, entrainment of circadian rhythms, immunological responsiveness, sexual growth and development, regulation of stress and fatigue, control of viral infections, and dampening of functional disorders of the nervous system, are all attributable to sunlight. The most important of these to optometrists is the influence of light on the endocrine system, but does this light energy reach the endocrine system?

Homasaki and Marge (1960) reported on the existence of the posterior accessory optic tract and the anterior accessory optic tract in primates. Some possible functions of these tracts could be to transmit information on light levels to various subthalamic and midbrain centers. Hill and Marge (1963) found, from single cell recordings using monochromatic light, that the accessory optic tract do respond to this stimulation. Luce has reported that light appears to act on the brain in a complex manner, and may influence the rate of maturation of the pineal gland in newborn babies. Light may also trigger the circadian rhythms of adrenal hormones found in the blood, and may influence the neuroendocrine system and thereby modify responses to certain drugs.

It is now generally accepted that light does effect our physiological systems. Many studies have shown the influences of using artificial lighting in schools and industry. Zamkova and Krivitskaya (1966) report that children who studied under full-spectrum lighting had a lower fatigability, significantly improved working capacity, and improved academic performance.

Specific Colors

What then is the role of specific colors for therapy? It is thought that specific colors (wavelengths) interact with the endocrine system to bring about stimulation or inhibition of hormonal production. Plack and Schick (1974) summarize the effect of color on nonvisual processes in humans. The effects they described included changes in mood, rate of breathing, pulse rate, and blood pressure.

Gerard's (1958) dissertation research is probably the most detailed examination of the differential effects of colored light on psychophysiological functions. His study investigated the effect of different colors on psychophysiological measures indicative of emotional changes. Blue, red, and white lights of equal brightness were each projected for ten minutes on a screen in front of 24 normal adult males. The autonomic nervous system and visual cortex were found to be significantly less aroused during blue than during red or white stimulation. The various colors also elicited significantly different feelings, with blue being associated with increased relaxation, less anxiety, and less hostility, while red illumination was associated with increased tension and excitement. Manifest anxiety levels were significantly correlated with increased physiological activation and subjective disturbance during red stimulation. Conversley, Gerard found responses of quiescence and relief during blue illumination. The work of Aaronson (1971) reports much the same effect of specific colors on activation and arousal.

Reading Problems

How then can syntonic light therapy help school age children who have reading problems? It has been suggested in the literature that there is a relationship between visual field size, blind spot size, and the ability of children to read. In the forties, Brombach reported on a study involving 158 children classified as poor readers; 109 of the children demonstrated enlarged blind spots. Eighty-three of the children recovered from the enlargement after occlusion of one eye, suggesting a relationship between an enlarged blind spot, and poor reading.

Brombach argued that the incidence of ocular pathology in these types of enlargements was very slight. He felt that the enlarged blindspots reduced the likelihood of full perception and this inhibited accurate and complete reading.

Eames (1938) studied the relationship of the central visual field to the speed of visual perception. A high correlation was found, and this supported an earlier study in which smaller horizontal and vertical visual fields were found in educationally disadvantaged children. The relationship between visual field size and the ability to be an adequate reader seems obvious from an anatomical perspective. The number of fixations that can be made without an associated head movement will be limited in the case of a significantly reduced visual field.

Research Project

The data from a number of previous studies, has suggested that form field size will be reduced in poor readers and that the use of syntonic stimulation can rectify the problem. Thus a study was designed to demonstrate this. The study tested two hypotheses:

1. Children who have reading difficulties as defined by the educational system, also tend to have restricted form visual fields as measured monocularly using a stereo-campimeter like device.
2. Viewing appropriate colored lights (Syntonic stimulation), the form fields can be expanded significantly.

Methods and Subjects

The study was conducted at Pacific University's Optometric Clinic in downtown Portland, Oregon. Children having specific difficulties in reading are referred to this clinical facility by educational, mental health and other settings for routine vision care as well as vision therapy. For this particular study, a specific educational service district in Multnomah County was contacted to refer children suitable for the experimental group. This meant that the Educational testing on the children was conducted by educators prior to their referral for the project. The children who served in the two controls groups were recruited through newspaper advertisements as well as through the vision therapy clinic of the college. All children in the study were healthy, wore corrective lenses (if prescribed), and were not receiving concurrent therapies. Each participant received a vision screening using the Keystone Telebinocular and a baseline visual field study using a modified stereo campimeter (loaned by the College of Syntonic Optometry). The baseline visual field measurement was conducted by a research assistant who had been specifically trained to obtain visual fields with the experimental instrument.

The protocol for the study was to first measure the form field using a white 1.0 millimeter target working from nonseeing to seeing. The blindspot was measured from nonseeing to seeing. The right eye form field was measured first followed by the blind spot, then red, blue and green colored fields utilizing the 1.0 millimeter target of the appropriate color. The same test was then repeated on the left eye. The average of the vertical and horizontal measurements are shown in Table 1.

Based on the visual field measurements, the principal investigator randomly assigned the children to the experimental or the white light control group. Neither parents, children or research assistants were told whether the colored light or white light treatments constituted the experimental or the control treatment.

Three of the children who were assigned to the Experimental Group had been examined by two Fellows of the College of Syntonic Optometry at the 1982 Annual Syntonic Meeting held in Portland. Six of the children were referred from the Multnomah Educational Service District, the University of Oregon Medical School, local optometrists, or from the Portland State University Special Education program. One child was brought in by her parents with specific difficulties with handwriting and was apparently at grade level in reading. In summary, 9 of the subjects in the experimental group were reading at a level at least two years below their chronological placement.

There were an equal number of males and females in the experimental group, (mean age 9 years and 9 months, range age 6 to 16.) The four children assigned to the white light control group consisted of three females and one male (mean age 9 years and 4 months, range 6 and 14 years). All four were classified as significantly below average in reading ability by the referral agency. Two of the children had esotropia while the other two were diagnosed as having a general binocular dysfunction. Table 2 summarizes the mean horizontal and vertical dimensions of the form and color visual field for the white light control group.

The second control group consisted of ten children with general binocular dysfunction who were randomly selected from the Pacific Vision Therapy Clinic. The results of the visual field measurements for these children are displayed in Table 3. The mean age of the children in the vision therapy control group was 9 years and 7 months with a range from 7 to 13 years. All of the children in this group were found to have experienced one or more symptoms associated with inefficient reading, thus the diagnoses were consistent with general binocular dysfunction. The subjects did not, however, demonstrate significant reading problems such as were found in members of the experimental and the white light control group.

Two similar instruments used clinically for administering the application of colored light frequencies were prepared for the study. One instrument presented a blank visual field with a background of white light and was used for the white light control group. The

The visual fields for the experimental and control as measured during sessions 8 and 16 are shown in Tables 6 and 7.

The vision therapy control group received standard general binocular dysfunction treatment that included: plus and minus accomodative rocks, vergence facility using prisms, eye movement training following a swinging ball and activities with red/green polaroid for monitoring suppressions and developing adequate fusion ranges. Visual field measurements were recorded for the vision therapy control group at the equivalent of the the 16th session for the experimental group. Table 8 shows the results.

Table 9 depicts the percentage increase or decrease of the form field prior to treatment through the 8th and 16th session.

Results

The mean baseline form field was only 18.4 and 18.8 degrees for the right and left eyes of the experimental group. The mean for the white light control group were above the average expected of at least 30 degrees while the vision therapy control groups mean size were 24.73 and 20.63 degrees at the beginning of the study.

By session 16, the form fields for the experimental group had increased significantly to 39.2 and 43.9 for the right and left eyes respectively. The vision therapy control group had not changed significantly.

Discussion

The findings of the study support the hypothesis that children who have significant deficits in reading demonstrate reduced form visual fields. When compared to children who have difficulties in reading primarily due to inefficient binocular vision, the form fields are more reduced in the more severe reading disabilities. Secondly, the choice of appropriate color filters for each of the 10 subjects produced significant changes in the size of the form visual fields.

Unfortunately, a direct numerical analysis could not easily be made between the white light control group and the experimental group because of the initial large field sizes in the control group. The study did reveal, however, the relative ineffectiveness of vision therapy in significantly increasing the size of the form visual field.

Why did the form field size in the white light control group reduce during the 16 sessions? These children had great difficulty sitting still and did not enjoy the sessions. The 47.6% average reduction for this group could be explained by a cluster of clinical observations. First, the children in the study who demonstrate lowered competency and interest in reading tended to be poor attenders or overactive. This observation was coupled with the fact that the children had pupils that tended to dilate within a 15 second period while a bright light was projected into the eyes, and they tended to have lowered amplitudes of accomodation. The reduced form field, dilating pupil, lowered accommodation and excessive body and head motion point to a dominance of the sympathetic system. The white light control group children became more agitated and irritable during the exposure to white light. The form fields reductions corresponded with the increased restlessness of the children. Parents requested termination of the study because their children "would not sleep", "had nightmares", "wouldn't eat" and were "unmanageable".

By definition, many of the children in the vision therapy control group had accommodative dysfunction. The vision therapy techniques did increase the form field by 8.7%, however, when compared to the experimental group, these changes were small. The children who received vision therapy had an extensive home vision training program and one might expect changes as large as those found in the experimental group. However, it would appear that working with the peripheral subsystems like accommodation and convergence is not as powerful as channeling appropriate colored light directly thru the eyes. Since vision training/therapy already produces significant changes in binocular disturbance and vision related learning problems, what would happen if syntonics was added to the general optometry and vision therapy armamentarium?

Conclusion

The results of the present study support the earlier observations that children having difficulties in reading also have significant reductions in form and color visual fields. Also, the collective evidence that colored light can alter the physiology of the organism should add credence to the idea of measuring functional visual fields in children with problems.

Based on clinical observations, vision therapy can be enhanced with the parallel use of syntonics. Future studies can explore whether the phenomenon of reduced visual fields can be generalized to larger populations.

ACKNOWLEDGEMENTS:

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Table 1

Pre-Form and Color Visual Field Summary

Subject	Form field	Red field	Blue field	Green field
S.L.	*24/20	17/15	10/8	8/-
H.T.	4/2	--	--	--
H.R.	31/29	7/9	--	--
F.D.	9/9	--	--	--
S.U.	19/18	14/12	11/6	--
K.N.	10/20	--	--	--
R.R.	19/16	12/13	12/13	6/7
M.F.	31/36	24/9	25/-	9/-
M.K.	24/22	-/16	--	--
J.M.	10/16	-/12	--	--
Ave.	18.4/18.8	14.8/12.28	14.5/9	7.67/7

*OD/OS in degrees

Table 2

Pre-Form and Color Visual Field Summary for White Light Control Group

Subject	Form field	Red field	Blue field	Green field
K.V.	*23/26	16/23	--	--
S.V.	39/37	28/35	26/16	27/18
G.W.	54/57	32/34	23/26	20/17
M.M.	50/43	35/20	20/17	15/25
Ave.	41.5/40.75	27.75/31.75	23/19.67	20.67/20

*OD/OS in degrees

Table 3

Pre-Form and Color Visual field Summary
for Visual Training Control Group

Subject	Form Field	Red field	Blue field	Green field
K.H.	* 27/20	17/10	--	11/-
K.K.	16/17	--	10/9	--
D.H.	18/17	10/14	--	--
C.L.	39/24	-/16	11/12	9/9
K.W.	22/19	18/14	13/10	10/7
M.J.	29/20	18/17	12/12	8/10
J.Z.	23/24	21/21	20/19	19/18
J.P.	21/20	15/10	10/9	6/7
S.C.	31/28	19/19	16/16	10/15
I.G.	26/22	11/11	6/7	--
Ave.	24.73/ 20.63	16/14.2	11.89/ 11.33	9.875/ 11

*OD/OS in degrees

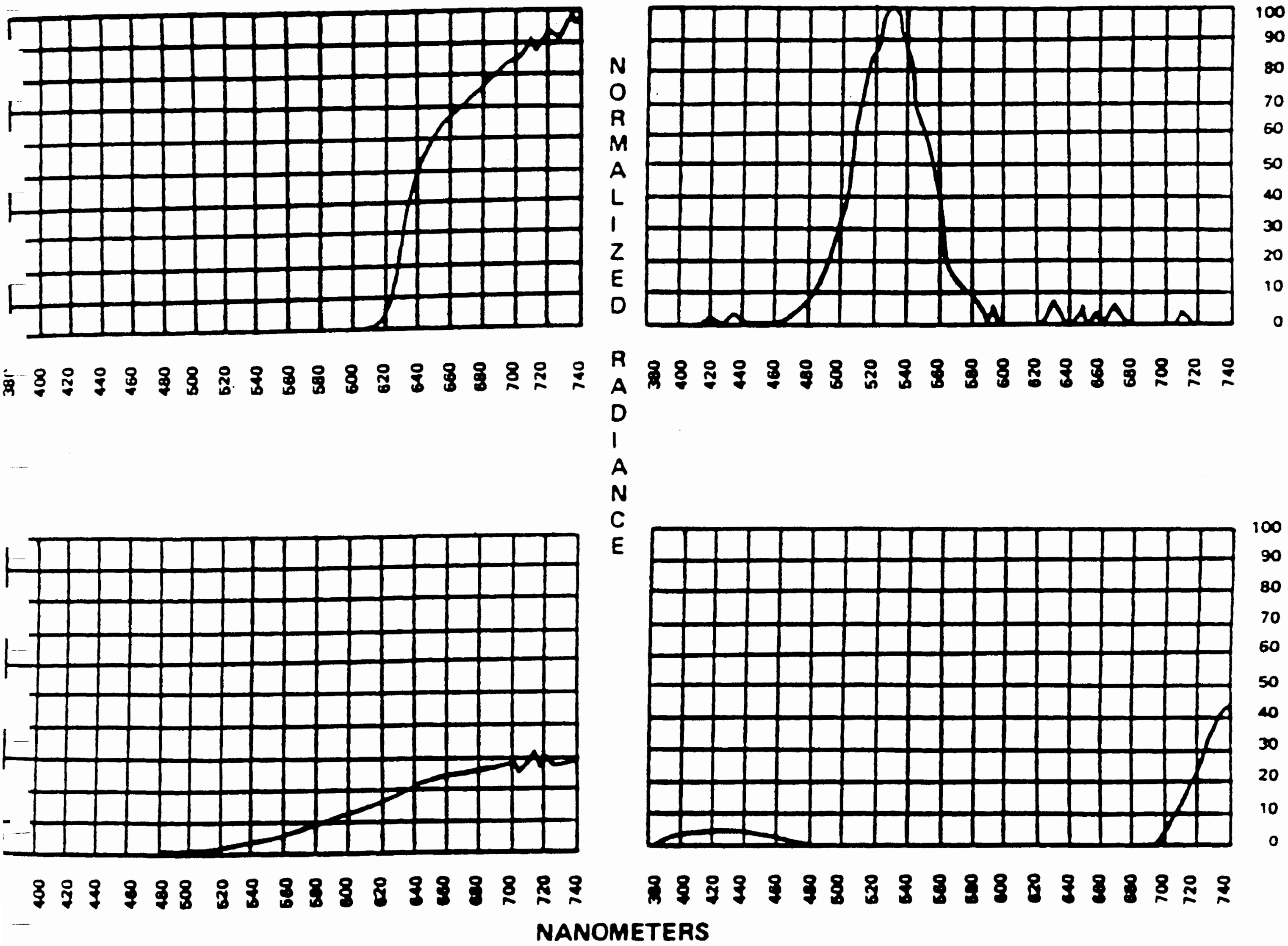
Table 4

Filters and treatment used for Exp. Group 1,2

Subject	Original Treatment	Modified Treatment
J.M.	$\alpha\omega^{10'}$ $\mu\delta^{10'}$	same
R.R.	$\mu\delta^{20'}$	$\alpha\omega^{10'}$ $\mu\delta^{10'}$
S.V.	$\alpha\delta^{10'}$ $\alpha\omega^{10'}$	same
H.T.	$\mu\delta^{20'}$	$\alpha\omega^{10'}$ $\mu\delta^{10'}$
S.L.	$\alpha\omega^{10'}$ $\mu\delta^{10'}$	same
F.D.	$\mu\delta^{20'}$	$\alpha\omega^{10'}$ $\mu\delta^{10'}$
M.F.	$\mu\delta^{20'}$	$\alpha\omega^{10'}$ $\mu\delta^{10'}$
K.N.	$\mu\delta^{20'}$	same
M.K.	$\mu\delta^{20'}$	same
H.R.	$\alpha\omega^{10'}$ $\mu\delta^{10'}$	same

1. All patients had Nacentization of red and blue light in each eye for 3 minutes
2. All patients had two 10' light sessions with a 3' rest inbetween

TABLE 5
FILTER DATA



(alpha) CIE Coordinates: x (0.7208), y (0.2787)

(Mu) CIE Coordinates: x (0.2139), y (0.7014)

(delta) CIE Coordinates: x (0.5936), y (0.4037)

(omega) CIE Coordinates: x (0.1664), y (0.0155)

Table 6

Form and Color Visual field Summary
for Session 8 and 16 for the Exp. Group

Subject	Form 8	Field 16	Red 8	Field 16	Blue 8	Field 16	Green 8	Field 16
S.C.	*51/43	45/50	33/38	30/33	28/31	17/22	19/26	12/16
H.T.	9/10	33/40	--	23/26	--	16/20	--	11/14
H.R.	47/54	47/50	19/21	15/15	18/13	9/10	--	7/8
F.D.	26/29	26/35	12/16	7/10	--	4/5	--	--
S.U.	48/49	40/40	40/36	21/25	32/33	14/15	22/25	11/11
K.N.	43/39	45/47	37/23	26/24	27/13	14/18	30/18	10/15
R.R.	42/36	40/42	25/19	31/26	20/16	23/17	10/10	12/11
M.F.	40/40	48/49	23/26	30/28	15/13	17/17	6/11	13/9
M.K	22/32	29/42	20/22	23/27	--	12/24	--	16/20
*J.M.	46/47	--	30/28	--	26/27	--	19/21	--
Ave.	37.4/ 37.9	39.2/ 43.9	26.2/ 25.4	22.9/ 23.8	23.7/ 20.4	14/ 16.4	16.7/ 17.57	12.1/ 13.7

*OD/OS in degrees
*Did not come in for 16th session

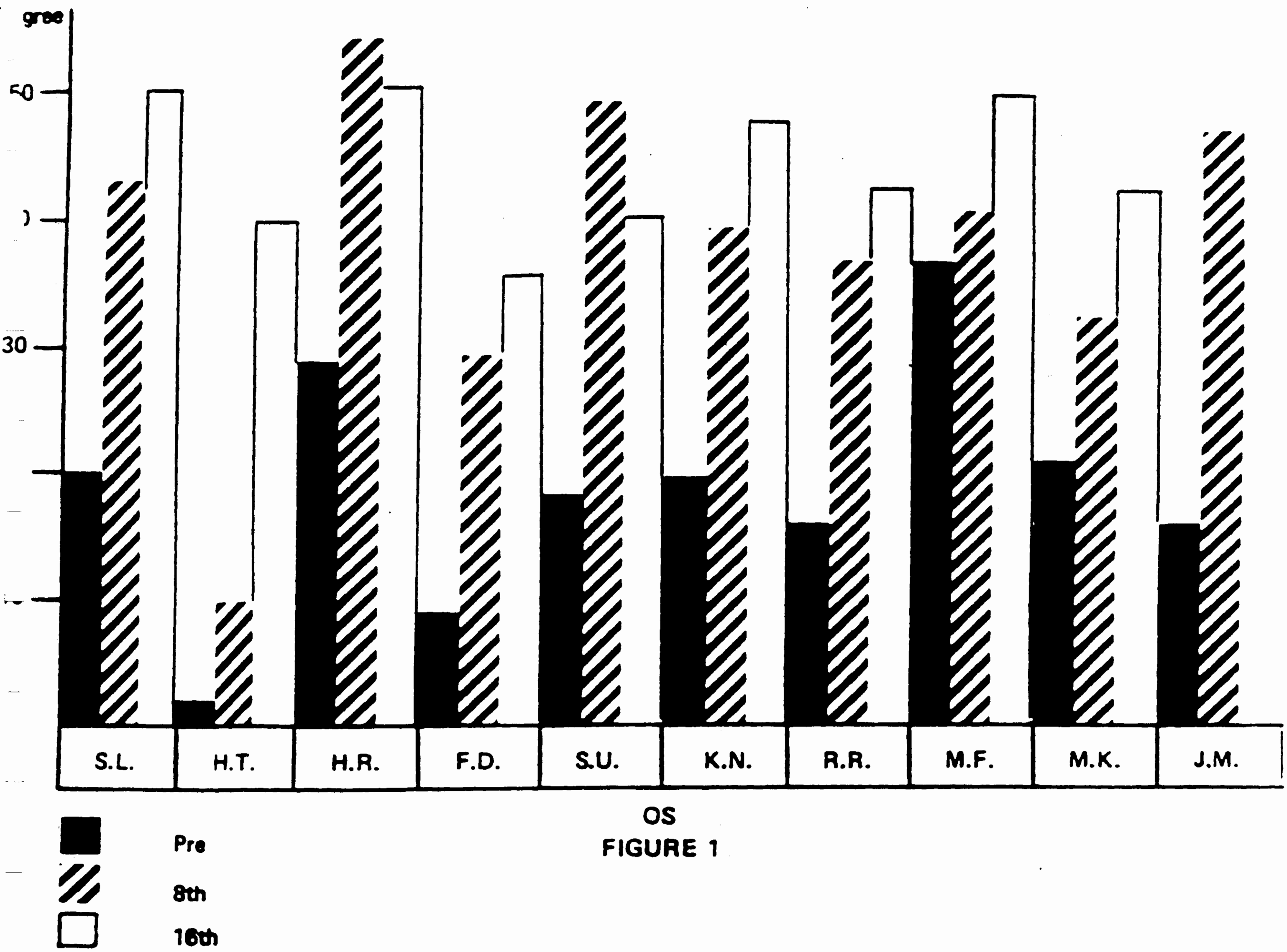
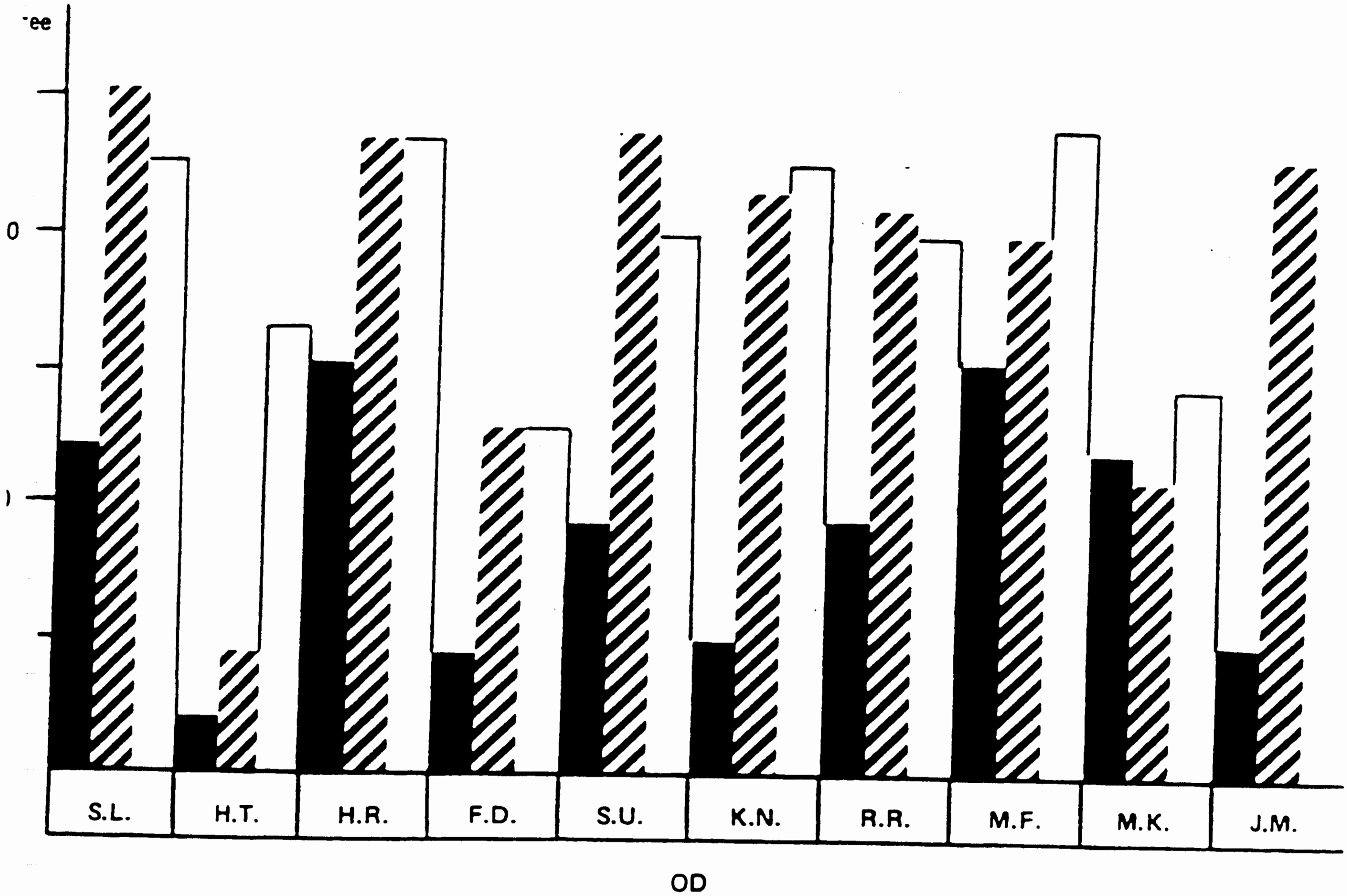


FIGURE 1


ee
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S.L.
H.T.
H.R.
F.D.
S.U.
K.N.
R.R.
M.F.
M.K.
J.M.
OD

Table 7

Form and Color Visual Field Summary for
Sessions 8 and 16 for the white light control group

Subject	Form field 8	Form field 16	Red field 8	Red field 16	Blue field 8	Blue field 16	Green field 8	Green field 16
K.V.	*30/32	7/6	23/18	--	18/12	--	12/7	--
S.V.	24/25	8/8	12/15	--	8/-	--	6/7	--
G.W.	57/59	52/51	37/45	35/29	25/36	17/19	21/28	10/10
M.M.	48/50	20/40	30/23	15/23	23/20	10/15	20/25	6/10
Ave.	39.75/ 41.5	21.75/ 26.25	25.5/ 25.5	25/26	18.5/ 22.7	13.5/ 17	14.75/ 16.75	8/10

*OD/OS in degrees

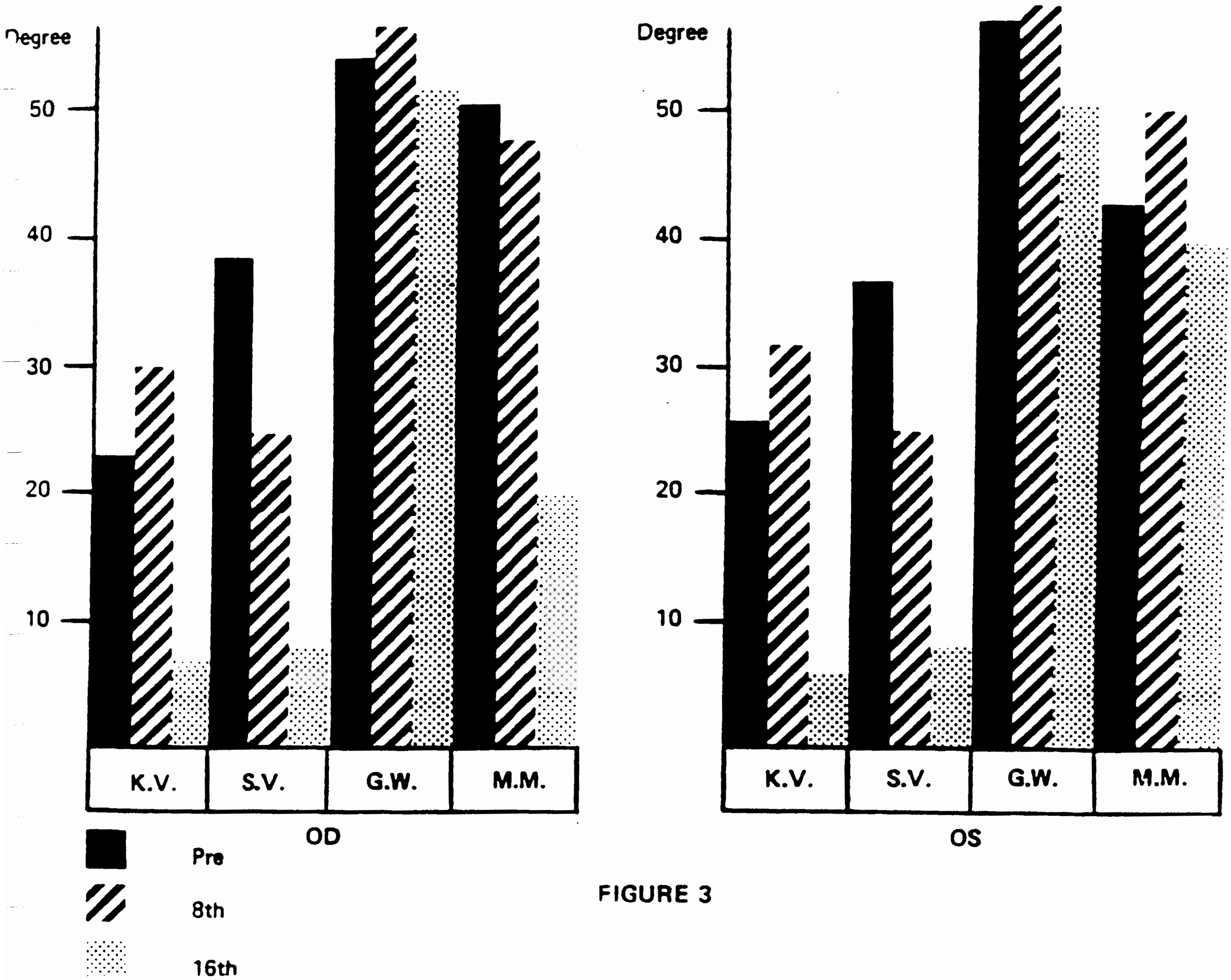

Degree
50
40
30
20
10
K.V.
S.V.
G.W.
M.M.
OD
Degree
50
40
30
20
10
K.V.
S.V.
G.W.
M.M.
OS
Pre
8th
16th

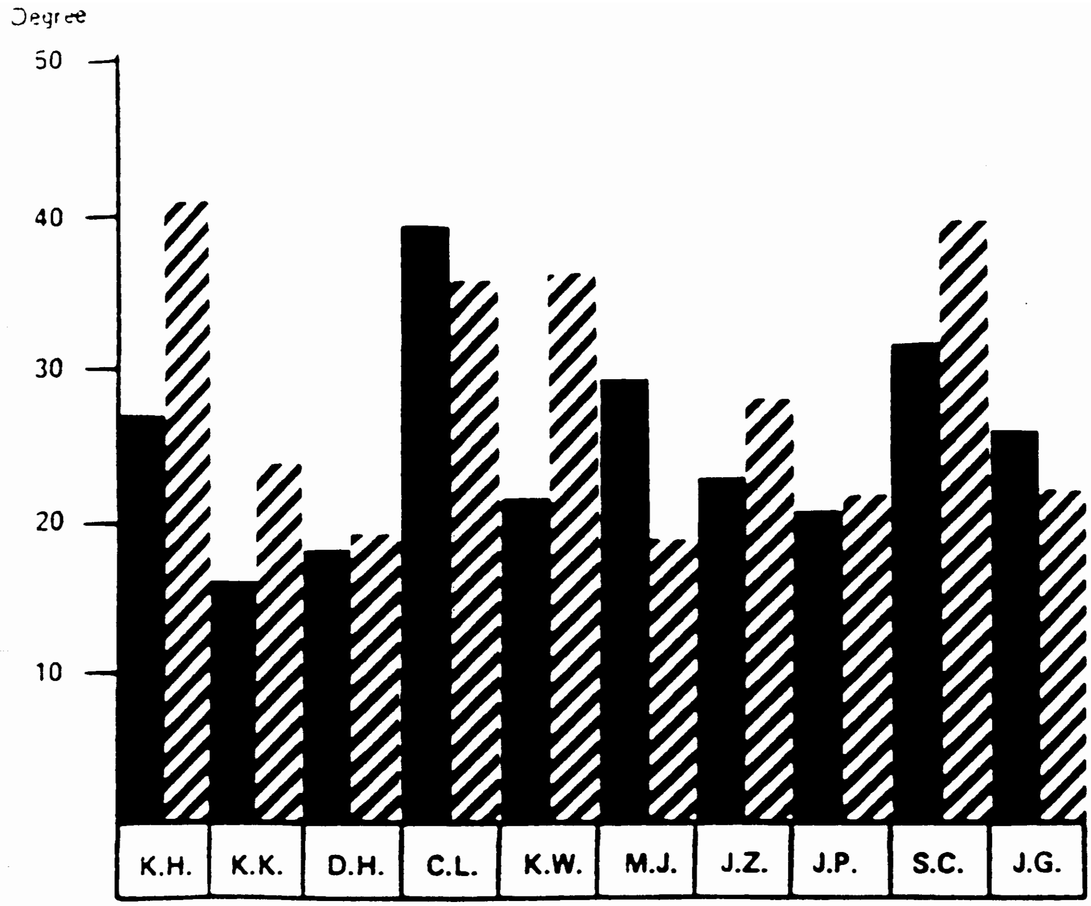
FIGURE 3

Table 8

Form and Color Visual Field Summary
for Visual Training Control Group - Post

Subject	Form Field	Red Field	Blue Field	Green Field
K.H.	* 41/39	21/22	11/13	-/12
K.K.	24/23	10/10	6/6	--
D.H.	19/21	12/15	8/10	--
C.L.	35/32	17/19	10/13	6/12
K.W.	36/35	19/23	9/16	-/10
M.J.	19/21	--	--	7/10
J.Z.	28/20	15/16	7/10	-/7
J.P.	22/23	9/7	--	--
S.C.	39/38	25/23	22/17	15/10
I.G.	22/20	13/-	7/7	
Ave.	27.1/25.63	15.7/16.1	10/11.5	9.33/10.7

*OD/OS in degrees


Degree
50
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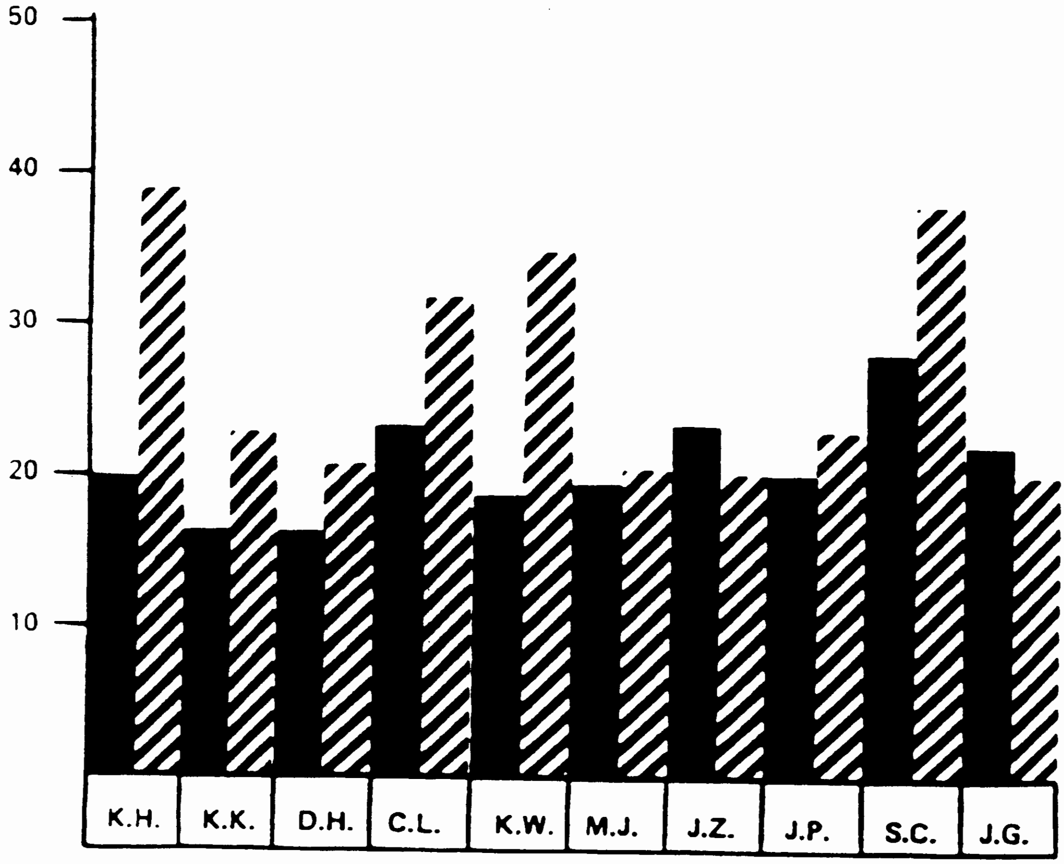
20
10
K.H.
K.K.
D.H.
C.L.
K.W.
M.J.
J.Z.
J.P.
S.C.
J.G.

OD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K.W.
M.J.
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J.P.
S.C.
J.G.

OS

Pre

Table 9

Results of Exp. and Control Groups Form Fields

	Exp. Group	White Light Control Group	V.T. Control Group
Before	18.4/18.8	41.5/40.75	24.73/20.63
8th Session	37.4/37.9	39.75/41.5	--
16th Session	39.2/43.9	21.75/26.25	27.1/25.63
% Increase B → 16th	53.1%/ 57.2%	-47.6%/ -35.6%	8.7%/ 19.5%
t-test of Significance	.001 level		no sig