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ARTICLE

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THE EFFECT OF SYNTONIC (COLORED LIGHT) STIMULATION ON CERTAIN VISUAL AND COGNITIVE FUNCTIONS

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ABSTRACT

Previous clinical reports have suggested that visual field sizes art, abnormally small in children who are classified as educationally disabled. It has also been reported that form visual, fields in reading disabled children were significantly enlarged by the use of syntonic (colored light) therapy. The present study investigates the isolated effect of syntonic (colored light) stimulation on visual field size, visual memory for objects, visual memory for abstract symbols, auditory memory, and speed and accuracy of eye movements. Thirty-six subjects took part in this study. Eighteen represented the experimental group, while the other eighteen acted as a control group matched for age and sex. The study was limited to subprimarily in, the area of reading. The subjects in the experimental group were treated with ocularly perceived colored lights of specified frequencies. The subjects in the control group did not receive any colored light treatment. Following this treatment, significant improvements were measured in the experimental group for form visual field size, visual memory for objects and visual memory for abstract symbols. No significant changes were mea-sured in the control group. A long with the measured improvement in the con-ditions treated, man y other changes occurred routinely in the experimental group. These patients frequently reported an improvement in their hand- writing, memory, and emotional well- being.

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INTRODUCTION

From the beginning of time, history has abounded with observations and scientific validation for the health-giving properties of light. From its obvious effects on plants and its proven stimulatory and regulatory effects on our highest neurological centers, light has how taken center stage as the primal element of life. The importance of light has been obvious since it was first mentioned in the Bible. From its documented medical use by the Egyptians and Romans, to its proven preventive and curative effect on a wide variety of physiological disorders, the health-giving properties of light are obvious to us on a daily basis. From the sun worshipers on our filled beaches to the differences felt in our moods and well-being when indoor confinement is necessitated by our jobs or educational process, sunlight is now recognized as that "super-terrestrial natural force under which all life originates and develops."

LITERATURE REVIEW

Although the general therapeutic value of light has been mentioned and demonstrated repeatedly throughout history, major research conducted within the last 40 years has now traced light's major route of entry into the body, as well as some of its major effects on our physiological functions.

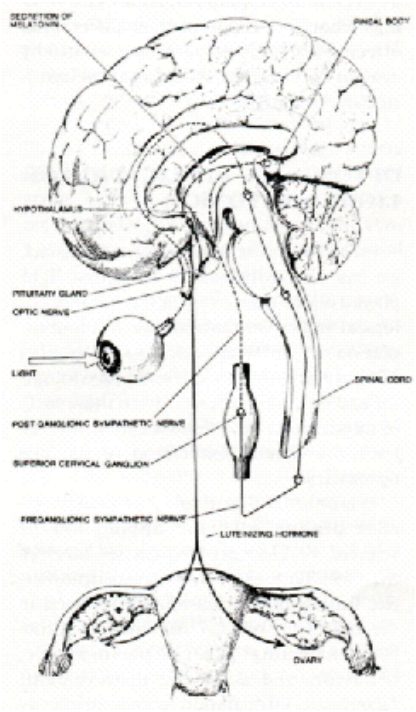
The sensory cells of the retina (cones and rods) transform the physical stimulus light by photochemical reactions into a neural sensory impulse. The resulting electric excitations run in two different routes. One route stimulates the visual cortex for vision, while the other stimulates the hypothalamus and affects our vital functions.

From the work of Greving (1925)1, Frey (1935-1955)2,3,4 , Becher (1955)5, Knoche (1956)6, Blumcke (1958). and others, nerve fibers were located in humans which are not present in the optic tract, but which clearly connect the eye with the hypothalamic region. Although these findings confirmed previous empirical observation, they were not accepted until recent autoradiographic and electron microscopic studies by such people as Hendrickson (1972)8, Moore (1973)9, Hartwig (1974)10, and others conclusively proved the existence of this pathway. According to Frey (1935)2, tile retinohypothalamic pathway is stimulated by light immediately after birth, therefore preceding the function of the optic pathway. Frey also felt that photostimulation by way of this pathway influences the reaction of the pupil, as well as dark adaptation.

In 1975, Richard Wurtman published an article in Scientific American titled "The Effect of Light on the Human Body."" In this article, Wurtman describes a non-visual neural pathway (Fig. I) for light reception. This pathway takes light's stimulation from the retina to the non-visual inferior accessory optical tract, through the color sensitive transpeduncular nucleus in the midbrain to the superior cervical ganglion which then influences the pineal gland. The pineal gland protrudes into the cerebrospinal fluid contained in the third ventricle and there activates hypothalamic cells with its chemical secretions. The hypothalamus controls seven vital functions via neural and endocrine routes: energy balance, fluid balance, heat regulation, activity and sleep, circulation and breathing, growth and maturation, and reproduction. All of these vital functions are integrated with our day-night rhythm and use light stimulation as their primary timer. The hypothalamus coordinates and regulates most of tile vital processes of life, but its direct connection with the pituitary gland causes the physiological effect of light to be even more widespread. Since the pituitary gland (which is highly active during the day) works in coordination with the pineal gland (which is primarily active during the night) in a diurnal rhythm, ocularly perceived light acts as a synchronizer between both these photoneuroendocrine glands.

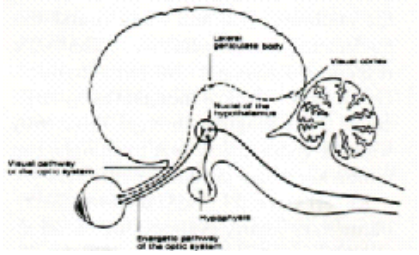
Perhaps the most comprehensive and profound publication on the influence of light on human physiology was written by Dr. Fritz Hollwich in 1979 and titled, "The Influence of' Ocular Light Perception on Metabolism in Man and in Animals." 12 Dr. Hollwich, an international authority, renowned researcher and professor of Ophthalmology at the University of Meunster in West Germany, has published over 47 scientific papers on the effect of light on physiology. Dr. Hollwich and his co-workers were the first to demonstrate, conclusively, that the stimulatory and regulatory effect of light on the human body, takes place by way of the eye (Fig. 2). Hollwich separates the visual pathway into the optic portion (used for vision as we know it), and the energetic portion, by which perceived light has a direct stimulatory and regulatory affect on the diencephalic-pituitary systems. In this manner metabolism and the endocrine system are exposed to the direct influence of light. In 1971, Hollwich published a study on 360 blind and 110 cataract patients before and after cataract surgery." He concluded that if light perception is absent, temporarily disturbed, or markedly reduced, statistically significant deficiencies occur in both endocrine and metabolic systems, as well as disturbances in emotional and physiological balance (Fig. 3). Perhaps Shakespeare's statement, "The eyes are the windows of the soul," was not far-fetched.

Fig. 1. "The Effect of Light on the Human Body," Scientific American, 1975



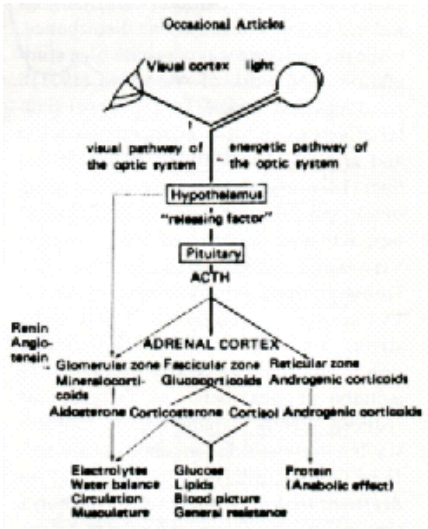
INDIRECT EFFECT OF LIGHT ON OVARIES OF RATS is shown schematically. Light activates receptors in the retina, giving rise to nerve impulses that travel via a chain of synapses through the brain, the brain stem and the spinal cord, ultimately decreasing the activity of neurons running to the superior cervical ganglion (in the neck) and of the sympathetic nerves that reenter the cranium and travel to the pineal organ. There the decrease in activity reduces both the synthesis and the secretion of melatonin. With less melatonin in blood or cerebrospinal fluid, less reaches brain centers (probably in hypothalamus) on which melatonin acts to suppress secretion of luetinizing hormone from anterior pituitary. Thus more hormone is released, facilitating ovarian growth and presumably ovulation.

Fig. 2. "The Influence of Ocular Light Perception on Metabolism in Man and in Animals," Dr. Fritz Hollwich, 1979



Schematic graph of the "energetic pathway" (F. Hollwich) of the optic nerve leading from the retina to pituitary gland or hypophysis.

Fig. 3. "Endocrine System and Blindness," *German Medical Monthly*, 1971



Scheme of the affect of light on metabolism: light impinging upon the retina causes stimuli to be sent to the hypothalamus along fibers of the energetic pathway of the optic system which is quite distinct from the optic pathway proper (2). On reaching the hypothalamus these stimuli, through the mediation of "releasing factors", act upon the regulatory and stimulatory cycle of reciprocal interactions within the pituitary – peripheral hormonal circle. Failure of light to enter the eye leads to a diminution in the activity of the diencephalon and to a lowering of the setting of the level of pituitary-peripheral hormonal activity with corresponding alterations in metabolic activity.

DIFFERENTIAL EFFECTS OF SPECIFIC COLORS

The previous section reviewed the major research which demonstrates conclusively that the stimulatory and regulatory effect of light on the human body takes place by way of the eye. Since color is merely our appreciation of light for different frequencies, is it not logical that different Colors might then create different physiological as well as psychological effects on us? In the literature review, it was mentioned that light traveled to the pineal gland by way of the inferior accessory optical tract, which synapses in the transpeduncular nucleus in the midbrain. Hill and Marg found this nucleus to be color sensitive.14 That is, it responded differently to different frequencies of light. It is now thought that specific colors (wavelengths) interact differently with the endocrine system to stimulate or inhibit hormonal production differently.

Robert Gerard's (1958) doctoral dissertation very clearly evaluates the differential effects of viewing colored lights on psychophysiological functions." His study showed that the autonomic nervous system and visual cortex were significantly less aroused when stimulated by blue or white light, versus arousal with red light. Each color also elicited significantly different feelings in the subjects. Blue stimulation was associated with increased relaxation, less anxiety and less hostility, while stimulation with red definitely increased tension and excitement. During red stimulation, manifest levels of anxiety significantly correlated with increased physiological activation and subjective disturbance, while the converse was true with blue stimulation. The work of Aaronson (1971)16 and Plack and Schick (1974) 17 report similar effects of specific colors on activation and arousal. The work of Wolfarth and Sam (1982) not only confirmed the effect of selected colors on behavior and physiology, but also found that blind subjects were as affected as sighted ones. 11 In 1980, Holwich found stress-like levels of ACTH and cortisol in individuals sitting under strong artificial (cool-white) illumination." His findings clearly explained the agitated physical behavior, fatigue, and reduced mental capabilities of children staying the whole day in school under artificial illumination. He concluded that the degree of biological endocrine disturbance that was produced and subsequent behavioral maladaptations were directly related to the difference in spectral composition of the source as compared to that of natural light. In other words, the spectral components play the decisive role. This finding is of clinical interest because cool-white fluorescent lamps are especially deficient in the red and blue-violet ranges, which are frequently used in combination syntonically as an emotional stabilizer. Hollwich's findings reconfirm the important differential effects of specific colors (wavelength) by evaluating the effect of their partial omission in our daily lives.

OPTOMETRIC APPLICATION OF LIGHT (SYNTONICS)

From the prior information discussed, we can now conclusively state that light plays a major role in regulating our physiological and emotional balance, while stimulation with different colors (wavelengths) of light has distinctly different physiological and emotional effects. With these facts in mind, let us now discuss syntonics-its background and application to modern optometry.

Syntonics is that branch of ocular science dealing with the application of selected visible light frequencies through the eyes. Syntonics is exclusively optometric, functionally oriented, and utilized in the treatment of various visual dysfunctions affecting general performance, behavior, and academic achievement. Diagnostic information comes primarily from interpretation of the case history, symptoms, observations, pupillary response, ocular-motor skills, analytical examination, visual field plotting , and general clinical experience. Of major importance to the syntonist is the plotting of central visual fields. This is done primarily with a stereocampimeter, although any visual field plotting instrument utilizing kinetic perimetry could be used. The stereocampimeter is used primarily because of its simplicity of use, speed of testing, and easy, accurate interpretation. These factors are of major importance when dealing with children and young adults, as prolonged fixation is not only difficult for this age group but can significantly affect the accuracy of results.

The work of Drs. Loeb, Henning and Spitler in the 1920's and 1930's generated much interest in the use of light therapy in the treatment of optometric problems. Dr. William Henning, in three separate books, developed an entire system of optometric case analysis and visual rehabilitation based on the use of color filters in conjunction with lenses and prisms. 20,21,22 Dr. H. Riley Spitler, in his book "The Syntonic Principle," was the first to organize the available data and experimentally determine the ocular and systemic responses to visible light as well as to specific light frequencies." Although Dr. Spitler formed the College of Syntonic Optometry, the combined work of Drs. Loeb, Henning and Spitler is responsible for most of the therapeutic techniques used in syntonic optometry today.

In 1936 Brombach reported on a study including 158 children classified as poor readers; 109 of these children demonstrated enlarged blind spots, suggesting a relationship between an enlarged blind spot and poor reading. 24 Brombach stated that these were not cases of ocular pathology and that the enlargement probably reduced the likelihood of full perception, therefore inhibiting accurate and complete reading. (It should also be noted that functional blind spot enlargements frequently accompany visual field constrictions.) In the late 1930's Dr. Thomas Eames, in a series of four published studies, concluded the following: 1) Nine percent of unselected school children have constricted central visual fields, and of these children 83 percent were failing in schoolwork in one or more subjects; 2) central visual field constrictions significantly limit the speed of visual perceptors; and 3) educational disability cases consistently present smaller visual fields than normals or unselected cases.25-26. 1-, 28

Kaplan (1983) reported that form visual fields in reading disabled children could be significantly enlarged by the use of syntonic therapy.29 In 1984 Otto and Bly analyzed 122 cases treated syntonically by Dr. Charles Butts." They found that visual fields increased significantly with syntonic therapy. Also, a high degree of success was found in treating headaches, tropias, reduced visual acuity, and diplopia. In a letter to me dated February 29, 1985, Dr. Fritz Hollwich stated that lie is sure that a functional reduction in visual field size reduces the photostimulation through the energetic portion and subsequently causes a loss in hormonal and metabolic function.

RESEARCH PROJECT

In previous studies by Dr. Thomas Eames it was suggested that form visual fields will be reduced in poor readers and in individuals experiencing learning difficulties .25-28 It has also been suggested that the use of syntonics can normalize form visual fields, consequently improving learning capabilities. It has been noticed that visual field size was only one of many variables affected by syntonics and that syntonics was valuable even for those individuals without a measurable form visual field constriction. This study was designed to investigate whether syntonics produced changes independent of visual field size and in areas of performance previously not evaluated.

METHODS

This study was conducted in my optometric office in Miami, Florida. Subject selection was limited to individuals with academic underachievement, primarily in the area of reading. A total of 36 subjects were tested. The first 18 subjects fitting the study criterion were automatically assigned to the experimental group. The second 18 subjects fitting the study criterion were assigned to the control group after matching them for age and sex with the individuals in the experimental group. All participants in this study were healthy, not receiving any concurrent therapies and, with the exception of visual field plotting, underwent all pre- and post-testing by a trained assistant. Pre- and post-visual field testing was conducted by me.

The following tests were administered to all participants in the order listed:

1) Central Form Visual Fields-Test was performed on a st ereocam pi meter using a 1.0 mm white target working from nonseeing area to seeing area. The right eye was measured first, then the left. Fixation was carefully monitored for stability, and a confrontation field was initially done for demonstration and complete patient understanding of instructions.

2) Visual Attention Span for ObjectsTest is part of the Detroit Tests of I-earning Aptitude and evaluates visual memory for objects. Age norms are listed from age 3.0 to 18.9.

3) Auditory Attention Span for Unrelated Words-Test is also part of the Detroit Tests of Learning Aptitude and evaluates auditory memory for unrelated words. Age norms are listed from age 3.0 to 19.0. 4) Monroe Visual III (Memory for Design-Power of Recall)-Test evaluates visual memory for abstract symbols and has norms from age 5.0 to 10.0. Scores higher than 10.0 were approximated by interpolation, based on suggestion from Dr. Louise Ames at the Gesell Institute.

5) Pierce Saccadics Test-Test evaluates speed and accuracy of eye movements. Test was developed by Dr. Jack Pierce. Age norms are listed for approximately age 6.0 to 14.0.

Both experimental and control groups were made up of 10 males and eight females and matched for approximate age (within a range of eight months for 15 of the subjects, and 23 months for the three adult subjects). Participants' ages ranged from five years to 29 years.

Two identical syntonizers were used for administering treatment to those in the experimental group. Treatment consisted of sitting before a syntonizer and fixating on a light source of a specified frequency. All patients in the experimental group underwent 20 treatments lasting 20 minutes each and averaged approximately four treatments per week. The control group did not receive any treatment. The average course of treatment was 47-1/2 days for those in the experimental group. Were it not for three patients whose course of treatment had to be extended due to illness, vacations, etc., the average course of treatment for those in the experimental group would have been 39 days between pre- and post-testing. For those in the control group, an average of 35 days passed between pre- and post-testing.

Determination of the appropriate therapeutic filter for those subjects in the experimental group was based on the syntonic optometry philosophy: functional vision problems affecting learning capabilities are in many instances linked to an imbalance in the autonomic nervous system. This imbalance will in turn be manifested as a sympathetic or parasympathetic predominance. A sympathetic predominance is usually manifested as an excessive exophoric finding, while a parasympathetic predominance will usually be manifested as an excessive esophoric finding. The phoria measurements as well as other optometric findings, the case history, and the author's clinical experience were all utilized in determining whether a subject received a sympathetic stimulant (i.e. red), or a parasympathetic stimulant (i.e. blue).

The following general criterion were also used:

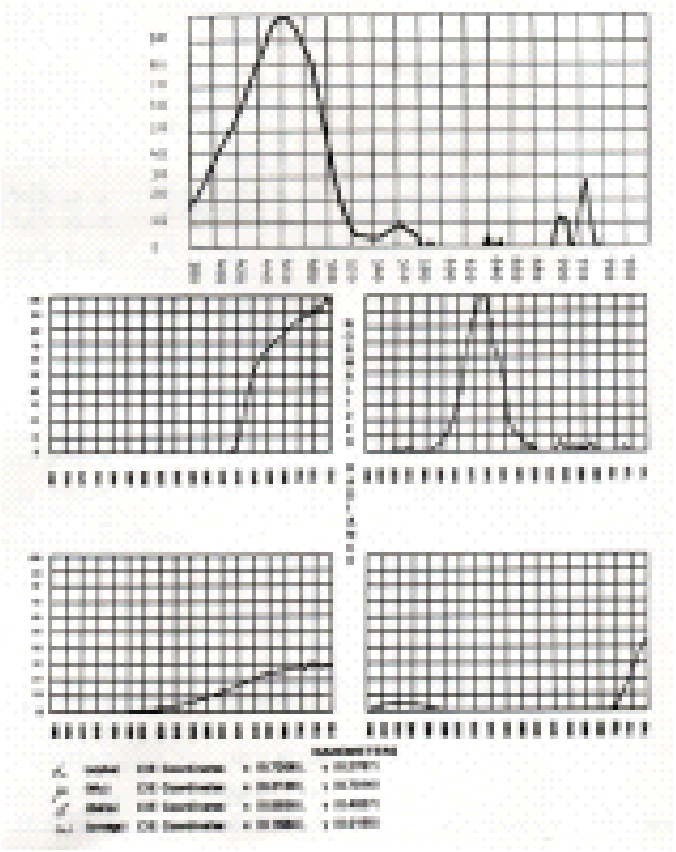
• Subjects manifesting constricted V isual fields with normal to minimal phoric deviations were treated with yellow-green (500-590 nanometers) to normalize the visual field.

• Subjects manifesting constricted visual fields with moderate phoric deviations were treated with yellow-green to normalize the visual field, followed by red (620-770 nanometers) or indigo (400-500 nanometers). (The use of red or indigo depends on whether sympathetic or parasympathetic stimulation is desired. In general, excessive exophoria is treated with a parasympathetic stimulant [indigo] while excessive esophoria is treated with a sympathetic stimulant [red]. This frequently affects a change in the phoric posture

• Subjects manifesting normal to minimally constricted visual fields, with moderate to large phoric deviations were treated with either red or indigo as described in #2.

Filter data are summarized in Figure 4. Patients did not undergo nacentization,

Fig. 4. Filter Data



and testing was administered only before the initial treatment and after the last treatment. No interim testing of any type was administered.

Two tests were used to determine whether the control and experimental groups were significantly different for each of the parameters measured. For normally distributed data, a t-test was used. For non-normally distributed data, a Wilcoxon Rank-Sum Test for Two Groups was used. Both of these tests are from the Microstat Statistical Analysis Package, Release 4.1 from Ecosoft, Inc., for use on a mini-computer.

It should be noted that the control group's treatment was different from the experimental group's. Usually the control group is subjected to the same treatment as the experimental group, but without the medication. In this case, the use of any color (medication) as a placebo was not reasonable. With the instrument off (approximating blackness) or with no filter (white light), there might still be an affect.29 The control group did not use the syntonizers, although the experimental group did. This fact alone could have caused some bias in the study.

RESULTS

Tables I -a through 6-b list the results of all data accumulated in this study. The

Table Ia. Visual Field Data (Experimental)

Subject (yr-mo.)	Age	Elapsed Time Days	Vis. Field (Pre) Right-H x V Left-H x V	Vis. Field (Post) Right-H x V Left-H x V	% Increase Vis Field Area Right Left	Avg. % Cha Visual Field
1. J.D.	(5- 3)	34	R- 4 x 4 L -3 x4	R-62 x 55 L-58 x 53	R - 23937% L - 37323%	30630%
2. GAN.	(6- 7)	36	R- 5 x5 L - 5 x5	R-55 x 53 L -57 x 49	R- 12003% L- 12899%	12451%
3. C. F.	(6- 7)	34	R - 18 x 18 L - 8 X 8	R - 57 x 44 L - 54 x 47	R - 903% L- 4457%	2680%
4. M. H.	(7 - 4)	55	R- 6 x 6 L- 6 x 6	R- 20 x 20 L - 20 x 20	R- 1011% L- 1011%	1011%
5. N.G.	(7 - 8)	57	R - 41 x 38 L - 3 8 x 37	R- 54 x 47 L - 5 5 x 47	R - 7 3 3% L- 110%	92%
6. C.M.	(8- 2)	35	R- 8 x 8 L - 8 x 8	R - 49 x 43 L - 53 x 43	R- 3652% L- 4289%	3971%
7. J. P.	(9- 0)	36	R - 50 x 43 L - 48 x 42	R - 54 x 47 L - 58 x 50	R- 17% L- 46%	32%
8. E. R.	(9- 1)	34	R - 40 x 60 L - 45 x 41	R - 61 x 46 L - 60 x 60	R- 132% L- 78%	105.5%
9. R.V.	(9- 4)	77	R - 41 x 34 L - 38 x 39	R - 62 x 63 L - 58 x 61	R- 129% L- 133%	131%
10. C.R.	(9-10)	36	R - 61 x 56 L - 60 x 55	R - 62 x 59 L - 62 x 57	R- 3.3% L- 7%	5%
11. M.E.	(10- 3)	33	R - 20 x 20 L - 19 x 19	R - 56 x 53 L - 54 x 50	R- 684% L -708%	696%
12. R.H.	(10-10)	30	R - 60 x 39 L - 54 x 43	R - 60 x 60 L - 61 x 57	R- 0% L- 28%	14%
13. M.T.	(11- 3)	48	R - 43 x 43 L - 48 x 43	R - 59 x 60 L - 59 x 57	R- 88 % L- 51%	70%
14. S.D.	(11-11)	36	R - 52 x 52 L - 55 x 46	R - 63 x 63 L - 64 x 61	R- 47% L- 35%	41%
15, D.S.	(13- 0)	65	R - 56 x 55 L - 5 6 x 54	R - 58 x 63 L - 58 x 49	R- 7% L- 7%	7%
16. W.S.	(22- 9)	44	R - 25 x 22 L - 22 x 22	R - 60 x 53 L - 58 x 57	R- 476% L- 595%	536%
17. J.S.	(24- 1)	126	R - 53 x 51 L - 54 x 53	R - 57 x 52 L - 58 x 55	R - 16% L - 15 %	16%
18. L. S.	(29- 10)	43	R - 62 x 56 L - 58 x 56	R - 62 x 56 L - 58 x 56	R - 0% L - 0%	0%

Table 1b. Visual Field Data (Control)

Subject (yr-mo.)	Age	Elapsed Time Days	Vis. Field (Pre) Right-H x V Left-H x V	Vis. Field (Post) Right-H x V Left-H x V	Field Area Right Left	Avg. % Cha Visual Field
1. K.P.	(5- 0)	30	R - 44 x 31 L - 42 x 46	R - 34 x 36 L - 37 x 33	R - -40% L - -22%	-3 1 %
2. J.S.	(6- 4)	38	R - 40 x 37 L - 45 x 41	R - 40 x 37 L - 32 x 38	R - 0% L - -50%	-25%
3. J.A.	(7- 3)	33	R - 60 x 55 L - 49 x 46	R - 40 x 41 L - 36 x 40	R - -56% L - -46%	-51%
4. J.C.	(7- 2)	30	R- 12 x I I L - 15 x 10	R- 12 x 12 L - 12 x 10	R - 0% L - -36%	-18 %
5. R. C.	(8 - 4)	28	R - 36 x 27 L - 48 x 38	R - 26 x 25 L - 43 x 37	R - 48% L - -20%	-34%
6. M. C.	(8- 7)	31	R- 7 x 7 L-11 x 9	R- 14 x 14 L- 14 x 14	R - 305 % L - 62%	184%
7. E. L.	(8-11)	61	R - 64 x 56 L - 56 x 60	R- 57 x 55 L- 57 x 54	R - -31 % L - -10%	-21%
8. P.R.	(9- 2)	34	R - 43 x 43 L - 50 x 50	R - 45 x 35 L - 41 x 37	R - -10% L - -33%	-22.2%
9. C.C.	(9- 2)	28	R- 9 x 9 L- 8 x 8	R- 19 x 20 L - 20 x 20	R - 344% L - 528%	436%
10. E. K.	(9- 6)	41	R - 45 x 34 L- 35 x 38	R - 43 x 28 L - 25 x 23	R - -9% L - -49%	-29%
11. G. L	(10- 4)	61	R - 61 x 63 L - 58 x 59	R - 59 x 48 L - 59 x 57	R - - 6% L - 4%	1%
12. M.A.	(10- 4)	33	R - 54 x 52 L - 51 x 48	R - 44 x 40 L - 39 x 38	R - -34% L - -42%	-38%
13. D.C.	(I1- 3)	30	R - 7 x 9 L - 29 x 22	R - 7 x 7 L - 19 x 18	R - 0% L - 57%	-29%
14. C.M.	(12- 1)	30	R - 56 x 59 L - 57 x 55	R - 49 x 45 L - 46 x 41	R - -23% L - -35%	-29%
15. G.G.	(13- 0)	36	R - 49 x 34 L - 48 x 39	R - 51 x 41 L - 42 x 45	R - 8% L- -23%	- 8%
16. K.M.	(20-10)	30	R - 56 x 56 L - 60 x 55	R - 55 x 41 L - 54 x 51	R - -4% L - -19%	-12%
17. C.M.	(25- 4)	30	R - 62 x 60 L - 5 9 x 60	R - 58 x 56 L - 5 4 x 55	R - -12% L - -16%	-14%
18. E.W.	(28- 0)	26	R - 61 x 58 L - 62 x 58	R - 66 x 62 L - 58 x 61	R - 17% L - -12%	2%

Table 2a. Visual Attention Span (experimental)

Subject	Age (Yr.-Mo.)	Elapse Time Days	Vis. Att. Span (pre) Age (Yr.-Mo.)	Vis. Att. Span (Post) Age (Yr.-Mo.)	Vis. Att. Span Change in months
I . J.D.	(5- 3)	34	7- 9	13- 3	+66
2. G.W	(6- 7)	36	6- 3	8- 3	+24
3. C.F.	(6- 7)	34	6- 9	8- 6	+21
4. M.H.	7- 4)	55	3- 3	10- 3	+84
5. N.C.	(7- 8)	57	10- 0	14- 6	+54
6. C.M.	(8- 2)	35	5- 9	11- 3	+66
7. J. P.	(9- 0)	36	9- 6	10- 9	+15
8. E. R.	(9- 1)	34	8- 9	9- 3	+ 6
9. R. V.	(9- 4)	77	9- 6	12- 0	+30
10. C.R.	(9-10)	36	10- 3	17- 3	+84
11. M. E.	(10- 3)	33	11- 9	12- 9	+ 12
12. R.H.	(10-10)	30	7- 0	10- 3	+39
13. M.T	(I 1- 3)	48	8- 0	15- 6	+90
14. S.D.	(11-11)	36	11- 0	14- 3	+39
15. D.S.	(13- 0)	65	10- 9	16- 6	+69
16. W.S.	(22- 9)	44	12- 3	17- 3	+60
17. J.S.	(24- 1)	126	11- 9	16- 9	+60
18. L.S.	(29-10)	43	10- 9	18- 0	+87

Table 2b. Visual Attention Span (control)

Subject	Age (Yr.-Mo.)	Elapse Time Days	Vis. Att. Span (pre) Age (Yr.-Mo.)	Vis. Att. Span (Post) Age (Yr.-Mo.)	Vis. Att. Span Change in months
I . K.P.	(5- 0)	30	4- 9	7- 0	+27
2. J.S.	(6- 4)	38	7- 9	8- 9	+12
3. J.A.	(7- 3)	33	8- 3	8- 6	+ 3
4. J.C.	(7- 2)	30	7- 0	8- 6	+18
5. R.C.	(8- 4)	28	15- 0	13- 9	-15
6. M.C.	(8- 7)	31	9- 3	10- 3	+12
7. E.L.	(8-11)	61	12- 9	13- 0	+ 3
8. P.R.	(9- 2)	34	8- 9	15- 3	+78
9. C.C.	(9- 2)	28	10- 6	9- 9	- 9
10. E.K.	(9- 6)	41	11- 9	14- 6	+33
11. G.L.	(10-4)	61	15- 3	15- 0	- 3
12. M.A.	(10- 4)	33	11- 9	11- 9	+ 6
13. D.C.	(11-3)	30	13- 6	15- 0	+18
14. C.M.	(12-1)	30	9- 6	10- 0	+ 6
15. G.G.	(13-0)	36	10- 9	11- 3	+ 6
16. K.M	(20-10)	30	13- 0	14- 6	+18
17. C.M.	(25- 4)	30	14- 3	17- 6	+39
18. E.W.	(28- 0)	26	17- 0	14- 9	-27

Table 3a. Monroe Visual III (experimental)

Subject	Age (Yr.-Mo.)	Elapsed Time Days	Monroe Vis. III (Pre) Age (Yr.-Mo.)	Monroe Vis. III (Post) Age (Yr.-M0.)	Monroe Vis. III Change in months
1 J.D.	(5-3)	34	5-11	7- 0	+ 13
2. G.W .	(6-7)	36	6- 3	7- 4	+ 13
3. C.F.	(6-7)	34	5-11	6- 2	+ 3
4. M. H.	(7- 4)	55	6- 1	6- 5	+ 4
5. N.G.	(7- 8)	57	6- 5	8- 6	+25
6. C.M.	(8- 2)	35	5- 8	7-10	+26
7. J.P.	(9- 0)	36	5- 3	8- 2	+35
8. E.R.	(9-1)	34	6- 4	7- 0	+ 8
9. R. V.	(9-4)	77	6- 11	10- 6	+43
10. C.R.	(9-10)	36	6- 9	7- 9	+12
11. M. E.	(10-3)	33	9- 0	12- 3	+39
12. R.H.	(10-10)	30	9- 1	9- 9	+ 8
13. M.T.	(11-3)	48	12- 7	13- 6	+ 11
14. S.D.	(11-11)	36	11- 0	10- 5	- 7
15. D.S.	(13-0)	65	8- 6	14- 4	+70
16. W.S.	(22-9)	44	13- 0	13- 6	+ 6
17. J.S.	(24-1)	126	9- 9	13- 6	+45
18. L. S.	(29-10)	43	8- 1	9- 10	+21

Table 3a. Monroe Visual III (control)

Subject	Age (Yr.-Mo.)	Elapsed Time Days	Monroe Vis. III (Pre) Age (Yr.-Mo.)	Monroe Vis. III (Post) Age (Yr.-M0.)	Monroe Vis. III Change in months
1. K.P.	(5- 0)	30	5- 8	6- 1	+ 5
2. J.S.	(6- 4)	38	5- 0	5- 0	0
3. J.A.	(7- 3)	33	7- 4	7- 0	- 4
4. J.C.	(7- 2)	30	8- 0	8- 5	+5
5. R.C.	(8- 4)	28	11- 0	13- 0	+24
6. M. C.	(8- 7)	31	8- 1	7- 9	- 4
7. E.L.	(8-11)	61	12- 1	12- 1	0
8. P.R.	(9- 2)	34	12- 1	10- 4	-21
9. C.C	(9- 2)	28	9- 9	10- 2	+ 5
10. E.K	(9- 6)	41	9- 0	11- 9	+ 33
11. G.L.	(10- 4)	61	8- 9	8- 5	- 4
12. M.A.	(10- 4)	33	11- 3	9- 2	-31
13. D.C.	(11- 3)	30	14- 2	13- 6	- 8
14. C.M.	(12- 1)	30	8- 7	12-11	+52
15. G.G.	(13- 0)	36	8- 6	9- 9	+15
16. K.M.	(20-10)	30	13- 6	13- 0	- 6
17. C M.	(25-4)	30	14- 4	14- 4	0
18. E.W.	(28- 0)	26	13- 6	13- 6	0

Table 4a. Auditory Attention Span (Experimental)

Subject	Age (yr.-mo.)	Elapsd Time Days	Auditory Att. Span (Pre) Age (yr.-mo.)	Auditory Att. Span (Post) Age (yr.-mo.)	Auditory Att. Span Change in months
1. J.D.	(5- 3)	34	5- 9	7- 9	+24
2. G.W	(6- 7)	36	5- 3	5- 0	- 3
3. C.F.	(6- 7)	34	6- 0	6- 6	+ 6
4. M.H.	(7- 4)	55	0- 9	3- 0	+27
5. N.G.	(7- 8)	57	to- 9	14- 0	+38
6. C-M.	(8- 2)	35	6- 3	7- 0	+ 9
7. J.P.	(9- 0)	36	7- 3	8- 9	+18
8. E. R.	(9- 1)	34	6- 6	6- 9	+ 3
9. R.V.	(9- 4)	77	7- 9	8- 9	+12
10. C.R.	(9-10)	36	7- 9	12- 3	+54
11. M. F.	(10- 3)	33	9- 0	10- 6	+18
12. R.H.	(10-10)	30	4- 0	7- 9	+45
13. M.T.	(11- 3)	48	9- 0	12- 0	+36
14. S.D.	(11-11)	36	10- 6	12- 9	+27
15. D.S.	(13- 0)	65	11- 3	12- 0	+ 9
16. W.S.	(22- 9)	44	7- 6	11- 6	+48
17. J.S.	(24- 1)	126	9- 6	14- 0	+54
18. L.S.	(29-10)	43	10- 6	11- 0	+4

Table 4b. Auditory Attention Span (control)

Subject	Age (yr.-mo.)	Elapsd Time Days	Auditory Att. Span (Pre) Age (yr.-mo.)	Auditory Att. Span (Post) Age (yr.-mo.)	Auditory Att. Span Change in months
1. K.P.	(5- 0)	30	3- 9	5- 6	+21
2. J.S.	(6- 4)	38	5- 0	9- 3	+51
3. J.A.	(7- 3)	33	6- 9	6- 0	- 6
4. J.C.	(7- 2)	30	5- 3	6- 9	+18
5. R.C.	(8- 4)	28	12- 6	16- 6	+48
6. M.C.	(8- 7)	31	6- 9	8- 0	+15
7. E.L.	(8-11)	61	12- 3	11- 0	-15
8. P.R.	(9- 2)	34	13- 3	16- 3	+36
9. C.C.	(9- 2)	28	9- 3	11- 0	+21
10. E.K.	(9- 6)	41	11- 3	13- 3	+24
11. G. L.	(10- 4)	61	10- 3	12- 9	+30
12. M.A.	(10- 4)	33	10- 9	10- 3	- 6
13. D.C.	(11- 3)	30	12- 0	13- 0	+12
14. C.M.	(12- 1)	30	10- 3	6- 3	-48
15. G.G.	(13- 0)	36	8- 9	10- 0	+15
16. K.M.	(20-10)	30	11- 0	13- 3	+27
17. C.M.	(25- 4)	30	8- 3	8- 9	+ 6
18. E.W.	(28- 0)	26	13- 6	14- 9	+15

Table 5a. Pierce Saccadics Test - Speed (Experimental)

Subject	Age (yr.-mo.)	Elapsed Time Days	Pierce Sacc. Test (Pre) Speed (yr.-mo.)	Pierce Sacc. Test (Post) Speed (yr.-mo.)	Pierce Sacc. Test Change in months
1 . J.D.	(5- 3)	34	6- 3	7- 5	+14
2. G.W	(6- 7)	36	5- 0	5- 0	0
3. C.E	(6- 7)	34	5- 8	7- 3	+19
4. M.H.	(7- 4)	55	7- 2	6- 3	-11
5. N.G.	(7- 8)	57	9- 0	8-11	- 1
6. C.M.	(8- 2)	35	8- 1	8-10	+ 9
7. J. P.	(9- 0)	36	It- 5	10- 4	-13
8. E. R.	(9- 1)	34	8- 0	8- 9	+ 9
9. R. V.	(9- 4)	77	9- 4	8- 8	- 8
10. C.R.	(9-10)	36	10- 5	7- 8	-33
It. M. E.	(10- 3)	33	8- 3	8- 2	- 1
12. R.H.	(10-10)	30	7- 6	8- 9	+ 15
13. M.T.	(11- 3)	48	8-10	It- 0	+26
14. S.D.	(11-11)	36	9-10	10-10	+ 12
15. D.S.	(13- 0)	65	9- 4	10- 4	+ 9
16. W.S.	(22- 9)	44	15- 0	15- 0	0
17. J. S.	(24- 1)	126	12- 6	15- 0	+30
18. L.S.	(29-10)	43	15- 0	15- 0	0

Table 5b. Pierce Saccadics Test - Speed (Cortrol)

Subject	Age (yr.-mo.)	Elapsed Time Days	Pierce Sacc. Test (Pre) Speed (yr.-mo.)	Pierce Sacc. Test (Post) Speed (yr.-mo.)	Pierce Sacc. Test Change in months
1 . K.P.	(5- 0)	30	N.A.	N.A.	N.A.
2. J.S.	(6- 4)	38	5- 0	5- 9	+ 9
3. J.A.	(7- 3)	33	6- 0	5- 9	- 3
4. J.C.	(7- 2)	30	7- 4	8- 3	+ 11
5. R.C.	(8- 4)	28	IT- 3	12- 4	+ 13
6. M.C.	(8- 7)	31	9- 5	9- 3	- 2
7. E.L.	(8-11)	61	9-10	TO- I	+ 3
8. P.R.	(9- 2)	34	1-10	9- 9	+23
9. C.C.	(9- 2)	28	8- 7	9 4	+ 9
10. E.K.	(9- 6)	41	7-11	8-11	+ 12
11. G.L.	(10- 4)	61	TO-	10- 5	0
12. M.A.	(10- 4)	33	8- 3	9- 3	+ 12
13. D.C.	(11- 3)	30	15- 0	15- 0	0
14. C.M.	(12- 1)	30	9- 9	15- 0	+63
15. G.G.	(13- 0)	36	9- 2	9- 1	- 1
16. K.M.	(20-10)	30	15- 0	15- 0	0
17. C.M.	(25- 4)	30	15- 0	15- 0	0
18. E.W.	(28- 0)	26	15- 0	15- 0	0

Table 6a. Pierce Saccadics Test - Accuracy (Experimental)

Subject	Age (yr.-mo.)	Elapsed Time Days	Pierce Sacc. Test (Pre) Accur (yr.-mo.)	Pierce Sacc. Test (Post) Accur (yr.-mo.)	Pierce Sacc. Test Change in months
1 . J.D.	(5- 3)	34	5- 6	5- 9	+ 3
2.G.W	(6- 7)	36	5-11	6-11	+12
3. C.E	(6- 7)	34	8- 9	14- 0	+ 63
4.M.H.	(7- 4)	55	5- 4	6-10	+ 18
5.N.G.	(7- 8)	57	8- 0	8- 7	+ 7
6.C.M.	(8- 2)	35	14- 0	14- 0	0
7.J.P.	(9- 0)	36	6- 7	8- 9	+26
8. E. R.	(9- 1)	34	8- 6	8- 9	+ 3
9. RX	(9- 4)	77	14- 0	8- 4	-68
10. C.R.	(9-10)	36	7- 4	6- 8	- 8
11.M.E.	(10- 3)	33	7- 5	7- 4	- 1
12.R.H.	(10-10)	30	7- 4	8- 9	+ 17
13.M.T.	(11- 3)	48	14- 0	8- 6	-66
14.S.D.	(11-11)	36	14- 0	14- 0	0
15.D.S.	(13- 0)	65	14- 0	14- 0	0
16.W.S.	(22- 9)	44	14- 0	14- 0	0
17.J.S.	(24- 1)	126	14- 0	13- 0	-12
18.L.S.	(29-10)	43	14- 0	14- 0	0

Table 6b. Pierce Saccadics Test - Accuracy (Control)

Subject	Age (yr.-mo.)	Elapsed Time Days	Pierce Sacc. Test (Pre) Accur (yr.-mo.)	Pierce Sacc. Test (Post) Accur (yr.-mo.)	Pierce Sacc. Test Change in months
1. K.P.	(5- 0)	30	N.A.	N.A.	N.A.
2. J.S.	(6- 4)	38	6- 9	5- 0	-21
3. J.A.	(7- 3)	33	7- 2	7- 2	0
4. J.C.	(7- 2)	30	7- 5	8- 4	+ 11
5. R.C.	(8- 4)	28	7- 3	14- 0	+81
6. M.C.	(8- 7)	31	7- 7	14- 0	+77
7. E.L.	(8-11)	61	8- 4	8- 0	- 4
8. P.R.	(9- 2)	34	10- 6	14- 0	+42
9. C.C.	(9- 2)	28	7-10	8- 6	+ 8
10. E.K.	(9- 6)	41	14- 0	14- 0	0
11. G.L.	(10- 4)	61	14- 0	8- 9	-63
12. M.A.	(10- 4)	33	14- 0	14- 0	0
13. D.C.	(11- 3)	30	14- 0	14- 0	0
14. C.M.	(12- 1)	30	14- 0	14- 0	0
15. G.G.	(13- 0)	36	14- 0	8- 9	-63
16. K.M.	(20- 10)	30	14- 0	14- 0	0
17. C.M.	(25- 4)	30	14- 0	14- 0	0
18. E.W.	(28- 0)	26	14- 0	14- 0	0

Table 7. Therapeutic Filters - Phoric Postures (Experimental)

Subject	Age (yr.-Mo.)	Elapsed Time Days	Filters Used	Phoric Posture
1 . J.D.	(5- 3)	34	UW (20) FF	EXO
2. G.W.	(6- 7)	36	Mu D (20)	ESO
3. C.F.	(6- 7)	34	Mo D (20)	ESO
4. M. H.	(7- 4)	55	Mu D (10), UW (10)	EXO
5. N.G.	(7- 8)	57	Mu D (3), AD (17) FF	ESO
6. C.M.	(8- 2)	35	AD (20) FF	ESO
7. J.P.	(9- 0)	36	Mu D (9), AD (11) FF	ESO
8. E.R.	(9- 1)	34	UW (20) FF	EXO
9. R.V	(9- 4)	77	AD (20) FF	ESO
10. C.R.	(9-10)	36	AD (20) FF	ESO
11. M.E.	(10- 3)	33	Mu D (10), AD (10) FF	ESO
12. R.H.	(10-10)	30	Mu D (20)	ESO
13. M. T.	(11- 3)	48	AD (20) FF	ESO
14. S.D.	(11-11)	36	UW (20)	ORTHO
15. D.S.	(13- 0)	65	AD (20) FF	ESO
16. WS.	(22- 9)	44	AD (20) FF	ESO
17. J.S.	(24- 1)	126	AD (20) FF	ESO
18. L.S.	(29-10)	43	UW (20) FF	EXO

experimental group has been designated "a", and the control group "b". Table 7 summarizes the therapeutic filters used as well as each subject's' phoric posture. Table 8 summarizes the average change per patient per test for both experimental and control groups. Table 8 also presents the results of statistical testing. The Horizontal Form Visual Field data were averaged for both eyes. The same was done for the Vertical Form Visual Field data. The Wilcoxon Rank-Sum Test for Two Groups was used to analyze the Form Visual Field data. T-tests were used for analyzing the results of the following tests: Visual Attention Span, Monroe Visual 111. Auditory Attention Span, and Pierce Saccadics Test (Speed and Accuracy).

Table 9 shows the comparison of the average changes for subjects whose original visual field diameter NN as :5 36 degrees versus those whose original visual field diameter was ± 37 degrees.

DISCUSSION

The results of this study clearly indicate that the use of colored light therapy (syntonics), will produce very significant improvements in certain visual and cognitive functions. It confirms the previous

Table 8. The average change per subject per test evaluated and results of statistical analyses.

Average % Change in Visual Field Area
Experimental group +2,916%
Control Group + 14%
Comparison of average amount of change in horizontal visual field diameter between the control and experimental groups (Wilcoxon, p ≥0.001)

Average % Change in Visual Field Area for Subjects Whose Original Horizontal Visual Field Diameter was : ≤36 degrees.
Experimental Group +7,425%
Control Group + 85%

Average Change in Visual Memory (Visual Attention Span)
Experimental Group 50-month increase.
Control Group 13-month increase.
Comparison of the average amount of change between the control and experimental groups (t-test, p ≥0.001)

Average Change in Visual Memory (Monroe Visual III)
Experimental Group 21 -month increase.
Control Group 3-month increase.
Comparison of the average amount of change between the control and experimental groups (t-test, p ≥ 0.001)

Average Change in Auditory Memory (Auditory Attention Span)
Experimental Group 24-month increase.
Control Group 15-month increase.
Comparison of the average amount of change between the control and experimental groups (not significant (n.s.))

Average Change in Eye Movement Speed (Pierce Sacc. Test)
Experimental Group 4-month increase.
Control Group 9-month increase.
Comparison of the average amount of change between the control and experimental groups (n.s.)

Average Change in Eye Movement Accuracy (Pierce Sacc. Test)
Experimental Group 0-month increase.
Control Group 4-month increase.
Comparison of the average amount of change between the control and experimental groups (n.s.)

Table 9. The average change per subject per test for subjects whose original visual field diameter was : ≤36 degrees (small) vs. those whose original visual field diameter was ≥37 degrees (large).

Average Change in Visual Memory (Visual Attention Span)
Small - 48-month increase
Large - 52-month increase

Average Change in Visual Memory (Monroe Visual III)
Small - 15-month increase
Large - 25-month increase

Average Change in Auditory Memory (Auditory Attention Span)
Small - 18-month increase
Large - 27-month increase

Average Change in Eye Movement Speed (Pierce Sacc. Test)
Small - 4-month increase
Large - 4-month increase

Average Change in Eye Movement Accuracy (Pierce Sacc. Test)
Small - 14-month increase
Large - 9-month decrease

clinical and research data that visual field constrictions enlarge significantly and within a short period of time with the application of the appropriate syntonic treatment. Of special interest is the fact that visual field size improved so significantly even though two-thirds of the subjects in both experimental and control groups did not have significant visual field constrictions at the outset. Comparing those individuals in each group whose original visual fields were: ≤36 degrees, the percent increase in visual field area seen in the experimental group was 87 times greater than that of the control group. Also of interest was the observation that 15 (83%) of the 18 subjects in the control group actually had a measurable reduction in visual field size, suggesting the possibility that individuals with reading difficulties will have a gradual reduction in visual field size if evaluated over time.

The area of memory function is of special interest because many patients reported a noticeable improvement in their memory following syntonic treatments, yet the existence of a relationship between syntonic treatments and improved memory had previously not been cited or evaluated in the literature. A large portion of the study was therefore spent evaluating the effect of syntonics on three different types of memory: 1) visual-verbal memory; 2) visual-motor memory; and 3) auditory-verbal memory. Visual-verbal memory (referred to as Visual attention span) is one's ability to recall Verbally something just seen visually. Visual-motor memory (Monroe Visual III) evaluates one's ability to reproduce motorically what was just seen. Auditory-verbal memory (auditor\ attention span) evaluates one's ability to recall verbally what was just heard. From the results of this study, it is apparent that syntonics increased all aspects of memory evaluated, and it produced very significant changes in the areas of visual-memory. These results indicate that syntonics increases one's receptivity to both visual and auditory information, as well as one's level of integration between visual, auditory, verbal and motor systems. It further demonstrates that this increase in receptivity and integration significantly improves an individual's memory and ability to recall.

Another area evaluated was the speed and accuracy of eye movements using the Pierce Saccadics Test. The results indicate that this function is minimally affected by syntonics. Interestingly, the control group showed more improvement than the experimental group. it appears from test results that the Pierce Saccadics Test has some built-in problem areas, making its use for

research purposes somewhat questionable and inconclusive. The major pitfall regarding, this test is that an error Lit one point of the test can automatically lead to a series of consecutive errors, similar to a 10question test where each question is dependent on the previous one. Unfortunately, this problem was not detected until the data analysis was completed.

Although 24 of the 36 subjects underwent pre- and post-reading tests, Unfortunately, we could not use the data in this study because normative information was not available for a large percentage of the subjects.
Perhaps one of the most important aspects of this study was the comparison of the changes produced syntonically on those subjects whose original visual field diameter was ≤36 degrees versus those subjects whose original visual field diameter was ≥37 degrees. On all three tests of memory function, those patients whose visual fields were originally large had a greater degree of change than those whose visual fields were originally small. Previously, syntonics was recommended primarily when visual fields were reduced. These findings indicate the following: 1) Not all individuals with reading problems manifest small visual fields; 2) Visual field size may gradually reduce over time in certain reading-disabled individuals; 3) Individuals with reading difficulties but normal visual fields improved as significantly in the evaluated areas as those with reading disabilities arid reduced visual fields. Additionally, most of the subjects in the experimental group reported other subjective changes aside from the ones reported in this Study. Greater release of emotions, less hyperactivity, less tension, arid a greater ability to handle criticism arid confrontation were among some of the most commonly reported changes. Approximately 75 percent of the subjects reported improvement in their academic scores. Approximately 40 percent experienced a significant improvement in their handwriting, and two of the subjects Acre able to totally eliminate their daily use of ritalin.

CONCLUSION

The results of this study clearly confirm the effect of syntonics on a wide variety of visual, academic, cognitive and emotional areas.
The way in which we mentally look at and respond to the world is at the 'heart and helm of human behavior. It is as though the mind selects how and what we took at, the brain records what the mind has selected, and the body enacts what the brain has recorded. Most, if not all, of our physiological functions are linked to our mental-emotional complex.

Although instincts may have been meant to be the final decision maker, it seems that the conscious mind constantly analyzes, scrutinizes, and colors our experiences, thereby camouflaging what the instinctive centers already know to be true. From clinical experience, syntonics seems to bypass conscious analysis and directly pierce the sub-conscious emotional centers, which then trigger significant physiological responses. This creates profound changes on many levels. Syntonics seems to increase the receptivity of the organism so that any subsequent treatment either is not needed or its effects are significantly enhanced.

I urge practitioners involved in the remediation of visual problems to consider the use of syntonics prior to or in combination with their standard treatment choice. It appears to be very valuable in the treatment of reduced visual fields, learning disabilities of varied origin, migraine as well as general headaches, memory dysfunctions, reduced attention span and/or hyperactivity, ocular edema of any type, ocular pain with or without trauma, and secondary affects of head trauma.

The therapeutic value of ocularly perceived light and color is truly fascinating and unexplored. Hopefully, this paper will stimulate further questions and research regarding the non-intrusive, powerful effects of syntonics.

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