Syntonic Phototherapy

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Abstract

The first part of this article explores the theoretical and therapeutic aspects of optometric phototherapy (syntonics). Patient selection, testing, diagnosis, prescribing and syntonic case management are included. The second part presents an historical overview of the general area of phototherapy, and specifically syntonics. It then proceeds to an in-depth discussion of recent research on the effects of light on biological function that is the foundation of the emerging field of phototherapy. The authors propose that optometry has a unique opportunity to obtain a special position in the emerging field of phototherapy.

Key Words

brain injury, color therapy, circadian rhythms, energy medicine, learning disabilities, low level laser therapy, phototherapy, photobiology, pupil reflexes, seasonal affective disorder (SAD), strabismus, syntonics, visual fields, vision therapy

Introduction

Syntonic phototherapy can be a significant addition to the armamentarium of behavioral optometry. When used properly in conjunction with traditional behavioral optometric approaches, the efficiency, speed and success rates of vision therapy increase dramatically.[1-5] Optometrists also use syntonics by itself for relieving ocular pain, headaches and photosensitivity that may not be treatable with standard procedures.[4] This article presents an overview of syntonics and a summary of research findings about light's impact on life processes.

Energy medicine, which also includes different forms of light therapy, is rapidly becoming a global phenomenon used by a variety of health professionals from medical physicians to chiropractors, acupuncturists, physical therapists and psychologists. In our view, there lies the future of medicine.

Optometrists who practice vision therapy should objectively investigate light therapy, and specifically syntonic phototherapy, not only to assist their patients to achieve higher levels of overall functioning, but to seek to include optometry in the field of phototherapy. We are in a unique position to utilize this time-proven, ocularly transmitted light therapy that some optometrists have used for nearly 70 years.

Syntonics

Syntonic therapy is non-invasive and can bring major improvements if patients are chosen carefully. The patients most likely to benefit have not just one or two but several visual deficits. Usually, they show deficits in ocular motilities, accommodation, visual discrimination, binocularity, visual information processing skills, and constricted visual fields.

A typical treatment plan requires 20-minute sessions on at least three consecutive days each week for a total of 20 sessions. Therapy devices use white light directed through colored absorption filters (one device uses narrow band interference filters) onto a frosted collimating lens. The patient views a glowing circle of light 50mm in diameter from a distance of about 50cm in a darkened room.

Specific filters are prescribed for particular ocular conditions. The rationale for determining the treatment frequencies is explained later in this article. Diagnosis is made on the basis of history, present symptoms and clinical measurements. Success of treatment is judged by changes in symptoms, behavior (mood/attitude, coping ability, and social/verbal skills), performance (academic, athletic and expressive) and changes in optometric test results. The syntonic evaluation places special importance and considerations of pupillary reactions and visual fields.

Evaluation of the Pupil

Optometrists routinely evaluate the pupil, particularly in terms of differences in size, direct and consensual reflexes and Marcus-Gunn reactions. We propose that this should be extended to include careful observation of excessive pupillary release. When a patient in a dim room views a distant target binocularly, and a penlight held at three inches is beamed into the pupil of one eye, we expect the pupil to constrict and stay small for at least ten seconds. Pupillary release occurs when the pupil dilates within a few seconds. Pupillary release is not uncommon, especially in children who exhibit weakness in several areas of functional optometric testing or in emotionally stressed, toxic or traumatized patients. The severity of release frequently correlates with reduced

visual fields and autonomic nervous system imbalance.

Functional Visual Field Evaluation

Fields are taken before treatment, after six to eight syntonic sessions to measure progress and to determine if a change in filters is necessary, at the end of treatment, and at follow-up evaluations three and six months later. Field constrictions readily improve with syntonic treatment and this increase in useful vision is credited with the often seen gains in patient comfort, efficiency, self-esteem, and functional/binocular vision.

Constricted peripheral visual fields are considered classically to be caused by anatomical defects in the retina, visual pathway or cortex. However, they can also result from fatigue, emotional distress or swelling around the optic nerve. Field measures of patients with Tourette syndrome show unique, inconstant field defects.[6]

Functional field constrictions are not uncommon in children. Studies since 1927 report between 9-20% of unselected school children have fields of less than 15 in diameter.[7-10] Some children lose all but the central 1 or 2 of vision. Generally, we have found that constricted visual fields are related to inadequate functional visual abilities and overall learning and performance deficits. Strabismics and amblyopes often have decreased fields in one or both eyes. We also propose that constricted fields can be related to binocular instability, since it is difficult to maintain fusion if the fields are only 2, 3 or even 10 in diameter. Sometimes blind spot plots are enlarged two or three times normal.

Syntonic optometrists use campimeter (tangent screen-like) devices for plotting fields. They carefully measure the central 60 with a 1.5 white target on a black background. The target is moved from the periphery, non-seeing to seeing, while the patient fixates on a central point. The optometrist is in a position to monitor fixation and is in immediate communication with the patient.

Threshold or flashed methods of taking fields may not pick up functional field loss. A recent study comparing threshold and kinetic visual fields found that simple kinetic fields correlate better with clinical symptoms and are easier to use with children.[11] The frequency doubling field plotter, a recently introduced automated field instrument designed to measure magnocellular nerve loss in glaucoma patients, strongly correlates with syntonic campimeter fields.[12]

Abnormal color fields can also improve with syntonic treatment. Color fields are measured by plotting the position at which a red, blue or green 3 target moved in from the periphery changes from a faded, off color appearance to one with the same strong saturation the patient perceives when looking directly at the color. Blue fields are expected to be the larger than red, with green being the smallest. When this order is violated or when the fields are excessively small, a physiological or functional distress is suspected. Color field anomalies as reported by clinical researchers over the past 150 years represent a variety of systemic problems such as endogenous and exogenous toxemias, cardiovascular problems, or metabolic/endocrine imbalance. Syntonic practitioners may use color fields in diagnosis and filter selection, and most often as a measure to evaluate progress.[9,13]

In view of the apparent prevalence of these types of field defects in children, optometrists who are involved with strabismus and learning problems in this population should seriously consider functional visual field testing.

Therapeutic Syntonics

Traditional syntonic therapy requires at least three consecutive days of treatment per week for a total of 20 sessions. Progress testing is done after six to eight treatments. Visual fields, binocularity, ocular motility, visual acuity and accommodation are tested and symptom changes are recorded. Constricted field diameters will often double in extent after six to eight treatments and will continue to expand to full by 20 sessions. Striking changes in quality of test results, symptom reductions, performance, behavior and mood occur as a result of syntonics, especially when used in conjunction with other optometric vision therapy.

The traditional syntonics approach to prescribing filters uses case history, symptoms and clinical data to classify patients into syndromes called: "Acute;" "Chronic," "Emotional Fatigue" and "A Lazy Eye."[13]

"**Acute Syndrome**" individuals have a history or symptoms relating to recent onset problems including infection, injury, head trauma, anoxia, stroke, or high fevers. They often suffer from headaches, hypersensitivity or pain. This syndrome requires palliation to alleviate the symptoms. Blue/green filters are used to reduce cortical and retinal swelling, redness and fluid, and to decrease pain by sensory depression. Symptoms include: diplopia, binocular or monocular (368.2), headache (784.0), transient blurred vision (368.12), asthenopia (368.3), orbital pain (379.91), abnormal posture (781.9), vertigo (780.4), motion sickness (994.6). Diagnostic factors include: high exophoria (378.42), exotropia (387.00), convergence insufficiency (398.83), enlarged blind spot (368.42), constriction of the visual field (368.45), visual field defects (368.4), accommodative insufficiency (367.5), deficiency of smooth pursuit movements (379.58), pupil release (794.14) are not uncommon. Pathology factors include: Acute trauma, i.e., corneal abrasions (918.1), strokes and head trauma syndrome, conjunctivitis (372.30), iritis (364.3), cataract (senile) (366.9), corneal opacities, and wet macular degeneration (362.50). [13]

The **"Chronic Syndrome"** includes individuals with chronic health problems due to glandular, metabolic or organic imbalances, toxic conditions, or a past traumatic event. Yellow/green is used as a physiological stabilizer and detoxifier. Symptoms include- general fatigue (780.7), loss of vision system stamina and speed, reduced peripheral vision, asthenopia (368.13), headache (784.0), orbital pain (379.91), photophobia, and transient blur. Patients who waken with morning headaches are suspects. Diagnostic factors include: constriction of the visual fields (368.45), pupil release, esophoria (378.41), low recoveries on ductions, especially abduction, esotropia (378.00), convergence excess (378.84), accommodative insufficiency (367.5), and excess (367.53), reduced ocular motor skills (794.14), reduced red/green fields, reduced blue field indicating liver involvement (toxemia), calcium deficiency. Yellow/green is often combined with indigo/red for 10 minutes of each in cases where emotional instability is also a symptom. The need for yellow/green increases with age.[13]

In the **"Emotional Fatigue Syndrome,"** individuals tend towards emotional exhaustion, mood swings, negative

emotional affect, and poor coping ability. This syndrome is more frequently seen in children. Symptoms include: photophobia (368.13), transient blurred vision (368.120), asthenopia (368.13), abnormal fatigue (780.7), headache (784.0), dizziness (780.4), frustration, allergies, asthma, and fluid retention. Diagnostic factors include: pupil release, low breaks and recoveries in ductions, especially adductions (368.33), and fatigue exophoria (378.42). A combination of indigo and red filters is used for sympathetic/parasympathetic balance and to support the adrenals. Indigo/red can be used for 20 minutes alone but is usually combined with yellow/green for 10 minutes each.[13]

In the **"Lazy Eye Syndrome,"** red/orange light is used. According to Spitler, red-orange stimulates the sympathetic nervous system and increases cell membrane capacitance (build up of electrical charge before discharge) that increases nerve cell charge in order to *break through* synaptic resistance to overcome amblyopia.[4]

Findings include: amblyopia (368.00), esotropia (378.00), amblyopia (368.00), esophoria (378.41), suppression of binocular vision (368.31), field constrictions (368.45), abnormal retinal correspondence (368.34), or deficient vergence abilities (368.33). These patients are often *parasympathetic dominant* individuals exhibiting patterns of generalized muscle tightness (tight-fisted pencil grip, gritted jaws, inward turning feet).[13]

While the choice of the appropriate treatment color frequencies remains an art, clinical experience has provided the basic guidelines for the syndromes above. Recently several approaches to using color light in optometry have evolved. Vasquez engages patients in therapeutic dialogue as he changes in the color or flash rate during sessions.[14] Liberman also advocates dialogue to help patients gain deeper awareness of their resistance to individual colors thereby gaining greater *receptivity* and more comfort with those colors and with themselves in the world.[15] Downing devised tests to determine a patient's *constitutional profile* using different filter combinations for *fast* or *slow* types (blue and red respectively).[16] Albalas combines the *syntonic principle*, Chinese medicine and applied kinesiology (selecting the filter giving greatest muscle strength) in determining treatment frequencies.[17] Searfoss used a rainbow of selected narrow band interference filters viewed for one minute each. He then asked patients to select the most relaxing or *healing* color(s) to look at for the remainder of the 20 minute session.[18]

Three recent controlled studies by optometrists have attempted to measure syntonic phototherapy's impact on children's learning and vision. In 1983 Kaplan reported on the use of syntonic stimulation for the treatment of learning disabled children.[2] Three years later, Liberman published an article on syntonic therapy applied in an optometric office an its effects on children's vision and cognition.[3] Ingersol in 1998-1999 investigated syntonic effects when integrated into an elementary school curriculum and used in conjunction with vision therapy.[1]

These studies provide evidence that relatively short-term syntonic treatment can significantly improve visual skills, peripheral vision, memory, behavior, mood, general performance and academic achievement. They also confirm that children with learning problems have a reduction in the sensitivity of their peripheral vision. During and after phototherapy they demonstrated improvement of peripheral vision and visual skills. These three studies found profound improvements in the children who used syntonic phototherapy compared with subjects matched for age and academic success who did not. The controls either looked at white light,[2] had optometric vision therapy[3] or had optometric vision therapy and academic tutoring. These students showed no or significantly less improvement in their peripheral vision, symptoms or performance than the groups treated with syntonics. And Ingersol found the experimental group receiving academic tutoring, vision therapy and syntonics had significantly superior outcomes than students given tutoring and vision therapy but no syntonics.

Behavioral optometrists using syntonics successfully treat children and adults with learning, reading and attention disabilities, people suffering the effects of head trauma and stroke, retinal diseases, strabismus, headaches and senility. Included here are brief descriptions of two such cases.

A 78-year-old woman patient came for vision therapy because of double vision. Her eyes had suddenly crossed eight weeks earlier. In addition, she was mentally confused and emotionally distraught and had been since the death of her husband 10 months before. Examination by her neurologist was inconclusive. After twelve 20-minute treatments, her eyes straightened and she regained mental/emotional balance and coherence. When asked what she thought had helped her get better, she said, "The green light. Every time I watched the green light I could feel waves and ripples inside my head. Finally during one light session I felt a kind of pop in my head and everything became clear."

Another patient, a 6-year-old girl, was on the verge of being discharged from her public school because she could not learn and was disruptive. Diagnosed as autistic and retarded from an early age, she was so hyperactive that even objective optometric testing was impossible. Her history included her mother's toxic pregnancy (pre-eclampsia), cord wrapped around her neck at birth, and her father was hit and killed in a crosswalk a few feet in front of her when she was two years old. She started syntonic color therapy using yellow-green filters, the goal being to eliminate any toxemia that might have remained from the pregnancy. In five treatments, for the first time in her life she had become a calm, cooperative and communicative little girl who could learn and participate in her normal first grade class.

Syntonics has some of its most profound effects in the treatment of traumatic brain injury. One informal study of 46 patients with head trauma revealed all 46 had visual field loss. Seventy percent responded with field expansion after treatment with syntonic phototherapy.[19]

While it is true that not all patients respond as favorably as is indicated in the above examples, there is nevertheless an increasing body of evidence of the effectiveness of syntonics. One might question that since sunlight has every wavelength in the spectrum, why doesn't exposure to it provide the benefits of syntonics? An answer is that our modern lifestyle limits natural light exposure and we have become victims of mallillumination, a syndrome of behavioral and medical conditions described by John Ott, a pioneer in the field.[20]

A recent California study showed that students in classrooms with predominately natural lighting scored as much as

25% higher on standardized tests than other artificially lit students in the same districts.[21]

An Abbreviated History of Phototherapy and Syntonics

Throughout history there have been reports of using light to heal. Egyptians used precious gems, Greeks built solarium cities in high mountains to harness ultra-violet light for healing tuberculosis, and red light was used to quell the effects of smallpox virus. Practitioners from the late 19th and early 20th centuries such as Babbitt, Pleasanton, Pancoast and Dinshah clinically found that color, applied to the skin, could have a non-intrusive, curative effect on bodily ailments. Similarly, the use of green or blue light on the skin is the currently preferred medical treatment for neonatal jaundice. At the turn of this century, it first became known that light entering the eyes not only served vision, but also traveled to other important brain regions.[22]

Clinical application of selected light frequencies in optometric practice began in the early 1920s. H. Riley Spitler theorized the role of the eyes in phototransduction and the roles of light and color in biological function and development. He developed the clinical science that he termed *Syntonics* — from "syntony," to bring into balance. Spitler concluded that many bodily, mental/emotional and visual ailments were caused primarily by imbalances in the autonomic nervous and endocrine systems. He was the first to elaborate on this function of the retinal-hypothalamic pathways. Spitler proposed that applying certain frequencies of light through the eyes could restore balance within the body's regulatory centers thereby directly correcting visual dysfunctions at their source. His model suggests that red (low energy, long wavelength) at one end of the visible spectrum stimulates the sympathetic nervous system, green (middle frequencies) yields physiological balance, and indigo (high energy, fast frequencies) activates the parasympathetic nervous system.[4]

In 1933 Spitler established the College of Syntonic Optometry to research the therapeutic application of light to the visual system. In 1941 he published his thesis as *The Syntonic Principle* and included a survey of clinical results from syntonic practitioners: Syntonic Effectivity: A Statistical Compilation of Ocular Anomalies Handled by Applying the Syntonic Principle. This study showed that of 3067 individuals, 2791 (90.7%) taking syntonic treatment responded positively.[4]

In the 1960s, Charles Butts developed a diagnostic workup and treatment regimen which added a new dimension to vision therapy. Patients were diagnosed according to symptoms using a specific case history, the Optometric Extension Program's 21 points, pupillary responses, central visual fields and other tests of eye teaming and motility.[13]

Scientific Findings About Light's Impact On Biology

Measuring light's biological effects is a complex business. Outcomes are dependent on wavelength, intensity, duration, timing and number of repetitions. There are short-term effects, measured a few seconds or minutes after irradiation, and long-term effects, observed after hours or days. The effects also depend on the type of organism studied, its growth phase and the parameter being measured. For an interesting discussion about the difficulties encountered in doing light therapy research see: Tuner- Hode's: Low Level Laser Therapy , Chapter 13 at: www.
laser.nu/lllt/LLLT_critic_on_critics.htm.

Low Level Laser Therapy

Only recently have scientists begun to give serious consideration to photobiology. Basic and clinical research is booming. Healing work with lasers started with Endre Mester in Budapest, Hungry, in 1966, as an investigation to determine whether ruby lasers could help cancer victims. He found that the laser irradiation increased the size and reproduction rates of monocellular organisms and stimulated fur growth on shaved rats. At a certain range of dose intensities, the hair grew fastest but slightly weaker and stronger doses had little effect. At even greater intensities, an inhibitory effect retarded fur growth. A similar experiment was conducted on wound healing. Again the light was effective in speeding wound healing but only in a window of intensities. Doses above and below had no effect. Even higher doses were detrimental to recovery.[23] These findings were ignored for years after the article was published in a Hungarian journal in the 1960s. Since then roughly 2000 articles have been published about the effects of Low Level Laser Therapy (LLLT).[24]

Until recently most LLLT research has taken place in the former Soviet Union and Eastern Block countries. For twenty years, Russian biophysicist Tiina Karu and her group at the Laser Technology Research Center in Troitzk, Russia, have been conducting a systematic study of the biological effects of low power laser irradiation. Their research shows that the light used for therapy does not have to be coherent (laser). Incoherent red light is as effective in healing peptic ulcers as coherent laser light of the same wavelength. Karu says that lasers are used only because they are easier to control. Her data prove that comparatively low doses (102 -103 J/M2) and short periods (10-100 seconds) of irradiation stimulate lasting changes in cellular respiration chains as well as in RNA and DNA synthesis. Even seven days post stimulation, the number of cells, cell size, and respiratory activity were still increasing above non-stimulated tissue. Research on various organisms and cell types consistently demonstrated that light alters cell metabolism, causing synthetic cell processes to dominate catabolic ones.[25]

In a recent paper, Karu proposed that the primary changes induced by light are followed by a cascade of biochemical reactions in the cell that do not need further light activation. These dark reactions are connected with changes in cellular homeostatis parameters due to an alternation of the cellular redox state.[26]

Which wavelengths of the spectrum stimulate these changes? She finds responsiveness in almost every visible-light band. However, cells stimulated first with red light, then with blue showed much greater increases than with just red or blue alone. Red followed by wide-band (white) visible light stimulated no acceleration of growth.[27]

Karu's research explains how light finds just the right places in the body to heal. She found that starving or oxygen deprived tissue responds to the irradiation. This response was not found in healthy tissue. Bacteria already reproducing exponentially are little changed, but the application of light triggers huge increases in both reproduction and cell mass in initially stagnant colonies. Wounded, chronically inflamed, and ischemic cells are characterized by their acidic, hypoxic and inhibited state. Light drives them to-

ward oxidation, balanced pH, and vitality.[27]

Karu's papers and books provide undeniable proof that light stimulates biological transformation and healing. Her work has encouraged clinicians worldwide to use low-intensity laser light therapy for healing a variety of human ailments.[28-30]

A growing number of Western clinicians are showing interest in phototherapy. One organization, the North American Laser Therapy Association (NALTA), convened The First NALTA Conference near Washington DC, in October 1999. The meeting was held in partnership with the FDA to clarify regulations concerning laser photo- stimulation and laser acupuncture and to educate leaders of government organizations about the clinical application of low-level laser therapy.

LLLT has been successfully applied in laboratory experiments and in clinics for relieving pain, resolving inflammation, enhancing tissue repair mechanisms, stimulating immune function, defeating infection, and improving damaged neurological tissue. Laser therapy has also been used for preventing dental caries and stress-related heart and cerebrovascular disease and for healing cancer, asthma, herpes simplex, rheumatoid arthritis, intractable wounds (ulcers), damaged nerves, tendons, muscles and bones, and for reducing infection, inflammation, and tennitis.[24,31]

Low Level Laser Therapy for Visual Disorders

Of special interest to optometrists is a controlled study on the use of light for myopia control and increased accommodation. Recently myopic children with accommodative insufficiency were stimulated with a 2mm spot of low intensity infra-red light on the limbal sclera for 12 minutes per day. A total of ten sessions were administered on consecutive days. One month following treatment, accommodative ranges in the treated children had increased to double that of matched myopic children who were not treated. After three years the average annual gradient of progressive myopia for patients subjected to laser therapy was equal to 0.43 D, whereas for the reference group this parameter was equal to 1.6 D.[32] Other Russian researchers using similar transcleral treatments successfully reduced symptoms of workers suffering extreme eye fatigue after long hours engaged in stressful visual tasks.[33]

Other more serious ocular conditions have also been successfully treated with light. Twenty-three patients with primary open-angle glaucoma and controlled intraocular pressure were administered ten sessions of red laser treatment (wavelength 0.63 microns, light spot diameter 5 mm, energy 2 mWt, session duration 240 seconds). Seventeen eyes of those patients with bilateral glaucoma were the controls. Visual fields were plotted before the treatment, immediately after, and 3 to 3.5 months later using full field 120 points threshold Humphrey field analysis and related tests. The treatment reduced the field loss by 10% or more in 75% of the 28 eyes. The mean improvement in visual field deficit reduction was 22.4%. Three to 3.5 months later the visual field loss was still 19.7% improved over initial findings. Field deficits increased in the control eyes during the same period. No side effects were observed in any of the experimental subjects.[34]

Another researcher treated primary glaucoma patients with endovascular laser therapy (low power red laser shined directly into blood) via the cubital vein. Control patients received traditional glaucoma therapy. Light-treated patients showed marked improvement of visual acuity, decreased blind spot and angioscotomas, reduction of intraocular pressure, and improvement of tonographic parameters.[35]

Low-energy red laser exposure of the blood has also been used to treat a variety of other ocular pathologies including central nonexudative chorioretinal dystrophies, vascular opticopathies, keratitis and uveitis associated with disorders of immunity. All cases resulted in improvement of vision acuity, widening of visual field, normalization of electro- physiological parameters, rapid resorption of corneal precipitate, reduced injection of the eyeball and opacities in the vitreous body, a more rapid corneal epithelialization, and normalization of blood and lacrimal immunograms compared with patients with the same diseases receiving conventional therapy but no light.[36]

Adding light to the treatment of injured corneas had significantly superior outcomes compared with only routine methods. Treatment consisted of daily 3-minute exposures with red laser (50-100 MicroW/cm^2) for 6 to 10 days on the cornea. The 512 patients with corneal conditions such as perforating wounds, burns, ulcers, and endothelial-epithelial dystrophy had faster reduction of inflammation, recovery of corneal sensitivity and epithelialization, and shorter hospital stays.[37]

Blood, ocular and brain tissues were examined before and after irradiation of rabbit eyes with He-Ne (red) laser. Local effects included increased corneal permeability, reduced lipid peroxidation activity and elevated antiradical defense enzyme activity in ocular tissues. Blood and tissue changes also appeared in the corresponding brain hemisphere. The researchers suggest that these non-local blood and brain effects occurred because the optic nerve may function as a light conductor for certain frequencies of light.[38]

Light Effects Via Blood

Light-sensitive blood constituents carry photic information and energy to affect various body functions.. Blue light delivered on the skin behind the knees, for example, resulted in significant alterations in human circadian rhythms.[39] Oren and Therman postulate that the blood constituents hemoglobin and bilirubin in animals may be counterparts to chlorophyll and phytochrome, the light-sensitive pigments in plants. Hemoglobin is similar to chlorophyll in structure. Both are reversibly altered by light.[40]

Other research has found that the heme oxygenases are reversibly altered by specific wavelengths of visual light.[41] The heme oxygenases, HO-1 and HO-2, are enzymes controlling oxygen-carbon dioxide exchange and also regulate vasodilatation, neurotransmission, antioxidation, anti-inflammatory, anti-viral, gene expression and other basic physiological functions.[42] HO-1, like the sympathetic nervous system, acts to protect the organism from acute environmental stress while HO-2 acts more like the parasympathetic nervous system.

Nitric Oxide (NO) is another important blood constituent that works to control bodily stress reactions. A well-known physiological effect of visible frequencies of light on blood is relaxation of blood vessel walls mediated by increases in free NO. Russian researchers confirmed that

bound NO-hemoglobin can reversibly release free NO when irradiated with low-power He-Cd (441.6 nm) or He-Ne (632.8 nm) lasers.[43]

Light Directly Stimulating The Brain

In the early 1900s, researchers found evidence that photoreceptors exist in animal brains. Until recently retinal and pineal opsins were detected in selected regions of lower vertebrate brains but not in mammals. Now, published data suggest the presence of cone-like, rod-like as well as non-visual types of photopigments in least two kinds of photoreceptor cells in mammal brains, in cells lining the ventricles and in classical neurosecretory neurons in preoptic centers. These photoreceptors have been implicated in the regulation of circadian and reproductive responses to light in all species examined.[44]

Until 1999, mammalian opsins were thought to be specifically expressed only in the retina and the pineal gland. But now scientists at NIH have discovered what appears to be the first opsin, called encephalopsin, expressed specifically in the mammalian brain. At this time encephalopsin function remains a mystery but because opsins have always been involved in light detection, we must consider the possibility that encephalopsin participates in this process.[45]

Recent work suggests that light excites mammalian brain tissue directly. Slices of rat cortex stimulated with low levels of visible light released more GABA (gamma-aminobutyric acid), a neuroinhibitor implicated in sex drive, anxiety, aging, inflammation and epilepsy. Higher light intensity stimulation suppressed this increased release. The effective light level was the same as that which penetrates through the skull to reach a rat's brain at the intensities of sunlight.[46]

Russian data indicate that low-energy infrared laser irradiation has certain neuroprotective activity in oxidative stress. Infrared laser irradiation lowered the increased levels of hydroperoxides and malonic dialdehyde and elevated soxide dismutase activity in the brain during ischemia, reperfusion, and acute edema of the brain. [47]

These findings have vast implications for the fields of immunology and rehabilitative medicine and suggest that light has biological impact on the brain by a means not considered in modern times.

Biophotons

It is now well established that all living systems emit a weak but permanent photon flux in the visible and ultraviolet range. This biophoton emission is correlated with many, if not all, biological and physiological functions. Biophotons may trigger chemical reactivity in cells, growth control, differentiation and intercellular communication, i.e., biological rhythms. Biophotonic communication may prove electromagnetic fields are more primary to biology than chemistry.[48]

New Information on Circadian Control Systems

Syntonic color therapy might work by altering the timing of circadian rhythms. These oscillations in biochemical, physiological, and behavioral functions of organisms occur with a periodicity of approximately 24 hours. They are generated by molecular clocks that are synchronized with the solar day by environmental light. The various clocks oscillate in complex phase relationships. They can go out of phase with each other and when they do, health suffers along with mood. If poor health is a result of a rhythm disorder, fix the rhythm, not the symptom.[49]

Individual cells undergo daily cycles of activity and rest just like whole organisms do. Daily oscillations of enzyme and hormone levels modify the timing of cell physiology, division, and growth. Body temperature, immune responses, digestion, susceptibility to anesthesia, and dental pain threshold (the best time to go to a dentist is in the afternoon) all undergo cyclic changes peaking at fixed times during the day. Visual and mental acuity fluctuate during the day. Malfunctions in circadian timing are responsible for chronic sleep disorders in the elderly, manic-depression, gastrointestinal disorders, and seasonal depression.[50]

Psychiatric research shows that light therapy through the eyes is the most effective and accepted treatment for seasonal affective disorder (SAD).[51,52] Psychiatrists are now investigating light therapy for other disorders such as subsyndromal SAD, nonseasonal depression, premenstrual depression, circadian sleep-phase disorders, sleep-maintenance insomnia, jet lag, and problems resulting from shift work.[53-55] One psychiatrist, Kripke, has carried out a systematic comparison of light and antidepressant drug studies in nonseasonal major depression. He argues that we should routinely prescribe light for nonseasonal depression, at least as a supplement to medication.[55]

Light is the major cue leading to realignment of the endogenous rhythms and the external entraining conditions. For example, depending on when during the night a short pulse of light is administered, circadian timing can be phase-delayed or phase-advanced. By controlling the time of a phototherapy treatment, recovery from jet lag or shift work is accelerated.[50]

The quality of human health and performance depends on the synchronization of the major 24-hour rhythm (core body temperature, REM sleep and plasma cortisol) with the 90-minute rest-activity or sleep-wake rhythm (slow-wave sleep, skin temperature, plasma growth hormone). These two major cycles go in and out of phase due to external (light-dark, hot-cold) and behavioral/social (meal time, work day/week) cues. Some individuals maintain a healthy, stable coordination between these cycles. Other people's rhythms modulate quickly through stages of organization and disorganization.[49]

Clocks are being discovered everywhere in the body. Evidence suggests that flies have biological clocks in their heart, lung, liver, kidney, and testes and that light sets each clock individually to follow a schedule independent of the brain's master clock.[51, 52]

In mammals a subset of retinal ganglion cells has direct projections to the master circadian clock in the suprachiasmatic nucleus (SCN) via the retinohypothalamic tract (RHT). Different cellular clocks in the SCN have differing resynchronization rates as do peripheral clocks in the various tissues.[53]

The nature of the photosensory molecules that detect the light signal is not established. Because severing the optic nerve abolishes the ability for light entrainment in mammals, it is generally accepted that the eye contains the photopigments for both visual (imaging) and circadian systems. Animals with severed optic nerves lose light synchronization, however, in mice with a retinal degeneration syndrome in which all of the rod photoreceptor cells and virtually all of the cone photoreceptors are destroyed,

light entrainment of the circadian rhythm is normal. Similarly, many blind persons with no conscious perception of light exhibit normal photic entrainment of the circadian rhythm. Other blind people do not entrain to light.[59]

In human beings, melanopsin is expressed only in the eye and is restricted to cells within the ganglion and amacrine cell layers of primates. Notably, expression is not observed in retinal photoreceptor cells, the opsin-containing cells of the outer retina that initiate vision. The unique inner retinal localization of melanopsin suggests that it is not involved in image formation but rather may mediate nonvisual photoreceptive tasks, such as the regulation of circadian rhythms and the acute suppression of pineal melatonin. The anatomical distribution of melanopsin-positive retinal cells is similar to the pattern of cells known to project from the retina to the suprachiasmatic nuclei of the hypothalamus, a primary circadian pacemaker.[60]

Different wavelengths have varying entrainment abilities relative to hormone output regulating such vital functions as reproduction, growth, body temperature, blood pressure, motor activity, sleep, and immune function and in such conditions as diabetes, osteoporosis, heart disease, cancer, Parkinsons, Alzheimers, and aging in general.[61]

Green light was found to be most effective in suppressing melatonin in humans. This may be different from resetting circadian clocks; the exact mechanism is still unknown.[62]

Two blue-light photoreceotor genes, cryptochrome 1 and 2 (CRY1 and CRY2), were recently identified in humans. Known to be active in modifying plant rhythms, evidence suggests that these pigments may also function as photoreceptors for setting the circadian clock in humans and other mammals. Studies have shown that light penetrates into and propagates in sufficient quantities through the human brain and other internal organs. This is a different light perception and a different time scale than in vision. Hence, it is plausible that light can reach the SCN directly to excite CRY1 in addition to the ready excitation of CRY1 and CRY2 in the retina.[63]

What unique physiologic function such excitation may elicit remains to be elucidated. Some researchers propose that rather than a master clock in the brain being solely responsible for coordinating all body rhythms, the true master switch for these many other clocks is just environmental light.[64] Not only does light intensity and day length change through the year but daylight color changes radically from dawn to sunset and modulates with the seasons.

Conclusions

Clock mechanisms have been identified in the brain as well as peripherally in organs, tissues and cells throughout the body. The peripheral clocks normally synchronized by master clocks in the brain maintain their rhythm and are light responsive even when cut off from the brain. Light may (1) directly trigger photoreceptors in cells in skin or deeper in the body, (2) may stimulate photosensitive elements in the blood by passing through the skin or through the eye into the vast retinal vascular beds to deliver photic information everywhere by way of the blood stream. (3) Finally, light may stimulate clock and other photoreceptive areas in the brain via the retina through the optic nerve. This may take place via rod and cone pigments, by non-visual retinal pigments or perhaps via direct fiber-optic-like pathways running from the retina through the optic nerve.

These examples of research included demonstrate the broad array of light pathways being investigated today. Applications in healing can be found in optometry, medicine, psychiatry, psychotherapy, color acupuncture (now termed colorpuncture), rehabilitative medicine, and a vast assortment of body centered therapies. Syntonic phototherapy is at the core of a rapidly growing interest in and shift towards energy medicine in our quantum age. At this time energy medicine is not a final or unified model. There is a dynamic rhythmic matrix of energies including mechanical, electric, magnetic, gravitational, thermal, acoustic, and photonic. Different therapeutic approaches focus on one or more phenomena. Our living matrix can extract information needed to pilot our biological systems. There is not one but many pathways through which this may occur. In Syntonics it may be the retinal-hypo -thalamic-pituitary-pineal axis, the retinal vasculature, several acupuncture meridians, or by a yet undiscovered means. These applications are the future of medicine and healing. Syntonics is a time honored and clinically proven modality of treatment. Optometry is in a unique position to further these applications and retain its special position in the light therapies of this new millennium.

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Suggested Reading

The Syntonic Principle by Harry Reily Spitler published by the College of Syntonic Optometry in 1941. The thesis from which the practice of phototherapy by way of the eyes known as syntonics was established, this is available through the College of Syntonic Optometry. *Available from OEP.*

Light Medicine of the Future published by Bear and Co., Santa Fe, NM, 1991, by Jacob Liberman. This is the most current far ranging text on the subject of light as a therapeutic tool. It covers medical and psychological uses of light and contains an extensive bibliography. It is a must-read for anyone interested in the subject. *Available from OEP.*

Spectrachrome Metricencyclopedia by Dinshah Ghadiali was published by the Spectrachrome Institute, Malaga, NJ, in 1933. This three-volume treatise on the systemic of application of lights on the body for healing and restorative purposes is a landmark in the application of color therapy in that century. This is available through the Dinshah Society.

Light Years Ahead, is a compilation of a conference during the 1990s in San Jose, California, of all the various light therapies practiced around the world at that time. This compilation is edited by Lee Hartley and Brian Breiling and published by Celestial Press. It is one of the best texts to get an overview of all the different light therapies and light technologies now in current use. *Available from OEP.*

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