Journal of Optometric Phototherapy

April 2016

"Out of the Woods" (c) 2016. Created by Bonita Tabakin. An intricate wood carving honoring the direction of the wood grain while telling this story of the multi sensory visceral experience before, during, and after brain restoration both internally and externally as experienced by a closed head concussion with severe body injuries to an OD/artist. 16 obvious eyes appear in this creation. Can you find the other 12 eyes?

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_ delta	Motor Stimulant
_ theta	Intense Motor Stimulant
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_ omega	Motor Depressant
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_ lambda	Slight Motor Depressant
_ D	Depressant
_ S	Stimulant
_ N	Neurasthenic

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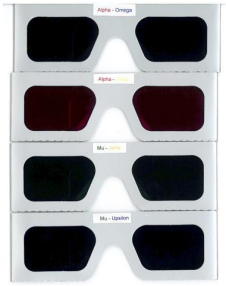

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College of Syntonic Optometry

A NONPROFIT ORGANIZATION DEDICATED TO RESEARCH IN PHOTORETINOLOGY.
THE THERAPEUTIC APPLICATION OF LGHT TO THE VISUAL SYSTEM

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Table of Contents

Journal of Optometric Phototherapy

The President's Message

Greetings from your Alpha Delta Prez:

Wow! It has been a very productive year for your College of Syntonic Optometry in 2015. The tide has suddenly turned and every speaker at any major Optometric education course now mentions Syntonics in their lectures. With our patient population increasing in the acquired brain injury section, there is an even greater need to include this gentle but powerful treatment modality into one's practice.

Larry Wallace, Ray Gottlieb, Phil Bugaiski, Rob Fox, and I gave a CSO 101 course in Oswego, IL last summer. It was very well-attended with attendees coming from across the US plus several from Canada. This was followed by our annual conference in the beautiful, historic city of Santa Fe. The CSO faculty also gave another CSO 101 course during our annual meeting that was a full house! It was encouraging to me to see so many of the leaders from our sister behavioral optometric organizations, NORA and COVD, attend. As you can see from my photos from the CSO Banquet that we made sure to have plenty of fun along with the education! Since our banquet landed on Halloween this year, many of our members came in some very creative attire! It was a rousing success!

While 2016 has just begun, it won't be long before our 84th Annual CSO conference will be here again! This year, we are meeting in my hometown, Indianapolis, crossroads of America and home to the Indianapolis 500 Race! We will be starting on Tuesday, June 7th for the CSO 101 course which will run through Wednesday, June 8th. On Thursday, by popular demand, we will be offering a one day CSO 102 course led by Larry Wallace and Ray Gottlieb. Then, our Education Director, Larry Wallace, has a great line up of speakers for the continuation of the conference on Friday and Saturday. With the Indy 500 Race completed two weeks before our conference, we should be able to arrange a tour of the Indy 500 Motor Speedway for you race car fans. I am also working on having a colleague who does visual evaluations of the Indy race car drivers share his evaluation battery. So be sure to save the dates: **June 7th – 12th**, in Indianapolis. We will be right in the center of it all at the Sheraton City Centre over-looking the Monument Circle with restaurants and museums all within walking distance from the hotel.

I would encourage each of you to get Norman Doidge's newest book, **The Brain's Way of Healing**, and be sure to read Chapter 4. This chapter is devoted to the latest research and information on the role of light in healing the brain. This is the type of third party information that lends greater scientific credibility to the work we do with light and goes a long way to helping general health care practitioners as well as potential patients better understand Syntonics as a viable optometric rehabilitation treatment.

Looking forward to seeing many of you at our 84th Annual Conference in Indianapolis in June!

Mary

Optometric Phototherapy-Based Multi-Sensory Training Facilitates Reduction of Symptoms in Post-Concussion Syndrome

Steven J. Curtis, O.D., FCOVD

Key words: neuro-optometric rehabilitation, post-concussion syndrome, multisensory integration, multisensory training, optometric phototherapy, oculomotor therapy, vestibular stimulation, auditory training.

ABSTRACT

Background: The objective of this article is to present the effectiveness of a multi-sensory training method that utilizes optometric phototherapy, oculomotor therapy, vestibular stimulation, and auditory stimulation, on reducing the symptoms of post-concussion syndrome. The setting is my neuro-optometric clinic.

Methods: The participants are 25 consecutive adult patients presenting to the clinic with post-concussion syndrome. The design is a comparison of symptoms and objective tests one week before and one week after treatment. The main measures are an acquired brain injury symptom survey, visual evoked potential, and Test of Information Processing Skills.

Results: 84% of patients reported improvement in a majority of their PCS symptoms; the patient group exhibited an average visual evoked potential (VEP) increase of 35% in low contrast amplitude; the patient group demonstrated an average increase in visual processing of 60%; auditory processing increased an average of 27%; delayed recall improved an average of 206%; all results were measured after an average treatment period of 38 days.

Conclusions: multi-sensory training utilizing optometric phototherapy, oculomotor therapy, vestibular stimulation, and auditory stimulation provides most post-concussion syndrome patients significant reduction in symptoms in a relatively short period of time. These patients were not making further appreciable progress in recovery prior to this treatment…they "hit a plateau". In addition to subjective improvements, patients also demonstrated significant improvement in objective testing.

Introduction

A review of the literature reveals that there is not a well-established, broadly-accepted treatment for post-concussive syndrome (PCS) symptoms. There remains a lack of evidence-based treatment strategies. However, some individuals benefit from several interventions depending on the particular presenting signs and symptoms. The most common treatment options that are effective for certain patients consist of medications, physical therapy, early education (1, 2), cognitive behavioral therapy (3), and aerobic exercise therapy (4).

The purpose of this article is to introduce a particular multisensory training method that has been an effective treatment of PCS symptoms when utilized within my neuro-optometric rehabilitation services. N**euro-optometric rehabilitation** is a therapy service provided by specially trained optometrists which utilizes therapeutic prisms, lenses, filters, occlusion, and vision therapy to help stimulate visual pathways of the brain which are not functioning properly due to brain injury. Depending on the particular history presentation and clinical results of my neuro-optometric evaluation, I prescribe one or more of these "tools". However, none of them have been as efficacious in reducing PCS symptoms as the multi-sensory training this paper presents.

The impetus for presenting this paper is the uniquely quick, relatively consistent, and comprehensive results I obtain on patients who have hit a plateau in their recovery. Further uniqueness is the fact that it is a more passive than active therapy. Therefore, it is usually receptive by symptom-sensitive patients who might otherwise "shut down" on us when traditional output-based active therapy approaches are attempted. I will provide both supportive scientific research references and my preliminary clinical study results.

Background

Concussion is a mild traumatic brain injury, usually occurring after a blow to the head. It can produce anything from loss of consciousness to impaired cognitive or

physical abilities. Estimated incidence rates for this condition, according to the Centers for Disease Control and Prevention, range from a conservative 300,000 per year to a more liberal and recent estimate of 3.8 million cases in the United States annually (5).

Post-concussion syndrome, or PCS, is a set of symptoms that may continue for weeks, months, or more than a year after a concussion (6, 7). Predictive factors for PCS are poorly understood. In fact, PCS does not appear to be associated with the severity of the initial injury (8). The rates of PCS vary, but most studies report that about 15% of individuals with a history of a single concussion develop persistent symptoms associated with the injury. Research indicates that many of these symptoms are, in part, a result of compromised processing of sensory inputs, including visual, vestibular, and auditory.

Researchers have found that efficient visual processing and sensory integration are essential to day-to-day functioning (9, 10). In a study measuring visuoperceptual performance in children, mild traumatic brain injury was shown to induce prolonged visual processing deficits (11). Auditory processing disorders can also be compromised in PCS patients. Turgeon, et al, found that concussions can disrupt the neurological mechanisms implicated in several auditory processes, including monaural low-redundancy speech recognition, tone pattern recognition, and dichotic listening (12).

If sensory processing is disrupted due to brain injury, one can intuitively conclude that **multisensory integration** is likely to be compromised in PCS patients. Multisensory integration describes a process by which an intact, well developed brain is able to integrate information from multiple senses and modulate these inputs for optimal identification of and reactivity to environmental events. All brains engage this strategy at multiple levels of the neuraxis (13), and its impact on cognition and behavior has been repeatedly demonstrated. Multisensory integration has been shown to enhance and speed up the detection, localization, and reaction to biologically significant events (14).

In recent decades, researchers have made advances in understanding the physiology of multi-sensory neurons and networks that provide the relationship between cellular responses and our perception and behavior. Prior to this, rehabilitation therapy did not focus on the multisensory networking of the brain but rather on the musculoskeletal system; neurologists limited their attention to central or peripheral nervous system disorders, and otologists confined their focus to the peripheral vestibular apparatus and inner ear (15).

During the past couple decades, success has been seen in **multisensory training** - combining sensory systems during therapy, such as in rehabilitation of brain-injured patients. A common example is when a physical therapist incorporates both head and eye movement during advanced stages of vestibular/balance therapy. The vestibular and visual systems are therefore both stimulated creating a multisensory training activity. Brain injury can cause disruption of visual-vestibular integration centers in the midbrain. Although damage to these areas of the brain cannot be measured with the imaging tools readily available today, we can infer these areas are negatively affected because positive results occur during rehabilitation that incorporates the pairing of these systems.

Moreover, this interaction of the vestibular and visual systems provides clear and stable vision during movement. The integration of vision and vestibular inputs also contributes to the maintenance of balance. When there is a compromise to this interaction, which often occurs in head injury, patients can suffer a constellation of symptoms and deficits including blurred vision, oscillopsia, decreased dynamic visual acuity, oculomotor deficits, poor depth perception, imbalance, nausea, dizziness, and vertigo. Since many of these symptoms exist in PCS patients, one might embrace the notion that PCS patients could have their symptoms improved with multisensory training that involves simultaneous visual and vestibular stimulation. The clinical results discussed later in this paper support this.

Jiang, Stein, and McHaffie recently demonstrated that multisensory training reverses midbrain lesion-induced changes and improves hemianopia. They found that cross-modal (auditory–visual) training reestablishes visuomotor competencies in animals rendered hemianopic by complete unilateral visual cortex ablation. This visual responsiveness occurred in deep layer neurons of the ipsilesional superior colliculus allowing these midbrain neurons to once again transform visual cues into appropriate orientation actions. The findings underscore the inherent plasticity and functional capacity of phylogenetically older visuomotor circuits that can express visual capabilities thought to have been replaced by more recently evolved brain regions. These observations suggest that multisensory training should be further considered as strategies aimed at ameliorating trauma-induced visual deficits in humans (16).

Research out of Boston University found that using multisensory training programs helps adults improve their performance of low-level perceptual tasks significantly faster than methods that use only one stimulus. These tasks included visually detecting the motion of an

object, discriminating differences in highly similar objects, and finding an item in a cluttered scene (17).

Methods

The multisensory training method utilized in my neuro-optometric rehabilitation simultaneously uses optometric phototherapy, oculomotor therapy, vestibular stimulation, and auditory stimulation in an intensive repetitive fashion. The training consists of 12 in-office visits lasting 75 minutes each and two to three weeks of daily home therapy.

The goal of this multisensory training method is to access the neuroplasticity inherent in the patients' nervous system augmented by the potential of dormant idling neurons (18). Neural connections are created and altered by the novel experience during the training (19). This multi-modal approach encourages improved connectivity between brain areas (20). The repetitive component of the training fosters automaticity in the neural pathways. I will provide a brief explanation of the individual sensory stimulations that are combined during this multisensory training method.

Patient #	Age	Days: Start to Follow up	Days: Injury to Start	% of All Symptoms Improved	% of V/V-V Symptoms Improved	VEP OD L_c % Δ	VEP OD H_c % Δ	VEP OS L_c % Δ	VEP OS H_c % Δ	TIPS Visual Pro % Δ	TIPS Auditory Pro %Δ	TIPS Delayed Rec %Δ
1	24	36	1461	80.0	100.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	45	43	940	53.3	62.5	n/a	0.0	n/a	n/a	n/a	n/a	n/a
3	40	36	39	73.3	87.5	n/a	n/a	n/a	31.0	-84.9	78.9	177.8
4	58	35	54	93.3	100.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	58	36	340	46.7	50.0	n/a	25.8	39.3	29.3	172.0	-26.5	368.8
6	38	36	119	86.7	87.5	-53.2	-19.0	43.2	-59.8	n/a	n/a	n/a
7	38	38	207	80.0	100.0	n/a	n/a	n/a	29.6	31.5	10.0	-9.0
8	69	38	532	73.3	75.0	n/a	32.1	n/a	n/a	n/a	n/a	n/a
9	54	36	244	86.7	100.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10	45	36	75	73.3	75.0	n/a	51.7	n/a	0.0	n/a	n/a	n/a
11	46	43	1096	35.7	28.6	n/a	206.9	n/a	66.7	35.1	-42.1	70.3
12	21	36	577	50.0	66.7	-41.0	-30.3	22.6	7.8	24.0	63.6	833.3
13	22	34	35	60.0	75.0	-16.7	17.3	12.0	-1.8	138.1	32.7	57.1
14	34	43	94	66.7	50.0	43.6	22.2	61.1	9.8	-55.3	200.0	900.0
15	71	36	159	86.7	75.0	-56.3	n/a	n/a	n/a	n/a	n/a	n/a
16	53	38	101	86.7	100.0	-62.6	-44.4	93.1	n/a	n/a	n/a	n/a
17	21	38	470	46.7	50.0	n/a	-81.5	-27.3	-24.0	36.4	0.0	26.7
18	51	36	111	83.3	83.3	151.7	-17.9	100.0	0.0	0.0	4.3	-10.7
19	55	38	807	69.2	71.4	47.4	106.3	n/a	51.9	97.3	7.6	525.0
20	45	43	120	35.7	28.6	68.8	60.8	187.1	163.5	79.4	-12.7	50.8
21	56	38	223	92.9	87.5	44.0	-41.8	1.1	32.3	-29.1	10.0	-10.7
22	34	36	54	75.0	60.0	-0.9	32.8	10.1	38.6	83.8	8.8	68.0
23	22	37	147	78.6	85.7	135.1	-25.0	24.1	-28.6	84.0	68.1	26.7
24	66	43	101	73.3	75.0	n/a	-13.6	n/a	33.3	-2.0	10.7	9.9
25	30	36	420	53.3	37.5	79.4	-9.4	-1.6	-30.2	354.5	23.3	212.5
Ave	43.8	37.8	341.0	69.6	72.5	26.1	14.4	43.5	19.4	60.3	27.3	206.0

Table 1 summarizes age, injury and therapy time-frame, symptom improvement, VEP (visual evoked potential) and TIPS (Test of Information Processing Skills) data per patient.

Optometric Phototherapy, also known as Syntonic Optometry**,** is the application of light through the pupil to the retinal blood supply and to retinal photoreceptors. It is a method of neuromodulation using photo-transduction – photons of light activating a graded change in membrane potential and a corresponding change in the rate of transmitter release onto postsynaptic neurons (21). It is a noninvasive use of prescribed light frequencies to treat injury and diseases of the nervous system including visual dysfunction, brain injury and imbalanced autonomic nervous systems (22), (23). As the photonic energy of the light stimulates the biochemistry of the brain, it can re-energize many neural pathways including visual, vestibular, auditory, brainstem nuclei, and glands including the hypothalamus, the pineal, and the pituitary, just to name a few. As a result, a patient becomes primed to be more neurologically receptive to clinical treatments and stimulations. I believe this is why the optometric phototherapy component appears to be the primary driving force behind the synergistic results of the multisensory training that we use in our clinic.

Oculomotor therapy is commonly prescribed for remediation of oculomotor (eye movement) deficits prevalent in brain injured patients. It has also been proven to improve visual attention (24). The patient is guided through saccadic and pursuit eye movement tasks to improve visual fixation accuracy and smoothness. It also includes vergence training to enhance efficiency and stamina of maintaining clear and single binocular fixation. The specific oculomotor therapy activities used during the multisensory training are based on those commonly used in optometric vision therapy.

Vestibular stimulation is provided by movement of the patient whereby the vestibular system in the inner ear registers motion, both linear and rotational, and sends this sensory information via the eighth cranial nerve to the vestibular nuclei of the brainstem. Here it engages with sensory inputs from the visual, somatosensory, and auditory systems. Efferent fibers proceed from here to provide motor output to extraocular muscles for appropriate oculomotor response and the spinal cord for balance. The vestibular nuclei also send sensory information to the cerebellum so it can modify and further control the motor responses (15).

ABI Symptom Survey

NAME_____ DATE_____

Please complete this questionnaire. After each symptom listed, circle the number that best describes how often you currently experience that particular problem.

0 = never, 1 = (not very often) infrequently, 2 = sometimes, 3 = fairly often, 4 = always.

		Never	infrequently	sometimes	often	always
1.	**Reading difficulties** (*fatigue, blur, loss of place, headaches, limited endurance, pain, shuts you down, nausea*)	0	1	2	3	4
2.	**Difficulty with concentration on tasks** (*difficulty multi-tasking/disconnected feeling/foggy-headed/hazed-over feeling/difficulty thinking or processing, general confusion*)	0	1	2	3	4
3.	**Photophobia** (sensitivity to lights or glare)	0	1	2	3	4
4.	**Headaches** (NOT associated with reading)	0	1	2	3	4
5.	**Spatial misjudgements** (*disorientation, clumsiness, poor eye-hand coordination, falls, bump into things*)	0	1	2	3	4
6.	**Imbalance**	0	1	2	3	4
7.	**Dizziness**	0	1	2	3	4
8.	**Writing difficulties**	0	1	2	3	4
9.	**Word/Name retrieval difficulties**	0	1	2	3	4
10.	**Phonophobia** (sensitivity to sounds)	0	1	2	3	4
11.	**Become "shut-down", or a nap needed to recover from excessive fatigue**	0	1	2	3	4
12.	**Double vision or eyes feel out of sync**	0	1	2	3	4
13.	**Sleep pattern difficulties**	0	1	2	3	4
14.	**Anxiety**	0	1	2	3	4
15.	**Visually busy environments or motion exacerbates or induces any of the symptoms listed above**	0	1	2	3	4
	Total Score	___	___	___	___	___

This survey was developed by Steven J Curtis, OD, FCOVD

Figure 1. ABI Symptom Survey.

The **auditory stimulation** included in this multisensory training is attenuated obscure music with customized sound frequencies, volume, lateralization, and modulation presented through headphones. After a thorough history is taken to rule out the need for a referral to an ENT, customization is accomplished via a listening profile taken on the patient using an audiometer.

Subjective and objective clinical results were obtained on 25 consecutive PCS patients before and after receiving this multisensory training. Tests were administered approximately one week prior to and then again 38 days after the start of their multisensory training. Patient ages ranged from 21 to 71with a median age of 43.8. The time since their most recent concussion to the start of training ranged from 35 to 1461 days with a median time of 341 days.

The tool utilized for subjective measurements was an acquired brain

injury (ABI) symptom survey I developed. The questions in the survey were chosen based on a review of the presenting history of the previous 25 consecutive PCS patients that were treated. The symptom survey is shown in figure 1. All participants completed the symptom survey.

Objective clinical results were obtained using two tests: visual evoked potential (VEP) and Test of Information Processing Skills (TIPS). These tests reliably paralleled the patient improvement in symptoms and they have evidence-based research credibility. An advantage of using these tests is because one (VEP) represents visual processing physiologically along a subcortical-cortical (non-cognitive) neural pathway, and the other (TIPS) represents an assessment of higher level cortical (cognitive/executive function) processing. Due to scheduling limits, eight of the patients did not receive the TIPS. Due to unacceptable reliability and/or scheduling limits, some or all of the VEP results of several patients is not available. Prioritization of these tests is now in place in our scheduling protocol and is represented in table 1 when reviewing patients 11 through 25.

All Symptoms	%Δ
Reading Difficulties	-44
Concentration Difficulty	-37
Photophobia	-39
Headaches	-17
Spatial Misjudgments	-36
Imbalance	-48
Dizziness	-50
Writing Difficulty	-38
Retrieval Difficulty	-30
Hyperacusis	-41
Shut Down from Fatigue	-26
Double Vision	-59
Sleep Difficulty	-47
Anxiety	-36
Environmental Trigger	-36
Ave	-39

Table 2 summarizes the percent change of each symptom for the patient group.

A VEP objectively measures the functional responses of the visual pathway including the retina, optic nerve, optic radiations, and visual cortex. Electrical signals are measured from the electrophysiological activity ("brain waves") at the visual cortex. VEP recordings have been used for a variety of applications that involve neuro-visual disorders such as glaucoma, amblyopia, multiple sclerosis, diabetic retinopathy (25, 26, 27, 28) and traumatic brain injury (29). VEP tests provide the clinician with objective data, as no response is required from the patient.

The TIPS is a norm-referenced test developed by neuropsychologist, Dr. Raymond Webster, that assesses information processing skills in children and adults between age 5 and 90. Performance on the TIPS reflects visual processing, auditory processing, executive functioning, working memory, and delayed recall.

Results

Improvement in a majority of symptoms was reported by 84% of patients – 21 of 25 patients improved in at least half of their presenting symptoms (see column 5 of table 1). The average amount of improvement in all 15 symptoms for the entire group was 39% (see table 2).

Figure 2 is a graph showing the percentage of patients reporting improvement for each symptom. Eight of the most responsive symptoms to the multisensory training were reading difficulties, writing difficulties, photophobia, imbalance, dizziness, double vision/"eyes out-of-sync feeling", spatial mis-judgements, and busy visual environment sensitivity. These are all vision and visual-vestibular (V/V-V) based symptoms, often referred to in the brain-injury medical community as "visual disturbances".

When considering only the eight V/V-V based symptoms, 88% of patients (22 of 25) reported improvement in a majority of them (see column 6 of table 1). Twenty percent (5 of 25) had improvement in 100% V/V-V symptoms. The average amount of improvement of the eight V/V-V based symptoms in this group was 44% (calculated from table 2 data).

More specifically, 83.3% of patients (20 of 24) reported improvement in reading difficulties. The amount of improvement the group reported in reading was an average of 44%. Seventy nine percent of patients (19 of 24) reported improvement in photophobia with an average improvement amount of 39%. Ninety percent of patients (17 of 19) reported improvement in double vision/ "eyes feel out of sync" with an average improvement amount of 59%. About 82% of patients (18 of 22) reported improvement in balance with an average improvement amount of 48%. Substantially improved non-visual symptoms worth noting were concentration difficulties (83.3%), sleeping difficulties (75%) and hyperacusis (81%).

Upon further review, dizziness was the symptom that resulted in the most patients reporting a 100% improvement from the multi-sensory training. Thirty six percent (9 of 25) patients stated that their symptom of dizziness had completely resolved. Traditionally, dizziness is treated primarily as a vestibular dysfunction but these results indicate that this multi-sensory training should also be considered especially if the patient has "hit a plateau" in recovery with vestibular therapy. Collaboration with local vestibular therapists is most appropriate for serving these patients well.

Although the symptom improvement is very satisfying and welcomed, as clinicians we feel more justified in our efforts if there is objective testing data that parallels the subjective improvements. The following section will review the objective clinical results for the same group of patients that were represented in the symptom data above.

VEP measurements were obtained using the Diopsis NOVA 32 spatial frequency configuration with multi□ contrast stimulus pattern at both low contrast and high contrast to test the integrity of the magnocellular (primarily peripheral vision) and parvocellular (primarily central vision) pathways, respectively. The patient group exhibited an average increase of 35% in low contrast amplitude and 17% in high contrast amplitude (average of OD and OS). The magnocellular pathway plays a much greater role in balance than the parvocellular pathway. I believe that the significantly greater improvement that occurred to the low contrast amplitudes compared to the high contrast amplitude means that these PCS patients gained needed improvement in neurotransmission throughout the magnocellular pathway including its integration with vestibular and motor areas. As a result, balance symptoms improved.

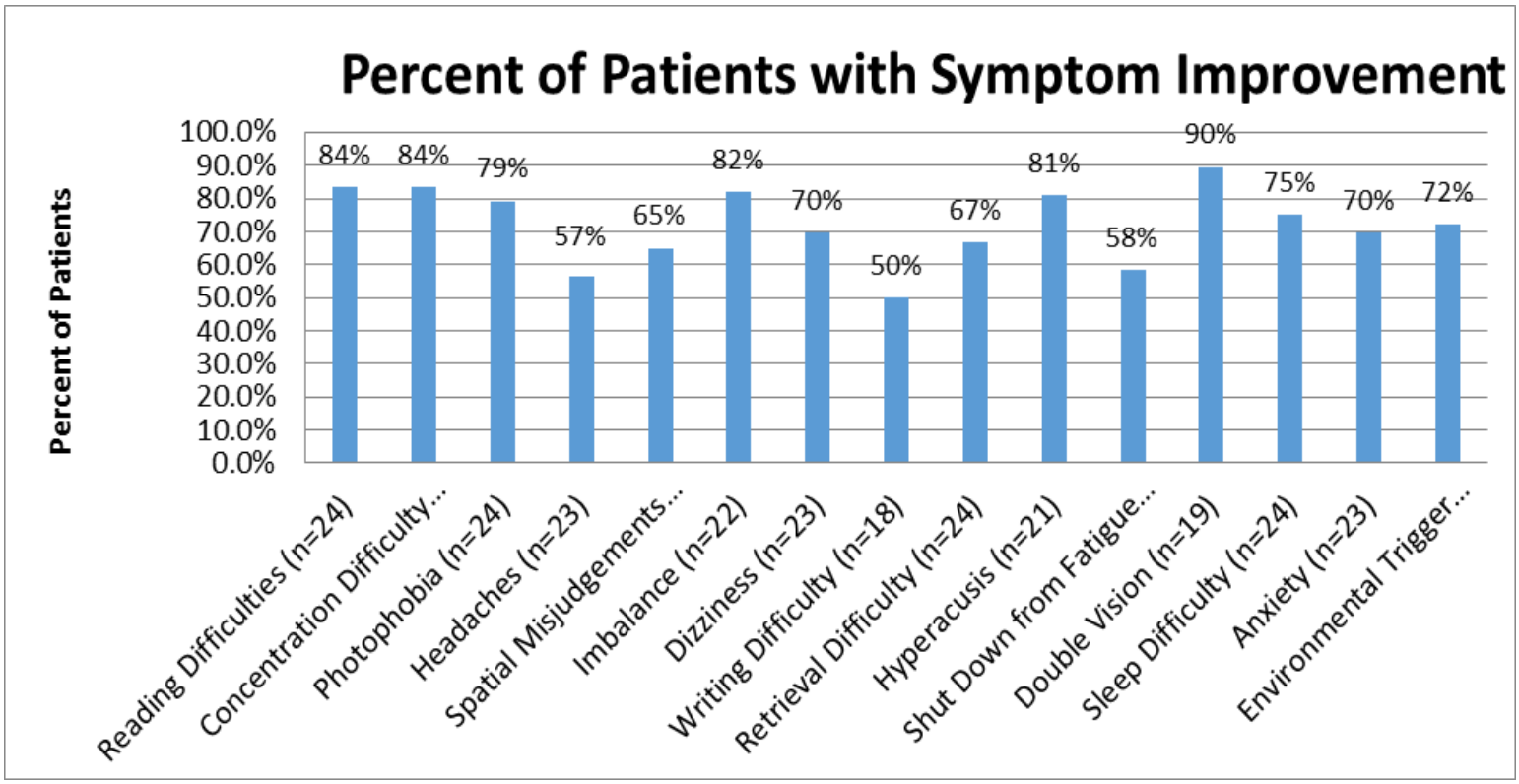

Figure 2.

In addition to improved amplitudes, patient reliability on the test improved likely indicating improved visual attention. Research that helps us understand this observation is present in a study by Ciufredda, et al. They studied the effect of oculomotor therapy on VEP amplitudes and visual attention. They found that visual attention improved as measured objectively via alpha band activity embedded in the VEP. The VEP amplitudes increased and the variability decreased. Latencies, both high and low contrast, exhibited no statistically significant change (24).

Using the TIPS, the patient group demonstrated an average increase in their visual processing score of 60%. Auditory processing increased an average of 27 %. Most notably, delayed recall improved an average of 206%.

Patients who reported an average improvement in all symptoms of greater than 50% had an average time between injury and start of treatment of 126 days. Those with average improvement below 50% had an average of 424 days between injury and start of therapy. This indicates that delaying treatment negatively affects the effectiveness of treatment. Age of the patient did not show influence in outcomes.

Discussion:

So why do these patients respond to this multisensory approach when single-sensory based rehabilitation methods such as physical therapy or vision therapy failed? Consider that while physical therapy often improves overall function in patients by improving the use of vestibular inputs, it may unfortunately decrease the dependency on visual information; likewise, vision therapy aids patients by enhancing visual input at the risk of decreasing dependency on vestibular inputs. In contrast, this multisensory integration training spreads the processing therapy amongst all the systems creating opportunity for the stronger systems to support the weaker systems until all reach the balanced and synergistic status that existed before the brain injury.

Anatomically, what are the neural mechanisms behind these positive changes for PCS patients who receive the multi-sensory training? The process of sensory integration occurs at several levels of the brain including the cerebellum, brainstem nuclei, the superior and inferior colliculi, the thalamus, the hypothalamus, the reticular system, anterior ectosylvian sulcus (31) and the intraparietal sulci of the cortex (32). The peripheral sensory organs provide individualized neural information from our environment to these areas. For example, the optic nerve has a path consisting of the chiasm, lateral geniculate nucleus (LGN), and optic radiations before terminating in the occipital cortex. But near where it junctures at the LGN, it sends collateral neurons to the superior colliculus. The superior colliculus is a major component in sensory integration. In addition to input from the retina, the superior colliculus receives inputs from the visual cortex along with sensory and motor structures including the hypothalamus, thalamus, and inferior colliculus (33).

Specific to visual-vestibular integration, the neuroanatomy begins with the vestibular nerve providing neurons from the inner ear to the vestibular nuclei of the brainstem. From here, fibers proceed to the oculomotor nuclei and to the spinal cord. Vestibular fibers are also sent to the cerebellum along with input from the visual cortex. This extensive interplay of sensory information provides for effective motor outcomes including saccadic eye movements, vergence eye movements, and balance maintenance (34).

An excellent example of this is represented by a patient I just saw for follow-up a few days prior to finishing the writing of this paper (thus, she is not included in the 25 patient group). K.A., a 54 yowf, presented with a history of several concussions throughout her life. Her most recent one (six months prior to her treatment) caused severe post-concussion syndrome symptoms. The most debilitating symptom for her was the constant sensation of being on a boat on the ocean. This case was one of my most interesting because binocular vision dysfunctions are often at the core of our neuro-optometric rehabilitation efforts yet, she is monocular, having a prosthetic right eye since age one. However, based on her symptoms and one particular clinical test I performed on her, I was confident she would respond to the visual-vestibular training effects of the optometric phototherapy-based multisensory training. Bi-nasal occlusion, or in this case, mono-nasal occlusion provided her with instant significant improvement in balance. I repeated the test three times both in the exam room and having her stand in our busy dispensary. Her husband witnessed the profound effects as well. This demonstrates to me that she is unable to integrate the entire amount of ambient visual information with her vestibular information thus causing her the visual-vestibular symptoms of "being on a boat". The nasal occlusion allowed for a manageable amount of ambient visual input to integrate more efficiently.

At her follow-up appointment with me 36 days after beginning the treatment, she reported that "I am off the

boat" and "this is the first day I have driven my car this far". Clinically, her ABI symptom survey improved from a score of 40/60 to 17/60. Her low contrast VEP's only improved from 9.05 microvolts to 9.64 microvolts, however her reliability improved from 78% to 98% indicating improved visual attention. TIPS scores for K.A. improved from 61st to 75th percentile in visual processing and from 63rd to 91st percentile in delayed recall. This explains why she reported her concentration abilities were significantly improved and stated "I'm out of the quicksand".

Why is this optometric phototherapy-based multisensory integration training predominantly providing improved PCS symptoms that are visual and visual-vestibular based? Three likely reasons are: 1) patients presented with these disturbances as their primary symptomology, while other symptoms were secondary; 2) since vision is considered the most dominantly used sensory system in humans, it will be the most influential one in symptom recovery; 3) this multisensory training targets visual-vestibular integration pathways in the brain. As a result, most patients reported improvement in reading, writing, photophobia, balance, dizziness, double vision/"eyes feel out-of-sync", spatial judgement, and busy visual environment sensitivity.

Furthermore, neural mechanisms are compromised when brain injury disrupts integration processing between the auditory and visual systems. The superior and inferior colliculi are key structures in maintaining coherence between vision and audition. For example, a visual stimulus takes much longer to arrive at the colliculus than a sound does. The colliculus performs the critical function of maintaining a memory for these varying responses and merges the differing lengths of time to provide temporal fusion (35).

It is my prediction that this multisensory training is uniquely more effective compared to other multisensory training methods. My hypothesis for this is based on the inclusion of optometric phototherapy. It is capable of energizing neural transmission throughout the integrative pathways in the midbrain **at the same time** that oculomotor and vestibular inputs arrive. Additionally, optometric phototherapy likely improves the flow of neural energy through the magnocellular pathway and dorsal stream enhancing parietal lobe function. This, in turn, provides the patient with improved spatial awareness of their environment creating improved cortical visual input available for integration.

In other words, as the sensory integration and spatial localization areas of the brain repetitively receive phototransduced energy while simultaneously receiving the vestibular and auditory inputs and performing oculomotor output, the brain has an opportunity to be retrained in the modulation and integration of multiple sensory signals while doing this in a safe and controlled clinical situation. This resultant improvement in sensory integration provides more accurate and efficient production of motor output including posture, balance, and eye movements thereby reducing related symptoms such as in PCS. When neurons fire in sync with one another, they are more likely to form new connections and grow stronger through repeated stimulation (30).

Further and more sophisticated study is needed to provide validity and expansion to these clinical results. For example, a much larger pool of subjects is needed. Ideally, future research should utilize fMRI to compare changes in the brain. I also propose comparing this multisensory training to other multisensory trainings or to single-sensory trainings.

Neuro-optometric rehabilitation is comprised of many other techniques that are sometimes effective in reducing PCS symptoms. Studies comparing this optometric phototherapy-based multi-sensory training to other techniques might help the provider understand when it is appropriate to choose one or the other during treatment planning. One of the most compelling factors that influence me to prescribe this multi-sensory training is when a patient presents with a history of intolerance to traditional active/output-based therapies. This multisensory training is primarily a passive and input only-based therapy thereby being more receptive by the easily overwhelmed patient.

Multi-sensory stimulation should be considered in the rehabilitation of PCS patients. This is because the foundation of essential human functions of daily living depends on the interaction of information transmitted from the various peripheral sensory systems to the brain. In promoting their PhD programs in multisensory neuroscience, Wake Forrest University states this on their website:

> "*Despite traditional emphasis on individual senses, there is growing appreciation that brains are inherently multisensory … multisensory therapeutic regimens may better ameliorate the sensory deficits associated with acute brain trauma (e.g., neglect following stroke), and training programs emphasizing interactions among senses are essential to pro-*

mote a better understanding of the debilitating effects of disease and the strategies necessary to ameliorate them."

Sue Barry, professor of neuroscience at Mt Holyoke College, once stated "one of the most important functions of our brain is to integrate the information from all our senses into a perceptual whole. Only then can we perceive the world as single, integrated, and stable. Brain injury shatters this wholeness" (36).

Finally, PCS has socioeconomic repercussions because it often prevents patients from returning to work, play, and enjoying family relationships. When PCS patients deal with their constant symptoms, they become irritable, anxious, depressed, and display a personality to their loved ones and public that does NOT reflect their pre-injury persona. They are less efficient at work with some losing their jobs. They become a medical expense drain for the insurance companies and their own out-of-pocket resources. If rehabilitation of these patients can be facilitated using interventions such as this multisensory training method, the patient, family, employers, providers, and insurance companies all win.

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About the Author:

Dr. Steven J. Curtis received his Doctor of Optometry degree from The Ohio State University in 1987.

He is president of Riverview Eye Associates in Columbus Ohio where he provides general, developmental, and neuro-optometric services. He is also on the medical staff at the OhioHealth Rehabilitation Hospital in Columbus.

Dr. Curtis is a fellow of the College of Optometrists in Vision Development and is currently on track to earn fellowship from the Neuro-Optometric Rehabilitation Association. He is frequently asked to lecture on the subject of vision rehabilitation to area physicians and therapists. Most recently he twice provided a 12 hour course titled "Vision Assessment of Acquired Brain Injury Patients for Non-Optometric Rehabilitation Providers". His role is to assist with the collaborative movement that is happening in rehabilitation by making sure non-optometric providers understand the role vision plays so they appropriately know when to request neuro-optometric involvement.

Dr. Curtis is enjoying the tremendous growth in his work with patients who suffer persistent vision disturbances after concussion. This has included athletes from professional teams of the MLS and NHL. Outside of optometry, Dr. Curtis enjoys spending time with his family and performing music.

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Spectral Power Distribution Research

Sonja Vanhimbeeeck, CEO of Optomatters

Editorial Note: Optomatters is a Belgium company specializing in developing, assembling and supplying syntonic and visual training equipment. The following research was done with gels.

Some of you will remember that last year there was confusion about the order of the filters in the syntonic goggles. In fact, one did presume that the wavelength of the outgoing light passing through a combination of different filters, is not the same when the order of the filters is changed. For example: putting the filters in the goggle like Alpha Omega (Alpha closest to the eye) or vice versa like Omega-Alpha (Omega closest to the eye) influence the wavelength of the outgoing light. This was the point of discussion.

Clearing out this issue, if there existed a difference, was Optomatters' concern. Optomatters is always looking to serve the optometrists' needs in the best way and therefore Optomatters assigned a light engineer to find this out. The scientific result of his research proved that the order of the filters in the goggles does not affect the wavelength of the light leaving the combined syntonic goggle. Conclusion is that is makes no sense to syntonic glasses with the same combination, put together in both directions because the wavelength remains the same in the two directions. If one presumes the opposite, then it concerns rather a personal preference.

On the other hand, as an experience optometrist, I love to share next consideration:

The order of applying two syntonic goggles in a specific light therapy DOES MATTER. Stimulating or inhibiting the sympathetic or parasympathetic nerve system by applying syntonic filters must be performed in the correct order! Using for instance first the alpha-omega combination and then mu-delta combination does have its meaning!

When changing that order, then the objective of influencing the autonomic nerve system properly, will not reach the attempted effect. On the contrary, it can establish a negative result.

Further research accomplished into the field of phototherapy with LED application will be released soon.

Test Report Spectrum (Alpha and Omega)

Unit of measurement: Spectral power distribution, Color coordinates (x,y in CIE 1931 chromaticity space), Wavelength maximum emissivity, Strength,-vertical, Effective irradiance, Spectral power distribution.

Source: Calibration light (halogen 250W 24VDC). In combination with Alpha and Omega.

Type: Manufacturer: Lichtconsult.nl.

Client: Optomatters CVBA, Dr.Van de Perrelei, 106, Borgerhout, 2140 Antwerp, Belgium.

Serial number: 15.102-07-S.

Lab technician: PKS

Measure Procedure:

The spectrum of the color filter was measured with the help of a calibrated image grating (flat field) spectro radio meter and a calibration light of 250W 24Vdc.The spectro radio meter is positioned at approximately 0.5 of the calibration light. The calibration light works on a stabilized power supply, where the color temperature is set to 2856 Kelvin. The color filter is placed between the spectro radio meter and the calibration light . The color filter is placed at approximately 0.01 meter distance from the spectro radio meter.

The effective irradiance (W/m^2) is measured starting at the wave length 380 nm until 780 nm of the following possibilities:

A: The calibration light without filter.

B: The calibration light with filter combination Alpha-Omega (Alpha = closest to the eye/spectro radio meter).

C: The calibration light with filter combination Omega-Alpha (Omega= closest to the eye/ spectro radio meter).

The color coordination (x,y in CIE 1931 chromaticity space) and the dominant wave length are based on the spectral distribution.

Three tests were performed of which the average was reported. After switching on the light there is a stabilization time of 30 minutes. After this stabilization the test has started.

Unit of measurement	Symbol	Unit	Test results
Color coordinates (in CIE 1931 chromaticity space)	x	-	**0.447**
	y	-	**0.407**
Dominant wavelength	λ	nm	**583**
Luminous emittance vertical	Ev	lx	**1.163**
Effective irradiance	Ee	W/m2	**7.46**

A. Results Calibration Light.

Unit of measurement	Symbol	Unity	Test results
Color coordinates (in CIE 1931 chromaticity space)	x	-	**0.723**
	y	-	**0.286**
Dominant wavelength	λ	nm	**640**
Luminous emittance vertical	Ev	lx	**1.73**
Effective irradiance	Ee	W/m2	**1.69**

B. Results Calibration Lights with Filter Combination Alpha-Omega.

Unit of measurement	Symbol	Unity	Test results
Color coordinates (in CIE 1931 chromaticity space)	x	-	**0.717**
	y	-	**0.285**
Dominant wavelength	λ	nm	**640**
Luminous emittance vertical	Ev	lx	**1.74**
Effective irradiance	Ee	W/m2	**1.69**

C. Results Calibration Light with Filter Combination Omega-Alpha.

Composition:

Composition: Spectra radio meter at a distance of 1 meter of the light source.

Measuring instrument: Jeti Specbos 1211, SN° 2010076

Date calibration: 16.03.2015

Accuracy chromaticity x,y: ± 0.002 @ Illuminant A

Accuracy CCT: ± 20K

Accuracy wavelength: ± 0,5nm

Environmental temperature: 25 ± 1 °C

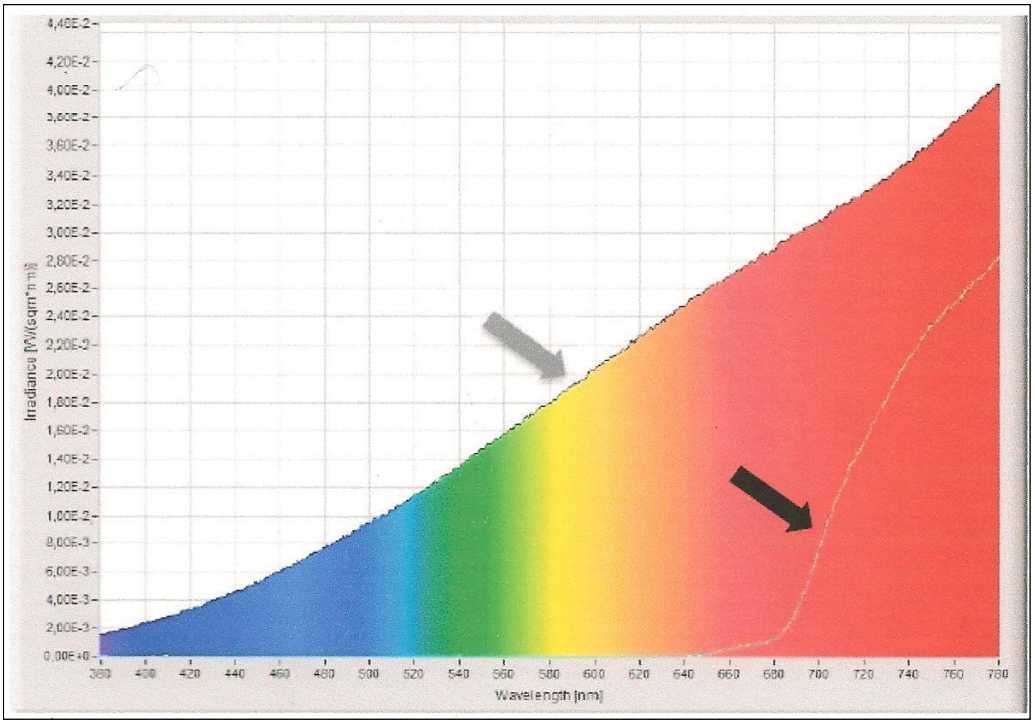
Relative humidity: 30 — 50 %

Spectral power distribution and CIE test color rendering index—See Attachment 1 and Attachment 2.

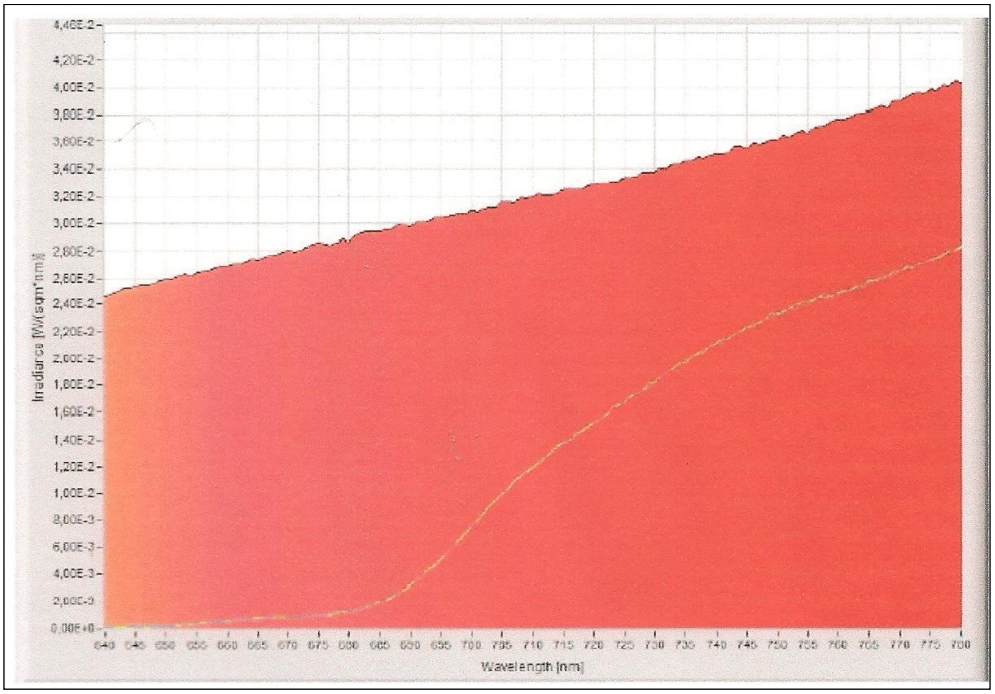
Accuracies are stated in accordance with the manufacturer specifications.

Attachment 1

Spectral Power Distribution
W/ [m^2 · nm]



The top grey line is the spectrum of the calibration light (grey arrow). The filter combination Alpha-Omega is the yellow line, Omega-Alpha is the blue line (black arrow). This is almost identical and hardly indistinguishable.



Attachment 2

The same spectral power distribution, enlarged from 640 to 780 nanometer.

Test Report Spectrum (Mu and Delta)

Unit of measurement: Spectral power distribution, Color coordinates (x,y in CIE 1931 chromaticity space), Wavelength maximum emissivity, Strength-vertical, effective irradiance, Spectral power distribution

Source: Calibration light (halogen 250W 24VDC) in combination with filters Mu and Delta.

Manufacturer: Lichtconsult.nl

Client: Optomatters CVBA, Dr. Van de Perrelei, 106 Borgerhout, 2140 Antwerp, Belgium.

Serial number: 15.102-08-S

Lab technician: PKS

Measure Procedure:

The spectrum of the color fitter was measured with the help of a calibrated image grating (flat field) spectro radio meter and a Calibration light of 250W 24Vdc.The spectro radio meter is positioned at approximately 0.5 of the Calibration light. The Calibration light works on a stabilized power supply, where the color temperature is set to 2856 Kelvin. The color filter is placed between the spectro radio meter and the Calibration light . The color filter is placed at approximately 0.01 meter distance from the spectro radio meter.

The effective irradiance (W/m2) is measured starting at the wave length 380 nm until 780 nm of the following possibilities:

A: The Calibration light without filter.

B: The Calibration light with filter combination Mu-Delta (Mu= closest to the eye/resp. spectro radio meter).

C: The Calibration light with filter combination Delta-Mu (Delta = closest to the eye/ resp.spectro radio meter).

The color coordination (x,y in CIE 131 chromaticity space) and the dominant wave length are based on the spectral distribution.

Three tests were performed of which the average was reported. After switching on the light there is a stabilization time of 30 minutes. After this stabilization the test has started.

Unit of measurement	Symbol	Unit	Test results
Color coordinates (in CIE 1931 chromaticity space)	x	-	**0.448**
	y	-	**0.408**
Dominant wavelength	λ	nm	**583**
luminous emittance vertical	Ev	lx	**1.157**
effective irradiance	Ee	W/m2	**7.57**

A. Results Calibration Light.

Composition:

Composition: Spectro radio meter at a distance of 1 meter of the light source

Measuring instrument: Jeti Specbos 1211, SN° 2010076

Datum calibration: 16.03.2015

Accuracy chromaticity x,y: t 0.002 @ Illuminant A

Accuracy CCT: ± 20K

Accuracy wavelength: ± 0,5nm

Environmental temperature: 25 ± 1 °C

Relative humidity: 30 - 50 %

Spectral power distribution and CIE test color rendering index—See Attachment 1 and Attachment 2.

Accuracies are stated in accordance with the manufacturer specifications.

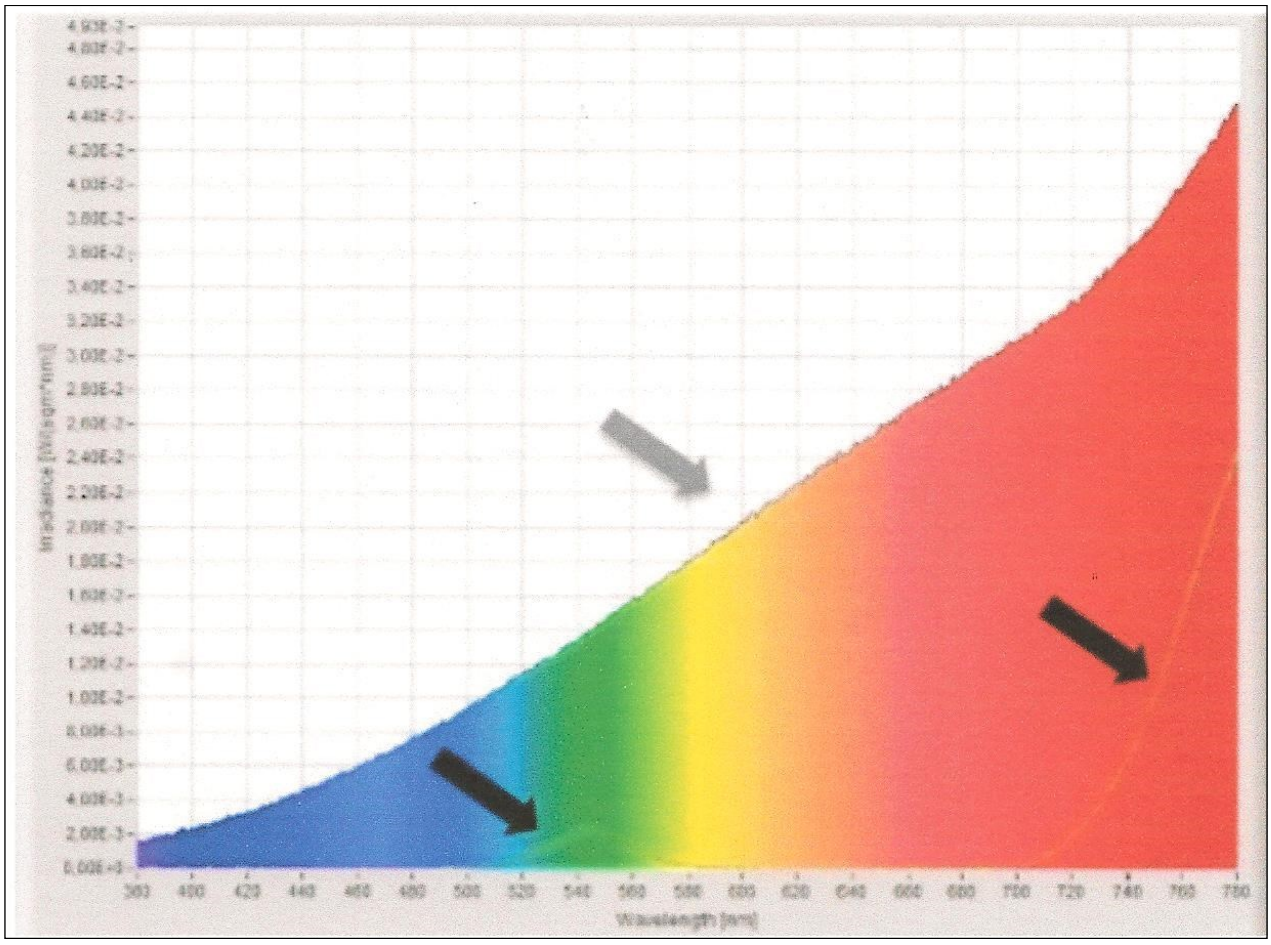
Measurement Report 15.102-08-S
Optomatters © 2016

Unit of measurement	Symbol	Unity	Test results
Color coordinates (in CIE 1931 chromaticity space)	x	-	**0.283**
	y	-	**0.692**
Dominant wavelength	λ	nm	**547**
luminous emittance vertical	Ev	lx	**52.9**
effective irradiance	Ee	W/m2	**0.78**

B. Results Calibration Lights with Filter Combination Mu-Delta.

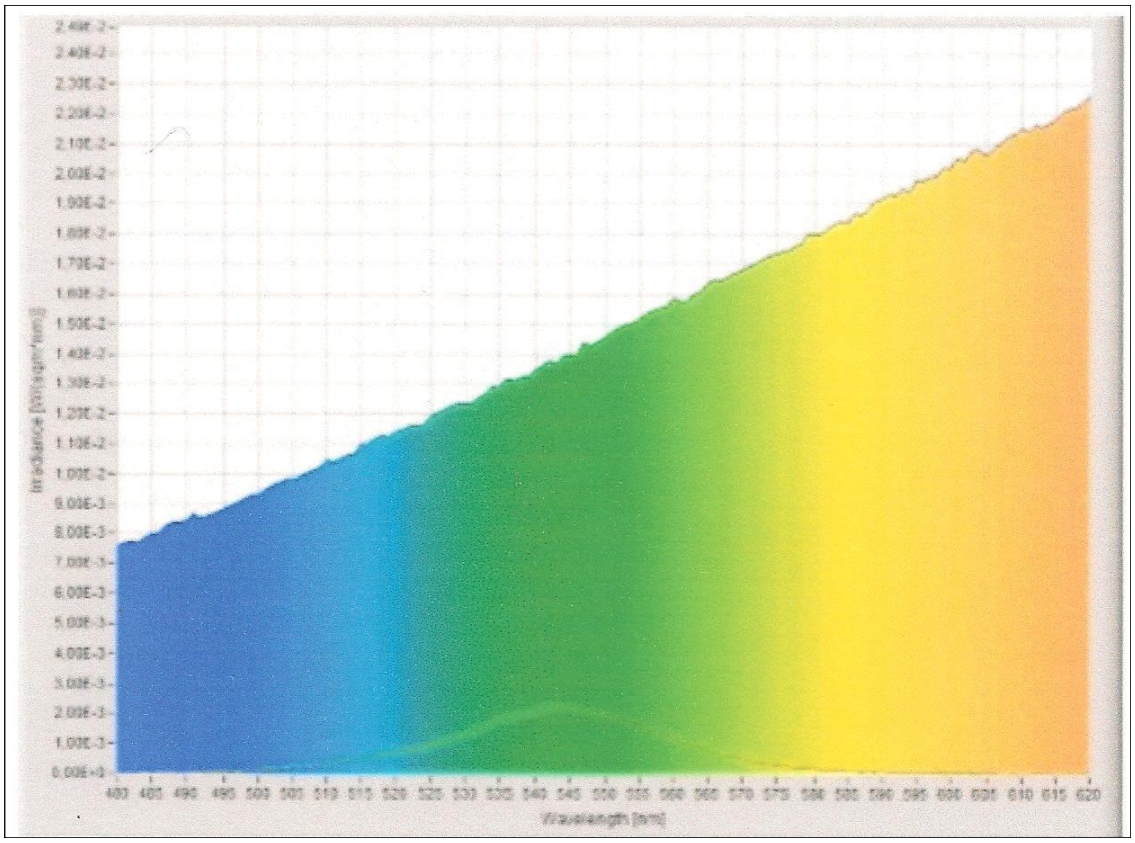
Unit of measurement	Symbol	Unity	Test results
Color coordinates (in CIE 1931 chromaticity space)	x	-	**0.283**
	y	-	**0.692**
Dominant wavelength	λ	nm	**547**
luminous emittance vertical	Ev	lx	**53.1**
effective irradiance	Ee	W/m2	**0.79**

C. Results Calibration Light with Filter Combination Delta-Mu.



Attachment 1: Spectral Power Distribution - W/ [m^2 · nm]

The top grey line is the spectrum of the calibration light (grey arrow). The filter combination Mu-Delta is the green line (black arrow), Delta-Mu is the orange line (right next to the green line), Delta-Mu is the orange line (right next to the green line). This is almost identical and hardly indistinguishable.



Attachment 2

The same spectral power distribution, enlarged from 480 to 620 nanometer.

About the Author:

Sonja Vanhimbeeck, Functional optometrist, graduated from the SCTOW Optometry school-Brussels in 1980.

She has worked as a functional optometrist for more than 20 years in two Optometric centers in Belgium and in the Netherlands.

Sonja has been a three time speaker at the COVD Congress (1993, 1996, 1997) and received the Getman Memorial Lecture Award for her presentation at the 4th International Congress of Behavioral Optometry in 2002.

Author of two books, *A Guide To The Optometric Training Of Myopia Control* and *A Guide To General Skills Training In An Optometric Practice* were published by OEPF.

***S*ince 1990, she is the owner and founder of Optomatters cvba, a Belgian company specialized in syntonic and vision therapy equipment.**

Call for a New Syntonic Principle

Ray Gottlieb, O.D., Ph.D., Dean of the College of Syntonic Optometry

> *Your Majesties, your royal highnesses, ladies and gentlemen, we live in a world of light.*
>
> Physics Nobel Prize Presentation Speech, 2005

Spitler's book, *The Syntonic Principle*, was published in 1941. His syntonic principle was based on scientific findings and beliefs from before 1940. In the 75 years prior to 1940, the theoretical foundations in all of science took a quantum leap. This led to the modern conception of the atom with a positive nucleus and orbiting negative electrons. Light phenomena played and still commands a central role in the advancement of science. In the last decades of the 19th century, the wave nature of light totally dominated scientific thought. In the first decade of the 20th century, Einstein and others recognized that when light impacts matter, it acts like a particle of energy (later called a photon) and that photons of different wavelengths impact matter with different quantities of force. Blue light photons carry greater force than green, yellow, and orange photons, and red photons carry the least force. This discovery was vital in the development of the quantum theory of matter. Light—it's color—measures the energy and dynamics of chemical and physical reactions. The color of the light absorbed and emitted by matter has been an important key to understanding nature.

> *Molecules send us messages through photons, be it through photons they absorb, be it through photons they emit.*
>
> Albert Szent-Györgyi

Now it is 75 years since Spitler published his thesis and we've learned a great deal about nature since then. It seems to me that Syntonics needs an updated Syntonic Principle and that we need a deeper understanding and an up-to-date science-based model that describes how syntonics and other forms of light therapy work. The physical, chemical, physiological, and medical sciences are experiencing huge paradigm shifts where long-held and unexamined assumptions are about to be revised. I hope that this article will be a catalyst for a Principle update.

This article attempts to:

- Describe what happens when a photon hits an atom or molecule.
- Show how this light works to energize the protein and water molecules in living cells, and the ways light works to help cells communicate, coordinate, and produce energy and balance.
- Describe a model of how syntonics phototherapy can possibly work the feats of healing we see with our patients.

Note that the findings and ideas here are greatly simplified and leave out quantum mechanics and modern physics. With every increase in the magnification, speed, and sophistication of the scientific technology that measures the spectrum of color, scientists can peer deeper into the nature of physical reality. The scientific and technological revolution happening right now has already impacted our lives more than the industrial revolution. And we ain't seen nothin' yet. Now is an exciting time to be a syntonist!

The Changing of Bodies into Light and Light into Bodies

Photons are force carriers. They carry the energy or the force of light. Photons have no mass, no charge, and they pulse or vibrate through a vacuum at the speed of light. Photons are not matter, but can interact with matter to alter its chemistry, structure, and energy. Under certain conditions, matter will emit and absorb light energy. Matter heated to above a certain temperature emits photons—think light bulbs, fire, and our sun. Increase the temperature and the emitted light gets bluer. Matter can also absorb photons. An absorbed photon striking an atom or molecule passes its energy into an electron. The excited electron is forced out of its ground state into an

orbit of greater energy. It is the energy of electrons that drives the machinery of life. The energy of light—its color—is directly related to the strength (ionization potential) of the donor molecule to release an electron and the willingness of the acceptor molecule to receive it (more about this later).Electrons, Atoms, Molecules, and Light

> *Are not gross Bodies and Light convertible into one another, and may not Bodies receive much of their activity from the Particles of Light which enter their Composition?*
>
> Isaac Newton, *Optics*, 1721

Solid matter is not solid when you get right down to it. Matter is active, energetic, and extremely fast-moving. An atom is mostly "empty" space. The mass of an electron is about 1/1500th the mass of a proton. The diameter of an atom (of its largest orbit) is about 10,000 times the diameter of its nucleus. Electrons are distributed in orbitals or shells described as probability clouds or allowed levels of energy. Between each orbit is a "forbidden zone" where electrons are not found.

The total number of electrons in an atom is equal to the number of protons in its nucleus. So since the total negative charge of the electrons equals the total positive charge of the protons, atoms have no charge.

Electrons in the orbital closest to the nucleus have the least energy and each successively larger orbit is more energetic. The highest occupied orbit, is the orbit that contains at least one electron. The lower orbits are fully occupied (have the maximum allowed number of electrons). The highest occupied orbit can be fully occupied, partially occupied, or almost empty. Beyond the highest occupied orbit is a series of "virtual orbits," generally empty but ready to accept excited electrons that have been "photoexcited" by colliding with a photon. Electrons in the outermost occupied orbital are the most loosely bound to the nucleus and it is these outer electrons that are shared between atoms or molecules to create new molecules with unique chemical and energetic properties.

An atom's behavior depends on whether its outer occupied orbit is full (not in need of any more electrons), almost full (wants another electron to fill the orbit), almost empty (wants to give away an electron), or half empty (wants to gain or lose electrons in order for its outer orbit to become fully occupied). That's chemistry. It is the outer electrons on the highest occupied orbits that are involved in chemical reactions. And it is these same outer electrons that absorb the energy of visible photons to bring about photochemical actions.

Spitler had it right when he wrote:

> Light carries chemical potentialities...It probably would seem strange to walk into a chemist's shop and request a quantity of light by the gram or pound as one might purchase other chemicals, yet the fact remains that light carries chemical potentialities just as do other chemicals that are purchased by weight.

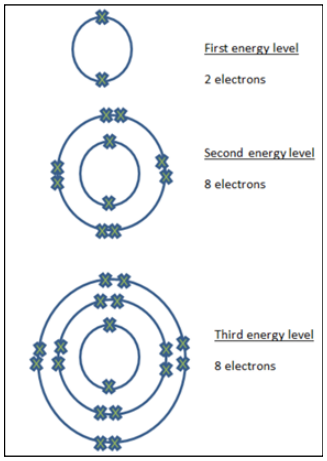
Chemical reactions between atoms and molecules can cause them to combine, split apart, or rearrange in a number of ways. Visible light (photochemistry) can trigger these same chemical interactions. The force of a single photon can cause molecules to:

- Bond with an atom or other molecule
- Split molecules apart
- Change the shape of molecules
- Transfer charge to other molecules
- Sustain excited electron configurations (triplets)
- Luminesce (like fireflies)
- Convert energy to heat and vibration
- Ionize atoms or molecules (become charged by gaining or losing an electron)

It is important to realize that even the slightest alteration in the outer electron configurations of atoms and molecules fundamentally alters their chemical characteristics**.** Identical atoms of an element, when they each bond with a different type of molecule, will exhibit totally unique behaviors that are quite different from those of the original atom and from each other. The addition of just a single proton (hydrogen ion - H^+) or an electron (e^-) to a molecule will change its nature and function. Molecules and atoms bond according to their outer occupied orbits and they conduct electricity and information by electron transfer chains. During this transfer process, excited electrons pass through a series of donor molecules that transfer electrons to acceptor molecules, which then become donor molecules for another acceptor and so on, each step draining a bit of charge away from the excited electron. All of this activity can be read directly by

measuring the spectrum of the light absorbed or emitted in these transactions. That is chemistry.

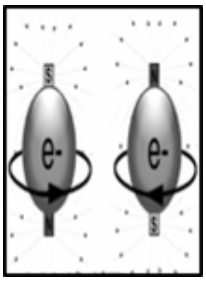
The smallest of all the atoms are Hydrogen and Helium. These have just one occupied orbit. The first or lowest orbit of all atoms can hold just two electrons, maximum. A Hydrogen atom has a single proton in its nucleus and one electron in its orbit. Its orbit is half empty or half full. A Helium atom has two protons and therefore two electrons (one pair) in its orbit. Its orbit is fully occupied. Hydrogen atoms readily give away an electron, thus becoming a hydrogen ion ($H^{+)}$ (a proton stripped of its electron leaves it with a positive charge). Hydrogen atoms can also gain a second electron to fill an orbit. This creates a negatively charged hydrogen ion (H^{-}). That is why hydrogen is such a versatile and active element. Hydrogen is the most abundant atom in the universe and arguably one of the most important elements in life. Helium with its fully occupied orbit is a "noble element" (like Neon and Xenon), is not driven to share its electrons and thus does not readily participate in chemical interactions.



For an electron to absorb a photon, the photon's energy (wavelength) must deliver just the right energy to force the electron out of its ground state orbit and into one of the empty and more highly charged orbits further out. Otherwise, the photon won't be absorbed and will pass unchanged through the atom or molecule. Absorption takes just 10^{-15} seconds. Most molecules are excitable by light of one wavelength or another but usually they convert this energy to heat and vibration. This happens in just 10^{-12} of a second, too quickly to be involved in electro-biological energy transmissions.

However, in some molecules (florescent molecules), the photo-excited electrons remain in the excited orbit for longer (10^{-8} seconds) before falling back to the lower ground orbital. As such an electron falls, it shoots out a photon of fluorescent light. Many of the most important molecules in life are florescent. And because some energy is used up in this process, the wavelength of a fluorescent photon is "red-shifted" to a less blue wavelength than the originally absorbed photon. This fluorescent photon can trigger further photochemical actions by being absorbed into another molecule to set off another chain of electron transfer events. Remember that we are actually talking about millions of molecules, millions of photons, and millions of electron transfer chains.

According to quantum theory, electrons are arranged in pairs. Most atoms have a maximum of just two (one pair) in their closest orbit and a maximum of eight electrons (four pairs) in the next orbit levels. Larger atoms have more electrons, more orbits, and can hold as many as 16 or 32 electrons in their outer orbits. Orbits are subdivided into sub-orbitals or shell layers with each housing a maximum of two electrons (one pair). Electrons can pair only if they have opposite "spins". Electrons with parallel spins are "forbidden" to hook up.



In certain molecules, some local circumstance causes the excited electron to flip its spin as it jumps to the higher orbit. Its spin, now parallel rather than opposite to the spin of its initial partner, prevents it from dropping back to pair with its former partner. Thus the charged electron is locked into an excited orbit in what's called a triplet state. Triplets last from a few milliseconds to several seconds—enough time to be passed along a string of donor to acceptor molecules, from protein to protein or enzyme, which ultimately triggers a targeted cellular response or until a thermic collision switches its spin back to its original direction, allowing it to fall back into its ground state orbit and to shoot out a red-shifted photon as it falls.

The emitted light from a triplet state is called *phosphorescence.* Triplets are considered to be the main instrument of energy transmission in biology. The more electrons there are in the triplet state, the greater the chances that some of them will drop back to the ground level, each emitting a phosphorescent photon as it drops. Thus, a flood of photons and an avalanche of electron transfer actions can occur and at the final step, emit a red or infrared photon. This light can then be absorbed by a crucial enzyme or co-factor. DNA and RNA emit very long phosphorescence. Triplet excitation is made possible and stable by the surrounding water structures (but that's a story too long to write about in this article).

Red and infrared triplet phosphorescence might explain how blue and ultraviolet light therapy applied over the skin surface can affect physiological systems at tissue depths much beyond the shallow penetration of blue light. Phosphorescent red and infrared photons released

in triplet reactions are able to penetrate much deeper into our tissues than blue and ultraviolet photons.

CELLS

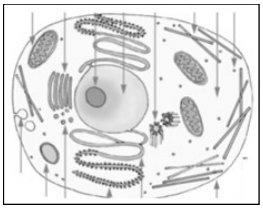
The average human body consists of a hundred trillion cells with an average size of a millionth of a meter. It is difficult to conceive a number that large and a volume that small. Within that tiny space, an enormous amount of activity occurs all the time at speeds and complexity we can barely imagine. The parts of the cell are in constant intracellular communication and cooperation between all of these cells runs so smoothly in every possible situation that we seldom have cause to reflect on what a tremendously sophisticated and redundant communication system is required.

> *An organism is a whirlwind of cells made up of whirlwinds of atoms*
>
> G. Albrecht-Buehler

Guenter Albrecht-Buehler said the following about the body's cells:

> Doctors don't heal patients. Only the cells of the patient that can heal the patient. Only cells know how to close wounds, understand what to do with insulin and how to destroy pathogens. The best a healer can do is to: remove obstacles (e.g. surgery); advise patients about diet and lifestyle; supplement with vital energy (e.g. oxygen, nutrition, light); and supply drugs (weapons) to aid the cells. But always, they must leave the fight against disease to the cells.

Living cells are not like tiny sausages filled with a watery solution of organic molecules, a nucleus and organelles (as in the familiar textbook rendition of the living cell).



There is almost nothing that's passive or random that happens inside the cell and organism. Cells are constantly adjusting to changes in the outside environment by turning on and off the right mechanisms, the right genes, creating new genes if required to resolve present needs and prepare for future needs. In fact, there is nothing like free diffusion possible in the living cell. It is jam-packed with molecules, membranes and organelles. Ultimately, syntonics and other low-intensity light therapies must influence molecular systems at the cellular level. If a cell is vital and working normally, light has little impact, but if a cell is under stress and out of balance, photons of the appropriate color can optimize a broad range of local and systemic systems.

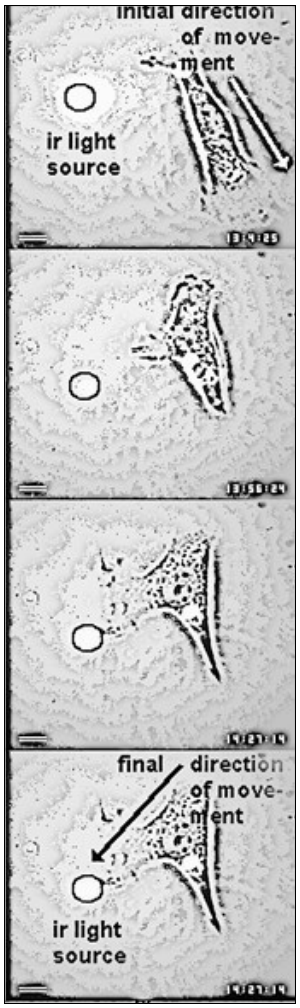
In the Mind of the Cell

Exactly 100 years ago, Nels Quevli wrote about the intelligence of cells:

> The cell is a conscious, intelligent being, and, by reason thereof, plans and builds plants and animals just as man constructs houses, railroads and other structures. Notice in this how precisely similar the actions of cells are to those of animals and human beings. They lie around and do nothing towards finding food as long as they have enough to eat, but lack of food and hunger stirs them to activity. … It never can be shown to be simply a chemical or mechanical act. There must be in the mind of the cell, a feeling or idea of a need of food to spur him to action. Matter can only act and change its place and form according to fixed chemical and natural laws without a sense of need or desire. Living beings act according to their wants and needs. They are masters and are able to direct the blind forces of nature and simple matter to their own purpose and use. It seems clear that the cells have invented, constructed and possess self-made devices with which they can gather and direct the heat or energy of the sun and thereby mold matter and direct the actions of the atoms of matter as they wish.

Seventy years later in 1985, these ideas were echoed by Albrecht-Buehler in an article titled *Is cytoplasm intelligent too?* Supporting the notion of cell intelligence, perhaps the most astonishing quality is the cell's ability to "see." Search online for this article to see a video showing a cell as it senses, locates, and moves while attempting to devour pulsating near-infrared lights placed near the cells. The figure to the right shows a series of still frames from the video. The natural emitters of such signals are not yet known, he says, but the vision of an organism requires sophisticated signal processing to detect objects. Additionally, to discriminate the intensity, color, location, and dynamics of the object is a sure sign of intelligence. The ability of mammalian cells to emit and detect signals may belong not so much to the realm of optics but to the realm of long-distance communication. In other words, he says, "…it appears that continued research along these lines may

demonstrate that mammalian cells exchange near infrared signals that influence their behavior." "The study of cellular "vision" may be the door to our next quantum leap in the development of medicine," he predicts. As mentioned above, all diseases are ultimately healed by cells. Doctors "merely" aid the cells of their patients to do their job. He goes on to state: "Just imagine the powerful medicine doctors might practice in the future if they can literally "tell" cells in their own language (light) what they want them to do! For example, cancer cells might be "told" to stop growing or at least may be "summoned" to a certain place on the skin to be easily removed. Cells at the wound of a lost limb or eye may be "told" to grow it again. They did it once. If we learn the right "commands, maybe we can persuade the cells to do it again. Obviously, we need to learn to speak the language of cells if we want to carry medicine to this advanced level. Initially, we would record the light signals of cells in different parts and stages of an embryo. Subsequently, we could reproduce these light signals using microchips and laser diodes, and "play" them back to the cells of an adult patient, to cause it to perform one of its embryonic functions. Later, we may learn to compose our own messages in the language of cells, in order to compel cells to carry out specialized tasks, which they have never performed, even in the embryo."



For more information on Albrecht-Buehler's ideas on cellular intelligence, refer to *Cell and Muscle Motility*. J. W. Shay, editor, Vol 6:1-21. You might also enjoy exploring Albrecht-Buehler's web site: http://www.basic.northwestern.edu/g-buehler/txtcont.htm.

Life is More of a Process Than a Thing

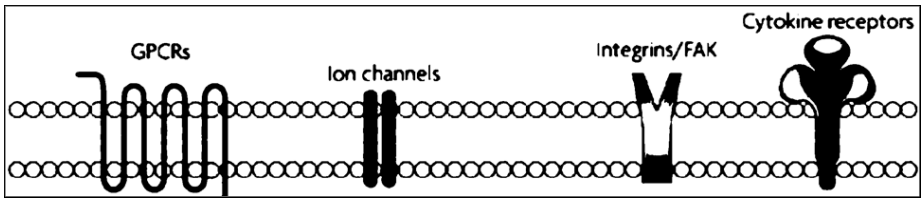
Addy Pross, a biochemical researcher, describes the whirlwinds of life:

> Living organisms are an ongoing extremely complex network of chemical and sub-molecular reactions compared to the world of non-living entities. Life is a self-sustaining, constantly changing, and dynamically responding network that is organized to effectively utilize its capabilities in realizing its potential and its purpose. That purpose is to self-replicate to sustain itself in an unstable and ever-changing environment. To make this possible, the system must be reactive and therefore is also unstable. To maintain itself, it needs constantly to seek and consume energy that is constantly supplied by the environment. Even the smallest structural change in its organized complexity can bring dramatic consequences. For example, a single change in the human DNA sequence, one of the three billion units, can potentially lead to thousands of genetic diseases.

The amazing feature of any living organism is its dynamic nature. Its parts are constantly changing. Each molecule in the body periodically is recycled and is replaced by a new molecule. A river can last for millennia, though it might flood or trickle through the seasons, but the molecules of the water that makes up the river are always new. Just so does a population of animals or a forest of trees live over thousands of years but the individual animals that make up the population, or the trees that make up the forest come and go, as do the cells that make the organism and the molecules that form the cells.

Cell Signaling

Cell signaling is part of a complex system of communications that govern and coordinate basic cellular activities in response to the ever-changing predictable and unpredictable conditions within and outside of the cell. Errors in cellular information processing are responsible for diseases such as cancer, autoimmunity, and diabetes. A thin membrane divides the cell's inside from its surroundings. However, this membrane is more than a barrier; it also functions as an information filter and signal amplifier. Cells sense that something is happening via specialized membrane receptors that attach to or are embedded in the membrane. The figure below illustrates four types of membrane receptor complexes that allow various types of signals from the outside to enter the cell. Additional types of receptor complexes exist as well.



A signaling cascade comprises a series of enzymes or proteins that pass an energized electron across a series of donors and acceptors in what's known as a redox reaction. Here a donor protein that is ready to donate its charged electron passes it to an electron-hungry acceptor protein. This protein now becomes a donator and so donates to another willing acceptor, an action that continues down the series until electrons are passed to oxygen, the final acceptor in the chain. This is an energetic and not a chemical process. In fact, this involves quantum events and follows quantum laws as well as classical laws of physics, too complex and difficult to describe in this short article.

Signaling molecules such as hormones, growth factors, neurotransmitters, and other stimuli such as drugs, light, and odorants, reach to the outside of the membrane and not directly into the cell interior. Cell membranes are not the smooth and shiny surfaces we imagine them to be. Instead, specialized receptor proteins coat the surface. Membrane proteins are workhorses of the cellular machinery. It is estimated that 50% of all our body's proteins are membrane proteins for our cells. Each cell differs as to which of the body's thousands of signals it will recognize, how and for how long the signal will last, and which of the cell's own internal machines it will start (or stop from) working. It's an extremely complex process redundant with multiple error- and danger-detecting fail-safe mechanisms.

Proteins

Picture a cell as a very tiny town, with active, ongoing systems that administrate, transport, generate energy, feed, recycle, communicate, construct, reconstruct, sense danger, etc. All these systems must work together to protect, prevent, and perfect the town's vitality and survival. In a society, all this is handled by humans. In cells, proteins do all the work. They are directly responsible for the cells' movement, shape, and function. Proteins form the enzymes that accelerate and control the various chemical reactions necessary for life. The cells in our bodies contain about one hundred thousand different proteins. Just as we humans use specialized tools to perform specific functions and work in teams with other humans to accomplish necessary tasks, proteins interact with other proteins by recognizing their co-workers, influencing their actions, and coupling with groups of different types of proteins that together organize and work to regulate cell processes—interdependent, intentional, and exquisitely choreographed. Within the crowded intracellular environment, individual proteins are constantly coming into physical contact with other proteins and biological macromolecules. There is huge diversity in the frequency, specificity, and duration of these interactions. Even the tiny expression of a simple energy signal, like a school bell or factory whistle, can start and stop an avalanche of activities. Thus a seemingly tiny signal is amplified to result in a huge end effect. Very small alterations in proteins significantly change their actions, and the process is reversible—proteins can be regulated in both directions—speeding up or slowing down and starting and stopping a reaction path.

Cell Functions and Behavior Patterns

Hormones work at concentrations as low as one thousand billionths of a gram per milliliter of blood. And yet hormones from far away organs travel long distances to produce vital and powerful actions. How does a tiny bit of hormone cause huge changes inside?

Hormones don't couple with their target's receptors on a 1:1 basis. The signal is like a catalyst that is not altered or used up in this effort and so remains active and able to attract another and another of the intracellular messaging machines. Thus the message delivered by a single hormone is amplified a million times until its job is finished. The same is true of other signaling molecules and biologically active energizers such as photons. This process is similar to the operation of brakes on a car, where a gentle touch of the brake pedal is amplified and can stop even the heaviest truck. *If such a tiny bit of hormone energy can cascade to such powerful effects, then so can photons of light.*

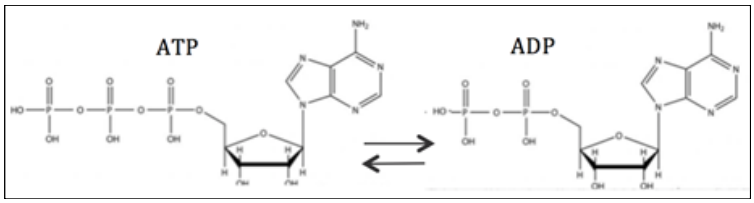
Most hormones can't initiate a cellular response until they are branded by a co-factor, enzyme, or coenzyme. Many of these remain dormant until energized by a photon. To add to this complexity, a cell might have several different receptor types that all recognize the same hormone but activate different signal pathways. Other cell membrane receptors can recognize a variety of different hormones that that all service the same function.

Nature's photoreceptors are typically composed of a chromophore (a light-sensitive molecule that is bonded to a receptor protein at the top of a signaling cascade). The light activation of enzymes is one of the fastest growing fields of photobiology. Enzymes are important because they are catalysts that cause inactive enzyme and protein molecules to wake up. One photon can activate one enzyme molecule, and this activated enzyme can in turn process many thousands or millions of substrate molecules, thus providing a huge amplification for initiating a biological response with light. This remarkable amplification factor may be the explanation for why low levels of light therapy are effective. If the effect of one photon can be amplified biologically, then one does not need a lot of photons to produce an effect. One just needs to find the proper wavelength of light to stimulate the proper enzyme, which in turn will stimulate the beneficial therapeutic effect.

Mitochondria and ATP

Mitochondria

In addition to the stew of proteins and signaling systems in the protoplasm of a cell are a nucleus and a variety of organelles. The nucleus contains the cellular DNA that directs the formation of proteins based not only on genetic information but also on adaptive signals related to cell survival needs (i.e., the cell learns from experience). Organelles are specialized intracellular structures that serve some of the same functions for the cell as our organs (liver, kidney, heart, etc.) serve for the whole organism. One of these organelles, the mitochondrion, is considered the most vital entity in our cells and body. This is because mitochondria control fundamental cellular processes such as metabolism, respiration, homeostasis, cell division, and apoptosis (cell suicide). Mitochondria in different cell types (e.g., liver versus adrenal cells) serve different functions. Depending on their need for energy, different cell types contain a greater or lesser number of mitochondria (e.g., lens versus cone cells in the eye). Mitochondrial dysfunction is now known to cause a diverse list of pathologies such as cancer, cardiovascular problems, neuro-degenerative diseases such as Alzheimer's and Parkinson's in the brain, and Age-Related Macular Degeneration (ARMD), glaucoma, and Retinitis Pigmentosa (RP) in the eye. The list continues to grow as new mitochondrial-caused pathologies are being identified all the time. The physical and functional losses related to normal aging might also be due to mitochondria dysfunction.



Mitochondria originally were single-celled organisms with DNA and nucleus that lived apart from, but in symbiotic relations with, other living cells. At some very ancient time they merged to live inside their neighboring single-cell organisms and these eventually evolved into higher life forms, including human beings. Mitochondria are passed to the next generation, not by means of sperm and egg, but maternally via the mitochondria of the female's egg cells. Mitochondria have their own DNA systems (mtDNA). One of the most important mitochondrial functions is the production of adenosine triphosphate (ATP), the universal energy transfer molecule.

ATP is produced in two very different ways. The first way is by the mitochondrial electron respiration chain. Here triplet electrons are transferred along a remarkable system of enzyme and protein complexes in a multi-step process that converts the energy of blood sugars and oxygen into ATP, water, and carbon dioxide. The "T" in ATP stands for "triple" because three phosphates are attached to the adenosine molecule (see three phosphates in the left side of the figure) as compared with ADP where "D" (double) indicates two phosphates. This process requires oxygen (i. e., it is aerobic).

The other way that ATP is produced is anaerobic—it doesn't require oxygen. This system employs a totally different mechanism called glycolysis. In glycolysis, sugar is broken down by a process of fermentation (as in beer, wine, and vinegar). Glycolysis serves a vital role as a backup to supplement ATP production when the supply of oxygen can't keep up with the demand for it. It supplies the needed ATP energy to muscles during periods of strenuous work and when escaping from danger. These actions relate to the sympathetic nervous system. Glycolysis is also triggered by an oxygen deficiency, hypoxia, resulting from insufficient blood flow following, for example, a stroke or head injury. Prolonged stress or illness can increase the fermentation ATP and this can lead to an acidic or toxic environment that contributes to chronic distress and disease. Lactic acid is a byproduct of glycolysis and when lactic acid builds up in the cells, muscular pain and cramping result. Cancer cells proliferating faster than the blood supply often exhibit a glycolytic cycle up to 200 times higher than the rate of normal cells. A similar disturbance in glucose metabolism is

seen in Alzheimer's disease. New categories of mitochondria-related drugs are being developed to reverse underperforming mitochondria.

It is well established that low-intensity red light and infrared light increase the rate of ATP synthesis in underperforming mitochondria. Thus, light can revitalize overstressed, starved, thirsty, oxygen-deprived, impotent, or toxic mitochondria, unless the mitochondria are too damaged and beyond help. The research shows that light is absorbed by a mitochondrial enzyme called *cytochrome c oxidase* (COX). COX enzymes play a critical role in the final stage of aerobic ATP production. But COX needs the energy of a photon to be able to function. Dysfunctioning mitochondria can be resuscitated by light and light exposure can prevent or reverse mitochondrial diseases. This is the basis of the success of low-intensity light treatment of difficult-to-heal wounds, soft tissue injuries, arthritis, skin traumas, toxicity, inflammation, and hypoxia.

In addition to the red and infrared influence on the COX enzyme at the final stage of mitochondrial ATP production, blue light can also increase ATP production. In this case blue light is absorbed by a flavin molecule (flavin means blue light-absorbing) at an early stage of mitochondrial respiration process. Thus, contrary to expectations, both blue and red light stimulation can increase mitochondrial ATP production.

ATP

The ATP molecules produced in the mitochondria quickly swarm into the rest of the mitochondria and out into the cellular protoplasm, cell membrane, and outside the cell to find specific targets to phosphorylate. Phosphorylation is when ATP's highly charged third phosphate is attached to a targeted protein. The ATP engages at one or multiple key places on the protein to supply the energy (in the form of a highly energized phosphate) that is needed to perform actions such as moving proteins from one place to another or causing the folding, unfolding or refolding of proteins. The ATP, now stripped of a phosphate, is thus converted back to ADP. The newly produced ADP must then quickly change itself back into a mitochondrion to be recycled to ATP.

The average cell contains about one billion ATP molecules. Human bodies contain about a sextillion (10^{23}) of them. The combined weight of ATP and ADP is about ⅛ pound. Each of the cell's billion ATP molecules recycles 3 times per minute. When working hard, a single muscle cell can consume and regenerate over 10,000,000 ATPs per second. The total mitochondria in the average human body reconvert 3 X 10^{23} ADP molecules into ATP each minute of the day and night. We convert the equivalent of our body weight of ATP each day. If ATP couldn't be cycled, we would have to consume nearly our body weight in ATP daily.

Cellular Mechanisms of Low-Level Light Therapy

In the late 1970s, Tina Karu, a biophysicist in Moscow, began researching to discover the cellular mechanisms related to low-level light therapy (LLLT). This section describes some of her discoveries and conclusions. In a chapter entitled "Mechanisms of Light Therapy on Cellular Level," (2000), and "Absorption of Monochromatic and Narrow Band Radiation in the Visible and Near IR by Both Mitochondrial and Non-Mitochondrial Photoacceptors Results In Photobiomodulation," (2014), she described several aspects of how light works. Her findings and conclusions support syntonic practices and provide hints that may answer questions about how filters that seem very similar can produce different effects, how different filter combinations from different parts of the spectrum produce similar results, why the same filter can improve many different functions, why syntonics doesn't always work, how light in the eyes can affect tissues and systems far from the eye, how light knows just where to go, and whether light always has immediate effects or whether the effects can be delayed by hours or days following a treatment.

The following paragraphs summarize some of her findings regarding these issues:

- *How does syntonics modify systems located far from the eyes?* Light excites actions that signal metabolic actions in cells that occur later in the dark. Photons excite light-absorbing molecules on the cell membrane's outer surface (the primary photoreaction). This sets off a chain of physical and chemical actions inside the cell that can occur in the dark (secondary photoreaction). The signals travel via cascades of biochemical redox reactions that amplify the initial signal and target specific molecular complexes that influence cellular homeostasis parameters.
- *Must therapeutic light sources be coherent or can the incoherent light used in syntonizers also work?* Conventional light sources (incandescent) at the right

wavelengths are just as effective as monochromatic, coherent (laser) sources.

- *Why does syntonics sometimes bring such great healing and other times little or negligible impact?* Light doesn't improve cell functions that are already working well. The impact of light on a cell depends on its redox state, whether it is in a normal pH range or more acidic than normal. If the pH is normal, the cell is already vital and light has little or no effect. If the pH is lower (acidosis and hypoxia), light stimulation can normalize the pH and vitality.
- *How can one filter combination produce so many diverse healing effects?* A single wavelength of light can improve multiple types of local and systemic functions. If the mitochondria are not recycling enough ADP to ATP, photons at appropriate wavelengths cause ATP production to increase. This can lead to various reactions in different types of cells that result in a diverse range of healing effects (e.g., wound healing, chronic inflammation, ischemia).
- *Can light therapy really help to balance the autonomic nervous system?* Cells communicate and coordinate with other cells throughout the body. Light's impact on one type of cell will influence the metabolism of other types of cells. Various types of cells (e.g. liver, muscle, hypothalamus, etc.) respond to photo-induced modulations of cellular pH in a variety of different ways.
- *Shouldn't light from the red and blue ends of the visible spectrum produce opposite effects?* Mitochondria are photosensitive. This is the major impact of light on cells. Mitochondrial respiration (the conversion of sugars and oxygen to recycle ADP to ATP and water) requires the energy of light to function. Cytochromes and flavoproteins are the key enzymes of the mitochondrial respiration chain that leads to ATP. Cytochromes are orange-red-, red-, and infrared-sensitive and flavoproteins are blue-sensitive.
- *Can light from syntonic filters that only slightly change the spectrum (like by adding D or S or changing mu/delta to mu/theta) really make a difference?* Studies that measured the absorption spectrum of light that improved important mitochondrial processes found that they were driven not just by one specific wavelength of light, but were improved by wavelengths from across the spectrum. They also found that other nearby wavelengths improved other metabolic-related mitochondrial functions such as ATP production, oxygen consumption, membrane potential, and refractive index. For example, Tiina Karu's findings showed that:
  - ATP production was increased by low levels of violet at 415 nm, orange at 602 nm, orange-red at 632 nm, red at 650 nm and long-red at 725 nm. However, blue at 477 nm and green at 554 nm had no effect.[9]
  - Oxygen consumption increased using ultraviolet at 365 nm and violet at 436 nm, but not at ultraviolet at 313 nm, green at 546 nm and yellow at 577 nm. Mitochondrial membrane potential, refractive index, RNA and protein synthesis were affected by red-orange at 633 nm (alpha-delta).[9]
- *Does the time of day or the season during which we are doing syntonics really matter?* The response to light depends on the current conditions at the time of irradiation. Thus, light treatments during the spring or summer season when cells are growing at their maximal rate may bring little or no results, whereas in the autumn and winter when the cells are the most dormant, light therapy increases cell vitality. This may explain why delaying a second series of treatment by a couple of months (to another season) can improve the results. The same principle can apply to circadian patterns that change throughout the day.
- *Why doesn't increasing the dose of syntonics bring increased improvement?* The speed of cell healing has a natural limit so that increasing the light intensity or length of treatment does not necessarily improve the outcome, even when using the appropriate wavelength of light. This limit of change might be why we must sometimes wait for days or weeks to see maximum results.
- *Why isn't there more definitive research that proves that light therapy really works?* Doing dependable light therapy research is very complex because there are so many factors at play. Because the results depend not only on the patient population (e.g. the age, gender, medical history, test findings, diagnosis and etiology of the patient and control populations), but the light parameters (e.g. wavelength, intensity, length, frequency, pulse rate, number of treatments, time of day, time of year, etc.) must be tightly controlled and optimized. Additionally, the results don't always appear immediately, but might manifest hours or even days after treatment. With this many factors to consider, light therapy results can be negative. Light therapy critics can always use one failed result to debunk dozens of positive outcomes, and research methods can be disparaged.

Foundations and the Future

This article was originally conceived as a review and tribute to the work of Nobel Prize winner, Albert Szent-Györgyi, whom I greatly admire. Just after Spitler's book was published in 1941, Szent-Györgyi began to publish his new ideas on the life sciences. He felt that life scientists had reached a dead end because their investigations stopped at the level of chemistry and did not embrace the sub-molecular and quantum energetics of matter and life.

Szent-Györgyi wrote simply and elegantly about photons, electrons, and hydrogen atoms, triplets, photochemistry, electron transfer chains, liquid ice versus bulk water, proteins, free radicals, the similarity between photosynthesis (sunlight produces sugars in plants) and photobiology (light's effects on animal respiration). He demonstrated his theories by showing rapid color changes in the fluorescent and phosphorescent light emitted as he mixed well-known biological molecules such as riboflavin (vitamin B_1), serotonin, and LSD (yes, LSD). He plunged these mixtures into liquid nitrogen to create long-lasting triplet electron states and showed how the color changes caused by adding just a tiny amount of oxygen, thyroxin or adrenalin did not require one-to-one molecular contacts, as would be predicted by chemical concepts, but that the color changes operated throughout the mixture, energetically or electromagnetically like electric waves or how a magnet gives shape to a loose pile of iron filings, all at once.

In this article, I've attempted to summarize some of the more recent research results connecting light, syntonic light therapy, and sub-molecular and quantum energetics. Szent-Györgyi's work, however, remains a vital foundation for the subsequent work in this field. I hope that we can continue in his tradition of visionary thinking and research to advance our understanding of the profound effects of light on living beings.

. . . the chief property of muscle is that we do not understand it. The more we know about it, the less we understand and it looks as if we would soon know everything and understand nothing. The situation is similar in most other biological processes and pathological conditions, such as the degenerative diseases. This suggests that some very basic information is missing.

Albert Szent-Györgyi, 1937[11]

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[2] Albrecht-Buehler, G., 1913, *Cell Intelligence and the Future of Medicine,* http://www.basic.northwestern.edu/g-buehler/vision.htm#.
[3] Quevli, N., 1916, "*Cell intelligence: The cause of growth, heredity and instinctive actions, illustrating that the cell is a conscious, intelligent being, and, by reason thereof, plans and builds all plants and animals in the same manner that man constructs houses, railroads and other structures*." The Colwell Press, Minneapolis, MN. (Search online for free download of the entire book.)
[4] Albrecht-Buehler, G. 1985. Is cytoplasm intelligent too? *Cell and Muscle Motility* . Jerry W. Shay, ed. V. 6 :1-21.
[5] Albrecht-Buehler, G., 1991, Surface Extensions of 3T3 Cells towards Distant Infrared Light Sources. *The Journal of Cell Biology*, Volume 114, (3), 1493-502.
[6] Albrecht-Buehler, G., 1991, Surface Extensions of 3T3 Cells towards Distant Infrared Light Sources. *The Journal of Cell Biology*, Volume 114, (3), 1493-502.
[7] Pross, A., 2008, How can a chemical system act purposefully? Bridging between life and non-life, *J. Phys. Org. Chem*., 21, p. 724–730. S*ee also* Twardowski, M., 2013, The Phenomenon of Life in the Eyes of a Chemist: Addy Pross, *Chemik*, 67, 12, p. 1163–1172.
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[9] Karu, T., 2000, Mechanisms of low-power laser light action on cellular level, *Lasers in Medicine and Dentistry,* Ed. Z. Zimunovic, Rijeka, Vitgraph, p. 97-125.
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About the Author:

A UCBSO grad, he wrote "The Psychoneurology of Nearsightedness" (PhD thesis) and Attention & Memory Training (OEP 2005) & co-produced The Road Without Glasses Method DVD (Cambridge Institute for Better Vision) for presbyopia reduction.

Lighting Up Lives, 2016

Denise Hadden, Optometrist, B.Sc. Hons, FBOA, FSMC, FOA [SA], FCSO

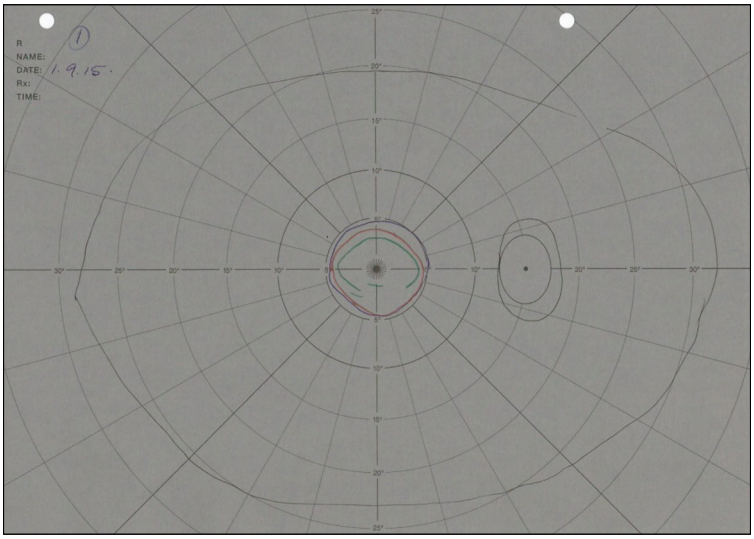
Light Informs Us All

I had a call from a patient who had been diagnosed with cancer about 6 months prior. She had a choice to make – have the chemotherapy or use holistic therapies to treat the cancer.

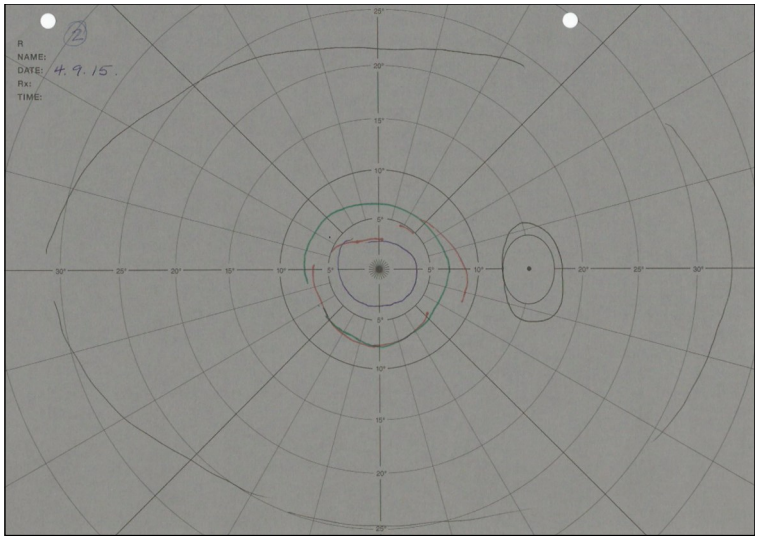
I asked her what she felt she most needed in her search for better health. Her reply was information...the kind of information that would enable her to choose which treatment was going to be the very best for her.

What fields and light do is give your system information – mentally, emotionally, physically and spiritually. What patients do with this information is never quite what we imagine…

Her fields were tiny. I have never seen an adult's fields as small as hers were and I wondered why she had not already given up her search for a cure. So I gave her the information that her fields revealed. I said that one part of her wanted to live, but another part of her felt that the struggle to live was more than she could deal with. She nodded in agreement. I said that if she did some light, the way that her fields changed would indicate the best decision for her to take. She decided to do a light treatment



First Fields—January 9, 2015.
Right shown above. Left shown below.



Second Fields—April 9, 2015.
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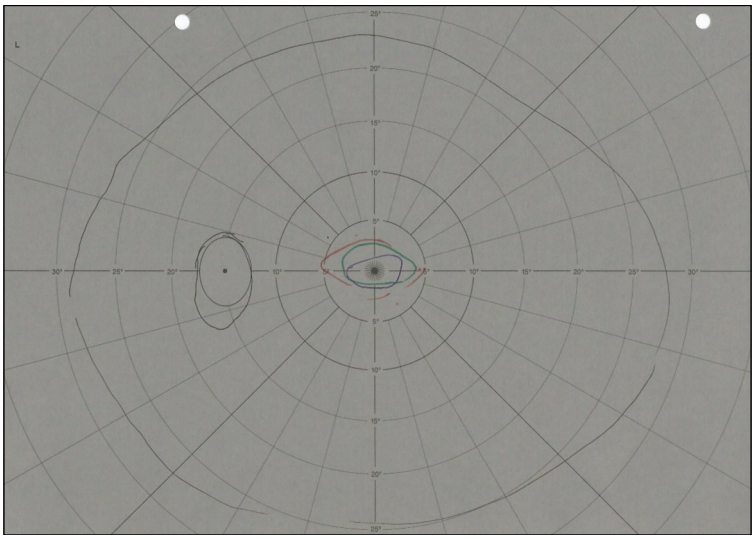
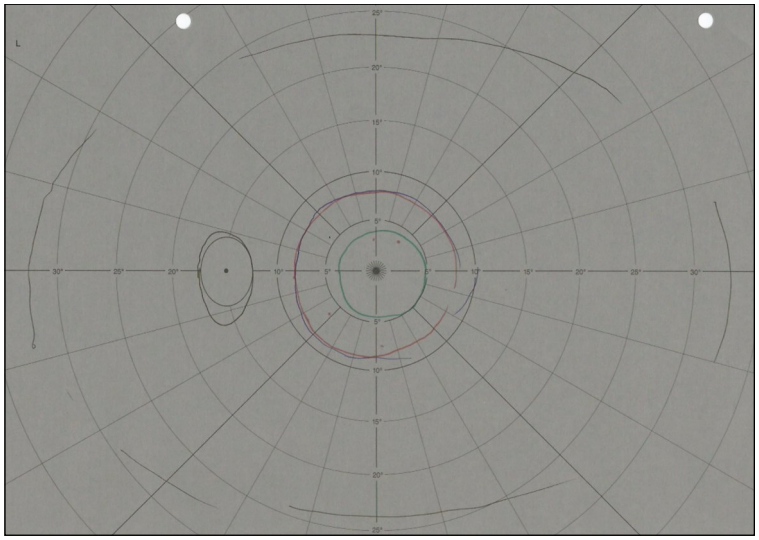




and I gave her a one-week program to follow, with a promise that she would let me know at any point if she wanted to stop the treatment.

Her first fields revealed to me that in her external life, she wanted to live, but her internal sense of self, felt too diminished to carry on living. After three days of syntonics at twice daily, she asked me to come and do another field. At this consultation, she said that she had quite suddenly and with great clarity, decided to go with the holistic treatment. I did not discuss her decision, or the indicators in her second field with her.

As I was about to leave, she turned to me, gave me a hug and said 'You were like an angel that just popped out of heaven at exactly the right moment - thank you.'

What her second fields showed, was that she had swopped - now - she was internally more desirous to live, but externally she had no desire to live. We had not discussed any of her personal history at all, nor her life and the provocations for this illness. But I knew, that this lady had seen the truth with the light, and had accepted that what was happening in her private life, she could neither change, nor cope with, nor fight in order to remain alive. She had in fact chosen to refuse treatment of any sort, but could not reveal this to me at the time. Her final message to me was her way of saying that the information that the light gave her, allowed her to gracefully accept her impending death. She passed away peacefully some 2-3 weeks later.

We are able to die in peace when we have an understanding of how we reached that point. When we are fortunate enough to have some early warning on our demise, we are afforded the gift of being able to forgive, release and let go. All our searching for healing has less to do with living and more to do with the information and resolution we require in order to die.

Polishing up ourselves...

I felt a sense of poignancy after the story above, of the need to remember that we could all do with a bit of light information...

2015 was a strange year for me - Into the light, out of the light –into the darkness or perhaps the shadows and cycling round in a never-ending circle.

Has life been different for you too? And has it been different for your patients?

Are you also searching for information? Do you feel that the way you are using light now must change? And have you tried to light up your own life recently?

How do we – as practitioners, therapists keep the light shining in our own lives? And – do you think it matters? Do you think that anyone notices what your 'glow' is like or how widely aware you are?

Lighting up our own lives, polishing up ourselves, is what this new year requires. In so doing – the light will present us with the information we require and we will discover new ways of approaching light, our patients and our lives.

For seminars and training in this method email light@denisehadden.com

About the Author:

Denise Hadden is an optometrist, light therapist, visual coach and author of 'New Light on Fields' and 'Coaching the Invisible Fields'.

She obtained her degree in Manchester, UK and has continued her studies throughout her career in behavioral and syntonic optometry, traditional Chinese medicine and coaching.

This culminated in the development of a unique method of analyzing human potential by combining information from functional visual fields, iridology and coaching.

Denise received the H.R. Spitler award in 2014 for her discoveries into the application of her research on Syntonic Phototherapy.

She now presents workshops on her developing work on light and visual awareness.

For information on workshops or presentations, please email light@denisehadden.com

(Editor's note: This article was first published in the Vol. 18, No. 5 Sept. – October 1955, Syntonogram. Photos were not in the original article.)

WHY SYNTONICS WORKS

By
Dr. J.O. Jenkins O.D.

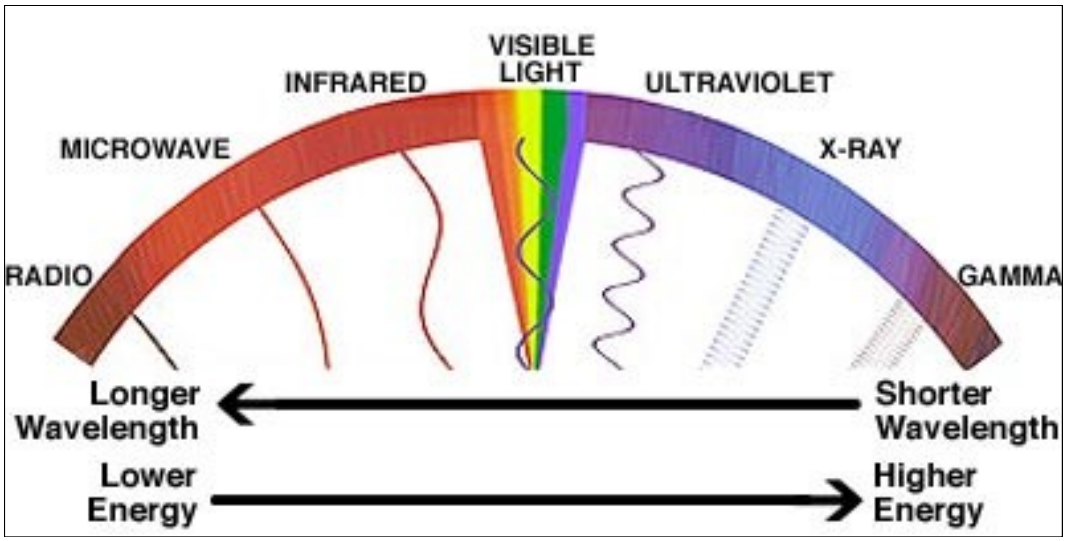
First I would like to lay a foundation for the following paper on the effects of light rays or the rays we know particularly pertaining to Syntonics. But first, we will have to lay a foundation on which to build. First of all what is electricity? No one knows exactly although it has been defined indefinitely as a concentrated stream of free electrons in motion. Electricity is energy in motion. We might also say that there is only one electricity no matter how produced. It is all one and the same identical force: Electricity. We might also say that electricity is the same except for wave length frequencies; when we speak of frequencies, we also think of vibrations.

All substance is subject to vibrations. Even our bodies are subject to vibrations. To demonstrate, if sound was the same wave length or frequencies as electricity, we might be able to light a bulb with it, but electricity is the same idea as sound. It travels in various wave lengths. It also responds and regardless of what it is, we say it is one and the same thing. The only difference is of the wave length or frequencies. We have the direct current wave length. We have the alternating current. We might split those down into galvanic and diathermy of various frequencies, and yet they respond differently. We respond differently to those frequencies as they are supplied to our bodies and our body tissues.

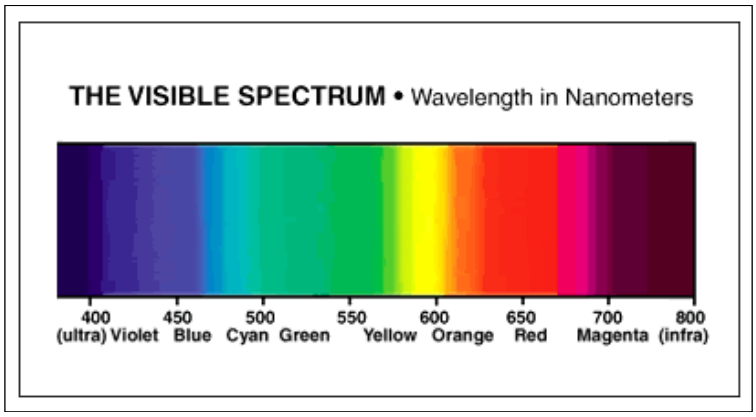
X-ray and white light are the same except for wave lengths. To demonstrate what we mean by that, if we take the Ultra-Violet ray, we find close to the visual spectrum a band of Ultra-Violet very germicidal. At the same time we find over in the visible spectrum rays also germicidal. The difference is that the Ultra-Violet is more dangerous to handle and may burn us and cause quite a lot of damage where the visible rays are not so dangerous. They might have a very definite effect on bacteria at the same time would not affect our system. To show the response, we might have two rods, one small one and one large one. If they vibrate at the same frequency, one can be some distance from the other. The other one will vibrate along with it. That shows you the harmony we have the same in light waves. We have the same in sound. We have an octave in sound and yet we do not think anything about it, so we also have an octave or wave in light. Light waves respond the same way as electricity.

We can turn light rays into electricity and we can make electricity into light. Our nervous systems, we know, responds to either electricity or light. We cannot live without light. We must have light, which is the source of life. For that reason we say that we can gain effects from various sources. Anything that vibrates will cause an effect upon the body. Color is light. Even paint on a wall will affect some nervous systems more than others.

I would like to raise the question. Why do some Doctors believe in Ultra-Violet Ray and Infra-red Rays and yet they will not believe in a visible spectrum as a source of energy and power? We can think of electricity as invisible rays of light. We know they may produce vibrations or frequencies. We know the vibrations of red is



about 400,000,000 vibrations a second. If we go to the visible spectrum we find the visible spectrum to be 3900 to 7700 angstrom units. So we have quite a variation in frequencies. If we take the Infra-Red rays, the vibrations are about 400,000,000. We can also measure the wave length in inches. The red would be about .0000174 of an inch. Below the red come the Infra-Red and invisible heat rays. Above the blue comes the Ultra-Violet and chemical rays. We know so many things about electricity and light and sound and yet we do not connect them.



There are so many sources that we should be digging into to find out responses and the effect of electricity as well as light rays. I sometimes think that even sound should be considered in experiments with men. We know that they have a dog whistle that a human ear cannot hear, and yet the dog responds. We know also through experimental work in laboratories that they have been able to create high pitch sound that do not affect the human being. Man cannot hear them yet they have been able to destroy animals with sound. So again, we are thinking today in visible spectrum of the variations here from the red up to the blues and the violets, and we must begin to realize the importance of those rays of light. We may find the various frequencies of the visible spectrum will affect the growth of plant life, either retarding it or giving it greater growth than the regular sunlight.

We must again realize the importance and power of what we call today the Syntonic work. The work that I have conducted is not complete by any means. But the following are some of the facts that I found but first I will relate how we conducted this experiment.

We took a front surface mirror. Put it on a 5 degree angle to pick up the rays of light from the Syntonic instrument and reflected them down upon a hanging drop slide. In the base of that was a dark box, or a box that was open at both ends. We conducted this experiment by taking two hanging drop slides and putting a drop a agar on each of hose and counting the bacterial colonies in each. One was marked control slide, the other work slide, They were put in the instrument over night. The work slide was put upon the platform of a little box and the control slide was placed inside so the light would not hit it. The next morning, they were taken out after being rayed all night. The bacterial colonies were counted again. We found the following results for these various filters. Now I will give you the number of the filter and control that we found.

First using the Alpha filter on the control slide, we had a total of 455 bacterial colonies. An average over ten periods of 45.5 colonies and the work slide had a total of 355 with an average of 35.5. On the control slide in the morning after laying over night, the total of 506, an average of 50.6. The work slide we had a total after being rayed over night 561 or an average of 56.1. In other words, we had a 58% increase in growth of bacterial colonies over night. Now on the Mu filter, we had on the control slide the night before 297 total. That is an average of 29.7.

In the morning, we had a total of 332 or an increase of 18 ½ %. And in the work slide, we had a total of 261 at night and after being rayed over night we had a total of 192, a decrease of 26.4, a total decrease of 44.9%. For the Upsilon filter, we had a total of 229 for the control slide for the night before and in the morning we had a total of 308. We had a slight increase there. The work slide the night before we had a total of 354 and in the morning we had a total of 284 which was a decrease there an average of about 55% decrease in the Upsilon filter.

So to be able to carry on this work sometime I hope to be able to take specific bacteria and a new control set-up so I can view the effects upon bacteria while it is still in the slide on the stage of the microscope. I would like to see some others become interested in this and do something along the same line using a high powered light and larger filters and ray these bacteria. While they are doing it see the increase or decrease right before their own eyes. I would like to hear considerable discussion on the effect upon bacteria.

Awards and Accomplishments

Fellowships awarded in 2015 at the Awards Banquet were:

Fernanda Leite Ribeiro, FCSO
from Brazil

Geoff Heddle, O.D., FCSO
from the USA

Pilar Vergara-Gimenez, O.D., FCOVD, FCSO
from Spain

Ana Vargas, O.D., FCOVD, FSCO
from Spain

Larry Wallace and Fernanda Leite Ribeiro, FCSO at the 2015 Awards Banquet in Santa Fe, New Mexico.

H. R. Spitler Award

To Honor:

John Pulaski, O.D., FCSO

For Deepening and Expanding Knowledge Regarding the Human Pupil and Advancing the Clinical Measurement of the Alpha-Omega Pupil for the Application of Syntonic Phototherapy and in Appreciation for Decades of Service to CSO.

Santa Fe, NM, Octoer 31, 2015

College of Syntonic Optometry

Charles C. Butts Award

For Distinguished Service
Gratefully Presented To:

Cathy Stern, O.D., FCSO

In Recognition for Decades of Dedicated Service & Creative Energy Devoted to Teaching, Writing and Advancing The Success of Syntonic Phototherapy and CSO.

Santa Fe, NM, October 31, 2015

The Stanley H. Levine Scholarship

was presented to:

Jonathan Q. Hall, O.D.

on October 31, 2015
in Santa Fe, New Mexico
at the 83rd International Conference
on Light and Vision.

The scholarship was established in 2013 in honor of Stanley H. Levine whose mission was to promote and increase membership in Syntonics. The scholarship's purpose is to increase the knowledge of Syntonics among new graduating optometric students and to provide some financial support for their syntonic training.

Dear College of Syntonic Optometry,

It is a privilege to be selected as the inaugural recipient of the Dr. Stanley H. Levine Scholarship. I was first introduced to the concept of Syntonics at an International Congress of Behavioral Optometry Conference in Ontario, California. I learned more about it while attending Western University of Health Sciences College of Optometry. I was able to gain more exposure through my fourth year rotations at Daniel and Davis Optometry in Carlsbad, California and Mind Eye Connection in Northbrook, Illinois. Seeing firsthand how Syntonics can impact a patient, I wanted to learn more about Syntonics.

Jonathan Hall with his parents.
Santa Fe, NM, October 31, 2015.

Thanks to the Dr. Stanley H. Levine Scholarship I was able to begin my journey into Syntonics via the Syntonics 101 course which provided foundational and applicable knowledge that could be implemented immediately in clinic. I was welcomed with open arms by the faculty, fellow members, and Irene Wahlmeier who has been wonderful in correspondence. I truly feel I have joined a family and cannot wait to grow in this field under the guidance of my predecessors.

I understand that Dr. Levine was an inspirational member of this great organization and was a man of action. I hope to live up and contribute to his legacy. I believe Syntonics has a place in our optometric practice and there are many out there desperately looking for answers- Syntonics should be considered. I look forward to meeting you all at future meetings and learning more about Syntonics.

Sincerely,

Jonathan Q.
Hall, Jr., O.D.

About The Cover

Bonita Tabakin

An innovative Fine Artist creating Oil and water color canvasses as well as intricate wood carvings, Bonita Tabakin honors the earth, trees and women through her work. For eons, earth, trees, and women have provided breath for life, health, shelter, solace, and escape. Women foraged, raised children, and grew crops. They banded together forming tribes, and these tribes transformed into civilizations. Hence she celebrates women and nature at the core of our very existence.

The media she uses reinforce her message. For instance, she deliberately repurposes wood to create artwork that demonstrates the interconnectivity of our world. Similarly, she colors handmade fibers, one strand at a time, and adheres the strands to wood or canvas, creating one-of-a-kind mixed media originals. The result is art that challenges the viewer to explore his relationship with the earth.

Her current work "Past and Present," "Wisdom with Joy," "Cosmos: Into the Woods," and "Fresh Air," are narratives of the imagination, vibrating with color that carries the spectator deep into his personal thoughts. Like most of her artwork, these new pieces lighten the emotions while encouraging the viewer to create stories from the vision before him.

Throughout her career, her art has consistently captured a deeper spirituality and healing as she has experimented with various media. Her artistic evolution is obvious on her web page, www.Bonitasart.com.

Color plays a huge role in her artwork as well, as she sees it as curative. Her work utilizing color to generate health, "Color for Health,"™ is on display in many corporate locations throughout the world, has been featured in numerous publications, and has been shown in more than 1,300 galleries throughout the world.

Ms. Tabakin was juried to study with two world masters: Pablo Picasso and L. Colbert Dubois. During 2015 she participated in juried shows in Scotland, Rome, Florence, Berlin and Morocco. She has just been invited to participate in a show in Venice, Italy later in 2016.

"Cosmos: Into the Woods" by Bonita Tabakin.

A lifelong resident of the Washington, DC area, Ms Tabakin is a member of Synonics. This Creation Dedicated to all Syntonic Optometrists and our publisher.

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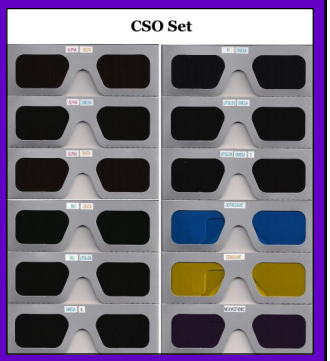

- Alpha-Delta
- Alpha-Omega
- Alpha-Theta
- D - Depressant
- Delta-N
- Delta-Omega
- Mu
- Mu-Delta
- Mu-Theta
- Mu-Upsilon
- N - Neurasthenic
- Omega
- Omega-N
- Pi
- Pi-Omega
- S - Stimulant
- Upsilon-Omega
- Upsilon-Omega-D
- Upsilon-Omega-N
- And Others….

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- White or Polished Steel Corded Lamp
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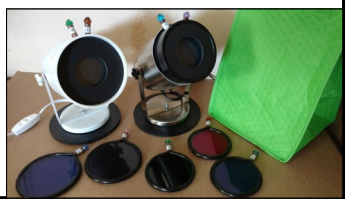

Polished Steel (Model B)

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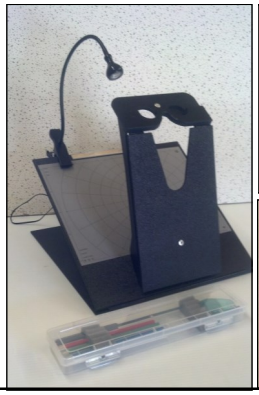

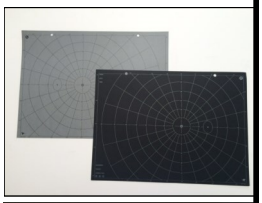

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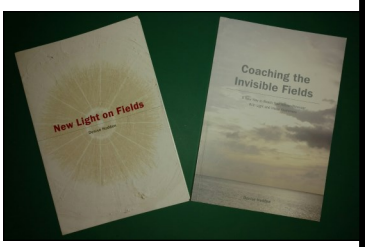
Books by Denise Hadden, Optometrist, B.Sc. Hons, FBOA, FSMC, FOA [SA], FCSO

New Light on Fields New Light on Fields describes a unique diagnostic tool that allows a deeply healing interpretation of the informational fields that surround us. It may be used to advance knowledge on the effects of light and energetics on humans. Using a new method of iridology analysis and combined with somatic and systemic coaching tools, it allows an empowered and extraordinary level of healing to occur. Visual fields of awareness are the key to understanding human potential. In revealing these neurological mind maps to clients, in presenting and exploring a new way of seeing themselves, co-created with light, it became apparent that people's greatest need is to feel empowered and in charge in their life journeys. Includes a clear iridology chart overlay. Full colour softbound. 112 pgs.



Coaching the Invisible Fields: A New Way to Reach Your Hidden Potential with Light and Visual Awareness Coaching the Invisible Fields uses visual awareness and coaching methods to map out a conscious, guided journey to the realization of your unique and greatest potential. It describes the informational fields that surround us and utilizes a visionary method of field analysis, described in the author's first book, New Light on Fields, combining it with coaching processes that allow clinicians an expanded view of their clients and clients an awe-inspiring journey towards health and happiness. Combining light with coaching magnifies and exponentially increases our capacity to reach, retrace and restructure old patterns into a 'spontaneous of our desire'. This groundbreaking book looks at the extended event field of life, and incorporates consciousness, possibility and potential into a pathway towards an empowered and joyful life journey.

College of Syntonic Optometry

A NONPROFIT CORPORATION DEDICATED TO RESEARCH IN PHOTORETINOLOGY,
THE THERAPEUTIC APPLICATION OF LIGHT TO THE VISUAL SYSTEM

College of Syntonic Optometry

84th International Conference on Light & Vision

June 7-11, 2016

Sheraton Indianapolis City Centre Hotel

Indianapolis, Indiana, USA

Contact:
Ron Wahlmeier
Email: syntonics@q.com

Optometric Syntonic Phototherapy 101

June 7-8, 2016 *Indianapolis, Indiana, USA*

Course taught by the CSO Faculty.

A 2-day course that will provide you with practical education and theoretical knowledge including understanding the history and basic concepts of Optometric Syntonic Phototherapy, pupil assessment, convergence near point, functional visual field assessment and case syndromes with practicum with CSO faculty. You will leave with confidence and competence and the ability to immediately add Optometric Syntonic Phototherapy into your everyday practice**.**

Optometric Syntonic Phototherapy 102

June 9, 2016 *Indianapolis, Indiana, USA*

Course taught by Larry Wallace, O.D., Ph.D., FCSO and Ray Gottlieb, O.D., Ph.D., FCSO.

The Syntonic Phototherapy 102 Course is an advanced course to expand the knowledge gained from the Basic 101. The latest scientific research will be presented. The course will be reviewing all the filters used in Syntonics, including the advanced filters. Case examples will be presented to illustrate these advanced filter combinations. Theoretical and practical information will include morphological or biotyping for prescribing, analysis of color fields, endocrinology and advanced concepts in understanding of the autonomic nervous system in treating with syntonics. Advanced applications will be presented:

- Heart Rate Variability and Color
- Postural Restoration
- Treating Brain Injury and Clearing Trauma
- RAPDx: Rapid Pupil Diagnostics
- Bio-photons and Water
- Aging and Syntonics
- Ocular pathology

These applications will teach practical methods of treatment, and better inform their patients of therapy options.