UNIVERSITY OF LATVIA
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EFFECT OF SYNTONICS ON MYOPIA

MASTER THESIS

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ABSTRACT

Thesis is written in English on 56 pages. It contains 17 figures, 22 tables and 54 references

AIM: evaluate the efficacy of treatment with syntonic phototherapy on young subjects with mild myopia within 3 diopters or uncorrected initial myopia

METHOD: 10 subjects, myopics, aged between 8 and 17, uncorrected or corrected with glasses. Verification tests were VA, myopia degree, accommodative amplitude, pupil αω and functional visual field. After an initial control participants were subjected to 15 treatments

RESULTS: the accommodative amplitude of the subjects statistically significantly improved after treatment; as well as, VA, pupil αω and functional visual field. There was also a total regression of myopia in 3 subjects with initial myopia and a marked improvement in the fourth subject

CONCLUSION: The statistical significance of the obtained results suggests that Syntonic can be a good therapy for young people with mild or initial myopia

Keywords: syntonic, phototherapy, myopia, filters, functional visual field, pupillary response

ANOTĀCIJA

Maģistar darbs ir uzrakstīts angļu valodā uz 56 lpp. Tas satur 14 attēlus, 22 tabulas un 54 literatūras atsauces.

MĒRĶIS: noteikt sintonikas fototerapijas efektivitāti jauniešiem ar vidējās pakāpes miopiju līdz 3,0D vai nekoriģēto sākotnējo miopiju.

METODE: 10 miopi vecumā no 8 līdz 17 gadi. Tika izmantotāss redzes asuma, miopijas pakāpes, akomodācijas amplitūdas, acs zīlītes αω reakcijas un redzes lauka noteikšanas testi. Pēc sākotnējās pārbaudēs dalībnieki tika pakļauti 15 sintonikas seansiem.

REZULTĀTI: pēc sintonikas pielietošanas statistiski nozīmīgi uzlabojas akomodācijas amplitūda, redzes asums, acs zīlītes reakcijas - αω un redzes lauks. Tika novērots miopijas samazinājums3 dalībniekiem ar sākotnējo miopiju un nozīmīga uzlabošanas parējiem 4 dalībniekiem.

SECINĀJUMI: Statistiski nozīmīgi rezultātu ļauj apliecināt sintonikas lābvēlīgu efektu jauniem dalībniekiem ar vieglu vai sākotnējo miopiju.

Atslēgas vārdi: sintonika, fototerapija, miopija, filtri, redzes lauks, zīlītes atbildes reakcija

INTRODUCTION

The aim of this paper is to analyse the development of Syntonic phototherapy, focusing attention on its applications in optometric therapy in the treatment of visual dysfunctions.

This approach, which developed in parallel to the evolution of neuroscience, includes various types of photo- and chromo-therapy. The technique uses the visible spectrum of light to treat visual disorders like amblyopia, binocular problems, functional myopia, learning disorders, and so on.

It is a little-known technique in Europe and is rarely used; that is to say, there is an association for behavioural optometrists who practice it and teach its principles (BOAF).

The purpose of this work is to evaluate the efficacy of syntonic phototherapy for the treatment of myopia and visual skills associated with it. The use of a particular visual field based on color perception called functional visual field will allow us to see if the treatment was effective.

This thesis is therefore divided into two parts: the first part is devoted to bibliographic research on the topic, and the second deals with the application of this therapy in young subjects who have an initial or mild degree of myopia.

In addition to the classical analysis of optometric data, i.e. refractive indexes, phorias and accommodation, I have also analysed the progress of the functional visual field as well as of blind spots, before and after treatment.

The functional visual field test is very different to the traditional visual field test, and aims to analyse how space is perceived and interpreted; it is a very commonly used test in Syntonic therapy, since it can be used to display, the efficacy of a treatment visually.

With this work, I wanted to investigate whether Syntonic treatment had any potential as a means of controlling myopia.

1 REVIEW OF LITTERATURE

1.1 Evolution of syntonic phototherapy

1.1.1 The scope of investigation of syntonic phototherapy

The term "syntonic" or light phototherapy refers to a branch of science that uses certain frequencies of visible light for the purpose of investigation and visual dysfunctions therapy (CSO: www.collegeofsyntonicoptometry.com).

The use of the light spectrum in visual science is a tradition that has been used for almost a century. The syntonic phototherapy was used, in fact, with considerable success, in the treatment of visual disorders such as strabismus, amblyopia, binocular problems, learning disorders related to difficulties in reading and visual sequelae determined by cranio trauma encefalici (Larkin, 1980).

Over time the syntonic method has emerged as one of the most effective tools for some specific interventions in the optometric field. Progressively, in fact, it was noted that the phototherapy, especially if associated with other traditional optometric protocols (like visual training), permits treatment to be particularly rapid and effective (Collier, 2012). Syntonic phototherapy can also be used independently in order to intervene on ocular photosensitivity and pain that are not treatable by standard procedures (Ingersoll, 1999).

Syntonic is part of the so-called "energy medicine", it includes several types of photos and chrome-therapy (Gottlieb & Wallace, 2001). It is a field of inquiry that has developed along with the evolution of neuroscience. The latter made it possible to highlight the importance of the limbic system as superior integrative center of visual perception and cognitive-emotional processes. The limbic system is connected not only at the bottom with the hypothalamus, but at the top with the neo-cortex. This discovery paved the way to the study of integration between visual processing and desire-emotional stimulation reactions, including the activities of conscious control of behavior performed by the cerebral cortex and the physiological and behavioral responses organized by the hypothalamus (Hubel, 1995).

The research is focused on identifying the specific functions of the limbic structures (amygdala and hippocampus) and identify the responsibility of specific cortical areas (especially pre-frontal and basal frontal lobe) in the control of vision and cognitive-emotional production. The same psychiatric investigation could ascertain how light therapy is an effective treatment for seasonal mood disorders. These results opened the way for

investigations in the field of depression, circadian sleep disorders and severe insomnia, SAD syndrome, etc.

Syntonic represents, in the specific field of visual therapy, a non-invasive treatment and stimulating action. It relies on the ability of the light spectrum to create a syntonic balance by means of a dual action (Collier, 2011):

a) by exploiting the spectrum of light as a visual rebalancing agent;
b) stimulating the biochemical properties of the brain through the visual system and the retina-brain hypothalamus-connection: the neurotransmitters trigger a biochemical response allowing for additional synoptic connections to initiate movement and growth in new directions.

The most recent studies have shown that the energy (in the sense of stimulations photo-energy) generated by the light field interacts with the eye photoreceptors favoring a series of biochemical reactions and ocular therapeutically relevant (Collier, 2012). This mechanism will also integrate with the neurological and endocrinological effects produced by the visual solicitation.

Phototherapy syntonic involves the use of specific filters for each particular type of disease and therapeutic intervention. The diagnosis is made based on the clinical history of the subject, current symptoms and the results of diagnostic tests. Treatment success should be evaluated based on the positive development of symptoms, behavior on the topic (humor, attitude, propensity for sociability), performance (school and expressive) and the changes that have occurred in the functional optometric test results (Gottlieb Wallace, 2001).

Regarding the latter measuring pupillary reactions and functional visual fields are particulary important for syntonic treatment. The analysis of the pupil involvs the pupil size, the direct and indirect reflections, and reactions of Marcus-Gunn (Pesner, 1994). Dale A. Fast, O.D., F.C.S.O., claimed the examination of the pupil as an important part of the evaluation of a candidate subject to a Syntonic treatment. One of the most important considerations is the Alpha-Omega pupil. The test gives a good assessment of how the autonomic nervous system is functioning at a certain time. Indicates if the subject is the dominant sympathetic nervous system or the parasympathetic; in particular it is indicative of an inadequate adrenal function. The name was suggested by Dr. Paul Johnson after seeing the article on fatigue pupil of Dr. Dutton Brewer in 1934.

"The 'Alpha Omega pupil' is a term unique to Syntonic Optometry. It is used to define a pupil which does not respond normally to light. When a penlight is directed at the eye continuously from the front, an 'Alpha Omega pupil' may fail to constrict, or may constrict but fail to hold the constriction. The pupillary response is an indication of the size of the

functional field, i.e., the faster the dilation (in the presence of the light source) the smaller the field. The response of one eye may differ from that of the other eye. Alpha + Omega is the combination frequency recommended to alleviate the faulty pupil function, hence the origin of the term." (Charles Butts, CSOJ pg7, Mar 1990)

The severity of the pupillary release may be related to a more or less marked reduction of functional visual field and neurological problems. Traditionally the anomalies in the peripheral visual fields may be due to anatomical defects of the retina, to problems in neurological mechanisms of visual transmission or to defects of the cerebral cortex. The syntonic has the merit of extending the scope of investigation of optometrists relating to functional alterations of the visual field related to fatigue, emotional stress or anatomical factors accidents on the optic nerve.

The practice of syntonic has identified a number of areas of intervention in which phototherapy is capable of intervening in the balance of the visual field. Reference is made to Tourette's syndrome (present especially in children and resulting in a restriction of the visual field diameter of 15 degrees), to strabismus and amblyopia (both characterized by a decrease of the field in the two eyes). As observed Gottlieb and Wallace, *«because very few optometrists know about functional field loss, visual fields are rarely taken on children and color fields, sensitive indicators of underlying pathology and/or dysfunction, are almost never measured»* (2001, p. 32).

The syntonic optometrists often use and systematically the "functional" visual field: this diagnostic method measures the different sensitivity to different light frequencies in the visual field, through the colored moving target detection on a defined background, mapping and quantifying the visual field at different frequencies .

In traditional optometry and in ophthalmology campimetric examination it is used to detect possible pathologies. The functional visual field test that is used in syntonic optometry has a purpose completely different than traditional examination campimetric: is indicative of visual problems or however problems related to visuo-perceptual-motor system. The functional visual field investigates how a person processes information in the visual field, if there is a reduction of field it means that the subject ignores a large amount of information that comes from its periphery. Such evaluation allows to detect anomalies in the visualization and define an intervention protocol that can rebalance the vision by acting on dynamic anatomical or on the biochemical reactions that regulate brain responses.

The practice has developed various approaches of photo and chrome-therapy in optometry. Some newer techniques have focused on the emotional dimension of the alteration of the visual field. This approach emphasizes that the hypothalamus is the location of dynamic

patterns of emotion. In the presence of a stimulus capable of eliciting an emotion, these schemes are freed from the cortical inhibition and give rise to peripheral events (also ocular), in turn the signal is returned to the cortex. More specifically, it has been suggested that the thalamus and hypothalamus are the center of integration, through homeostasis, of the sensations and also visual behavior.

Other approaches have experienced the use of different light filters, or have proposed "visual training" techniques that focus on the interaction between mind and body. The syntonic, in turn, developed a diagnostic protocol that organizes eye disorders based on the fact that the syndrome is acute, chronic or linked to the so-called emotional fatigue.

1.1.2 The Riley Spitler studies in the '20s and' 30s

Most of the current syntonic therapeutic techniques are based on studies, conducted in the twenties and thirties, by Harry Riley Spitler.

In fact the use of light in medical and therapeutic purposes has ancient origins. We know that in Greece and Rome the action of ultraviolet rays for the treatment of tuberculosis and the red light was used to reduce the effects of smallpox (Griffin, 1980). After a long period of neglect, phototherapy was revived in the nineteenth century, thanks to studies conducted by US researchers. In his study of 1871 entitled *The influence of the blue ray of the sunlight and the blue color of the sky*, Augustus J. Pleasanton claimed that sunlight, filtered through blue glass, acquires some healing properties. Six years after Seth Pancoast, in his contribution entitled *Blue and red light*, he reiterated that the blue and red have a therapeutic specificity. In 1878 Edwin Babitt founded modern light therapy, theorizing the principles in *The principle of Light and Color* (Griffin, 1980).

The three researchers have had the merit of bringing attention to the fact that the color, applied to specific parts of the body (especially the skin) has curative effects, antiseptic and non-intrusive, acting on the cellular and biochemical dynamics to the scientific world. Reading glasses with colored lenses were already used in order to reduce the visual eye strain in the nineteenth century. Furthermore, the use of gray and blue light were employed to reduce the neonatal jaundice. The early twentieth century optical science became aware that the luminous element, in addition to making vision possible, acts on the neurological and anatomical structure of the eye, working on specific brain areas (Lessmann, 2014).

In the late nineteenth century, in Europe, the Italian Antonino Sciascia and the Dane Niels Finsen conducted scientific research on the physical components of light and the effects of phototherapy. Initially the two doctors developed a technique to treat the scars from smallpox through exposure to light and then opened the door to a series of important medical

studies on the effects of light on the human body (so that Finsen was awarded the Nobel Prize in 1903 for his discoveries on phototherapy in the treatment of tuberculosis).

In the nineteen twenties Ghadiali created the " Spectro-Chrome Therapy", a therapy that involved the use of specific lights, for each disease, of different colors. His "Spectro-Chrome", the effects of which have been illustrated in the work *Spectro-Chrome Metry Encyclopedia* and in *Spectro-Chrome* magazine, consisted of a light source in front of which colored filters could be inserted.

This set of studies attracted interest in the optometric field, encouraging the spread of studies on the use of light in the treatment of disorders and eye disease. The first clinical application of specific light frequencies in optometric practice dates back to the early twenties. Spitler, who graduated in medicine and optometry, initiated a series of studies on the role of the eyes in the photo-translation and the role of light and color in the biological and biochemical functions (Wallace, 1999). Spitler was able to ascertain that "*many bodily, mental / emotional and visual ailments are caused primarily by imbalances in the autonomic nervous and endocrine systems*" (Griffin, 1980). Moreover he ascertained that by applying certain frequencies of light and using the view to convey the light stimulus by means of the optical-neurological structures, it possible to determine a rebalancing of:

a) both of the visual dysfunctions;

b) both the brain centers deputies to the regulation of mood and emotion.

1.1.3 The formulation of the method in *The Syntonic Principle* essay

In 1933 Spittler created the College of Syntonic Optometry, in order to study the therapeutic applications of light in the correction of visual disorders. The results achieved have led to the formulation of clinical science defined as "Syntonics", as aimed at building a new tune or balance in some visual and behavioral functions. The principles of this approach, directed at establishing an equilibrium that integrates the nervous system, have been formalized in the work *The syntonic principle* (1941). Spitler was the first researcher to investigate the characteristics of retinal-hypothalamic tract.

He was able to verify that by applying certain frequencies of light and using the eyes as a neurological vehicle, it was possible to act on the brain structures and corrects visual dysfunctions working on their neurological origin.

The light in the form of nerve impulses, arrives through two different pathways, one is the visual cerebral cortex, where the perception of color is, the other is the hypothalamus, placed at the center of the brain. The hypothalamus participates in the homeostasis and controls some of the main vegetative and metabolic functions. It also monitors the activity of

the endocrine glands in the brain: pituitary gland and epiphysis (pineal gland). We observe through the vision of specific wavelengths (colors) we transmit information to the hypothalamus that influences the physiological aspect; while psychic effects are induced through the visual cortex. Moreover, homeostasis is generally regulated by both mechanisms (Hubel, 1995).

The Spitler model showed that the red light that is placed at one end of the spectrum (low frequency and high wavelength) is able to stimulate the sympathetic nervous system; the green light (with an average wavelength) is a physiological balance factor, while the blue (with high frequency and short wavelength) is an activator of the parasympathetic system.

In 1941, in the publication of *The Syntonic Principle*, Spitler attached a large study of syntonic photometry entitled *Syntonic Effectivity: A Statistical Compilation of Ocular Anomalies Handled by Applying the Syntonic Principle.* This publication presents the results of a study of 3067 patients undergoing a syntonic treatment. 2791 of them (90.7%) responded positively, demonstrating how the retinal-hypothalamic solicitation can actually have positive effects on some visual disorders and emotional-behavioral balance of subjects. Spitler's research lists subjects treated according to disorders, among which there are 68 cases of progressive myopia, 46 are the subjects where myopia has stopped or is reduced, equal to 67.65% of success.

In the same years in which Spitler developed his Syntonics Theory, other researchers (including Skeffington, Harmon, Renshaw, Gesell and Getman) have shown how the vision is subject to a learning process and thus allows to perform individual correction programs of imbalances and enhancement in visual ability. This set of contributions led to the creation of so-called *behavioral vision care* and practice of *vision therapy* (Pesner, 1993).

1.1.4 The contribution of Butts in the '60s

After World War II Syntonics experienced a significant development, particularly in Anglo-Saxon countries.

In 1960 Charles Butts reorganized and integrated the theory. He clarified the use of light is on one end of the weighing plate and acts on the sympathetic nervous system. Purple (high energy and short wavelength) is on the other side of the scale and affects the parasympathetic. The fulcrum of the balance is constituted by the green.

Butts has, a new diagnostic protocol of visual disturbances and a new methodology that can give a new dimension to visual therapy. Patients were evaluated on the basis of their symptoms using a specific examination sequence: 21 points O.E.P., the pupillary responses, visual field tests and other analysis.

This approach has also enabled him to identify a method that can reduce the visual imbalances giving, in some children, a learning disability called dysgraphia, which affects the fundamental functions of writing. It may be defined as any altered handwriting and unregulated, wherein the graphemes are deformed and illegible. The visual dysgraphia arise on the basis of a brain disorder, consisting of problems in visual perception and to an individual's spatial disorientation. This results in the inability to organize a text or a script on paper or on any other media. Thanks to its approach, Butts has identified a therapeutic procedures, employing beams of light, it was able to reduce the visual dysfunction in dysgraphic subjects and improve his performance. The researcher noted, in fact, that the prescription of a selected color filter, or an acetate sheet, can sometimes help individuals with disabilities in reading. The colored lenses and acetate sheets act differently on the visual system using acetate sheets as the eye is adapted to the white light, while with the lenses, the eyes are adapted to the color of the filter, and then the lenses and acetate sheets can operate even better with different color combinations.

In the 70's and 80 clinical studies on the effectiveness of the color filters produced conflicting results. Some do not show any improvement in the listening and reading skills; others showed significant improvements as long as you choose the proper color filter to the subject under consideration.

Kaplan (1983), and Liberman (1986) have shown that relatively short syntonic treatment can significantly improve the mobility and visual precision, peripheral vision, memory, behavior and performance in general. The two scholars have conducted research on children characterized by learning disabilities, showing that the worst educational performance were linked, in many cases, to a lower sensitivity of their peripheral vision. The use of phototherapy was able to facilitate a significant improvement in their visual skills, with a positive effect on academic performance.

These studies, in particular, have led to the conclusion that the Syntonics therapy is able to determine four types of changes:

- **Physical**: the crystalline lens changes its shape, in greater or lesser extent depending on the color, so as to determine a correct focus on the retina;
- **Chemical**: the lights of different colors produce different effects on rhodopsin, namely the membrane protein which is located in the rod cells of the human retina.

  Ladd states: *"The bleaching effect of different parts of the spectrum is of very different strength, being greatest for a yellowish green. It has long appeared probable that the first effect of light on the retina must be of a chemical character, and therefore the discovery of the visual purple, and of its reaction to light, was hailed as opening the*

way to a more complete understanding of retinal functions. It soon appeared, however, that the visual purple was not essential to sight" (Collier: "*In Syntony*" 2011, pag.25)

- **physiological**: visual stimuli affect the photoelectric properties of the retina which, by reaction, causes a shortening of the cones that recede toward the outer membrane, the side of the pigmented cells. Although the magnocellular system is not directly involved in color discrimination, it receives input from all three types of cones informing the magnocellular system of the brightness and not the color. It has been found that the S cones have the ability to inhibit the magnocellular system, while it is more sensitive to yellow light. Yellow filters would be able to cut the low wavelengths and to normalize the input of the cones L and M, improving the efficiency of the magnocellular system.
- **psychological**: the tonicity and irritability of the vegetative system are regulated by the endocrine system; this explains why the light can have a significant effect on the mood of a subject but the psychological effect of the treatment is still poorly understood (Collier, 2012).

1.1.5 Jenkins and the creation of the first light stimulators

During the 90's, measuring of the functional visual field became central in the Syntonics Theory study.

Jenkins, a student of Spitler, created the C & J Instruments, a company active in the production of instruments, sponsored by the College of Optometry Syntonic. The development of these new measurement tools has encouraged the study of the most suitable light frequencies to stimulate and balance the nervous system and take action on specific visual dysfunctions.

In 1994, Jenkins explained the characteristics of the phototherapy treatment, the length of which was been detected in one or two months, with three to five sessions a week. The standard phototherapy program has been defined in a series of twenty sessions of twenty minutes each, to be implemented as a standalone program of visual therapy or as an intervention to be implemented in conjunction with other techniques. The syntonic therapy is considered, however, by its promoters as a *"an integral approach to a vision therapy practice"* (Gottlieb-Wallace, 2001).

In the '90s and the beginning of the new millennium studies continued with reference to visual dysfunction, both emotional and behavioral dimension.

N.J. Ray and colleagues (1999) studied the effect of exposure for three months of yellow filters on convergence and accommodation of patients with convergence (> 18 cm) and accommodation deficit. They ascertained that the convergence and accommodation immediately improved significantly and the positive effect persisted even after the use of filters was terminated. The yellow filters could also improve the perception of movement (Stein, 2000). In a study performed in Oxford which evaluated the effectiveness of only the deep yellow filter (blue negative) and the deep blue (yellow negative) and noticed, three months from the constant use of filters, significant improvements in convergence and amplitude of visual field, more with the blue filter than the yellow one. Stein (2000) hypothesized that the positive effect of blue and yellow filters is related to selective wavelengths that pass through such filters and which are more precisely brought into focus on the retina. The few reported cases of therapy with the colors in epileptics used blue filters.

In terms of psychiatric disorders, the discovery of *Seasonal Affective Disorder* has paved the way for extensive testing of light stimulation, enhancing knowledge on the effects of light on the neurological system (Oren et al., 1993). These studies are based in large part to Spitler theory, published in *The Syntonic Principle*, according to which the low-frequency light stimulates the sympathetic nervous system, and the high frequency parasympathetic.

1.1.6 Recent visual disorder studies

Optometric research using syntonic phototherapy have been made in several areas, especially during the last thirty years.

In 1983, Kaplan published the article entitled Changes in Form Fields in Reading Disabled Children with Syntonics, in which he described the results of a study that attests that the syntonic significantly improves the functional visual fields and the learning performance of children with specific disorders. The study by Liberman entitled The Effect of Certain Syntonic Colored Light Therapy on Visual and Cognitive Functions (1986) research some visual disorders in depth. This researcher verified that subjects, receiving a syntonic Protocol, increased the viewing area by 400%, 208% of the functional dimension of the field, 700% visual memory, auditory memory by 160% and 75% school performance.

Thirteen years after (in 1999) Ingersoll and colleagues developed an integrated visual learning program (IVL) used as part of an intervention by a group of students. The result determined that the use of syntonic allows the enhancement of the functional visual field and also has a significant impact on the learning levels.

1.1.7 Correlation between light frequencies and syntonic filters

The electromagnetic spectrum is divided into three parts:

- the infra-red band
- the visible band
- the ultra-violet band

The syntonic treatment uses only the portion of the visible spectrum since it is the only one that can be perceived by the eye and processed by the brain. Some filters used in Syntonic treatment let through a broadband spectrum, while others are very selective. It is important to point out that each selected filter produces specific effects (Collier 2011).

The syntonic treatment acts on the balance of the autonomic nervous system that is divided into the sympathetic and parasympathetic sectors.

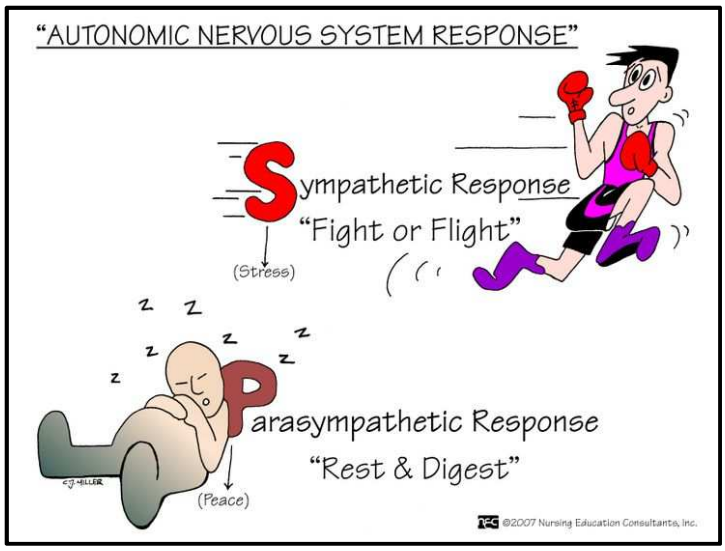

Fig. 1.1 Autonomic nervous system

(https://it.pinterest.com/explore/autonomic-nervous-system)

The parasympathetic system stimulates calm, relaxation, rest, digestion and storage of energy; as shown in the figure 1.1, the parasympathetic system presides over an adaptation system called "rest and digest". Following stimulation of the parasympathetic system, digestive secretions increase (salivary, gastric, biliary, enteric and pancreatic), peristaltic activity is exalted, pupil constriction, decreases heart rate, forces the bronchi and favors urination .

The parasympathetic system contrasts with the sympathetic system called "fight or flight", which promotes excitement and physical activity.

The sympathetic and parasympathetic nervous system controls many functions of our body as is shown in tab. 1.1.

Most often the action of the two systems is finely balanced, without a prevalence of one over the other (concept of homeostasis).

SYMPATHETIC	PARASYMPATHETIC
Anatomic	
D2 to L3 inclusive	3, 7, 9, 11 cranial,vagus, sacral, principally 2, 3
Stimulation, Over-Activity, or Dominance Effects	
Protects organism in danger - defence reactions	Keeps organism alive - vital forces
Catabolic (“brakes”)	Anabolic (“engine”)
Dilates pupil	Contracts pupil
Protrudes eye ball	Widens eye slit
Lessens lacrymation	Increase lacrymation
Upper lid retraction, lagging	Upper lid ptosed, puffy
Ocular hypertension	Ocular hypotension
Lessens accommodation	Increases accommodation
Causes exophoria reflex	Causes esophoria reflex
Low adduction tendency	Low abduction tendency
Inhibits ocular activity	Activates ocular activity
Lessens mucus secretions of nose, nose and throat	Increases secretions of nose, mouth and pharyngeal glands, producing catarrh
Supportive Effects	
Lessens salivary secretion	Increases salivary secretion
Lessens secretion and motility of stomach; stops digestion	Hypermotility and increased stomach secretion/excess HCI
Slows peristaltic wave with common type of constipation	Hypersecretion and hypermotility of intestines leading to colicky pains and either constipation or diarrhea
Increases pulse rate	Slows heart
Constricts arteries	Dilates arteries
Increases blood pressure	Decreases blood pressure
Increases blood sugar	Decreases blood sugar
Goose flesh; cold-sweating hands, feet, and under-arms	Stops sweat of hands, feet and under-arms
Increases respiration	Decreases respiration
Diminishes quantity of urine	Causes irritable bladder
Contracts uterus	Decreases adrenalin presumptively
	Increases bronchial secretion: produces asthma
Organs involved	
Sympathetic Action Increases: CATABOLIC FUNCTIONS	**Parasympathetic Action Increases: ANABOLIC FUNCTIONS**
Thyroid	Parathyroid
Adrenal	Stomach
Pituitary	Liver
Gonads	Pancreas
Muscles (not glands, but involved in catabolic process)	Spleen Duodenum and intestines
Upright position stimulates	Horizontal position stimulates
Base-In tends to stimulate	Base-Out tends to stimulate
Atropine stimulate sympathetic	Aspirin stimulates parasympathetic

Tab. 1.1 ANS Sympathetic vs. Parasymphatetic (Collier, 2012. Curriculum 101, BOAF-EASO-CSO)

The syntonic model suggests that a low-frequency and long wavelength light (red) stimulates the sympathetic nervous system; the middle frequencies (green) favor the balance

of the physiological processes of a neurochemistry nature, while a high frequency and short wavelength light (blue) activates the parasympathetic nervous system.

Spittler analyzed and selected specific frequencies of the visible spectrum and, for simplicity, chose to call the various frequencies with the characters of the Greek alphabet (see Table 1.2):

Name	Color	Function
α Alpha	Red	Sensory Stimulant
δ Delta	Amber	Motor Stimulant
θ Theta	Yellow	Intense Motor Stimulant
μ Mu	Green	Equilibrator or Balancer
π Pi	Bright blue	Sensory Depressant
ω Omega	Blue-Violet	Motor Depressant
υ Upsilon	Medium Blue	Intense Sensory Depressant
λ Lambda	Indigo	Slight Motor Depressant combined with Sensory Stimulant (Lambda is seldom used alone, but in combination with Alpha to get a particular type of Sensory Stimulant)
D Depressant	Purple Blue	Combined with other filters to give a greater depressing effect
S Stimulant	Yellow	Combined with other filters to give a greater stimulating effect
N Neurasthenic	Purple	Generally used alone for neurasthenics, but sometimes with other depressant

Tab. 1.2 Correspondence between the filter names and colors, description of the basic effects of the frequencies (College of Syntonic Optometry)

Usually the filters are combined to achieve a greater effect (see Table 1.3):

Filter	Color	Effect
Alpha-Delta (αδ)	Red-Orange	High Sensory Stimulant + Motor Stimulant
Mu-Upsilon (μυ)	Turquoise	Equilibrator + Intense Sensory Depressant
Alpha-Omega (αω)	Ruby	Emotional Stabilizer
Mu-Delta (μδ)	Yellow-Green	Physiological Stabilizer
Upsilon-Omega (υω)	Violet	Intense Sensory Depressant + Motor Depressant
Omega-N (ωN)	Dark Violet	Weakest Motor Depressant
Pi-Omega (πω)	Dark Blue	Sensory + Motor Depressant

Tab. 1.3 Basic filter combinations (College of Syntonic Optometry)

The figure 1.2 shows the filter balancing system:

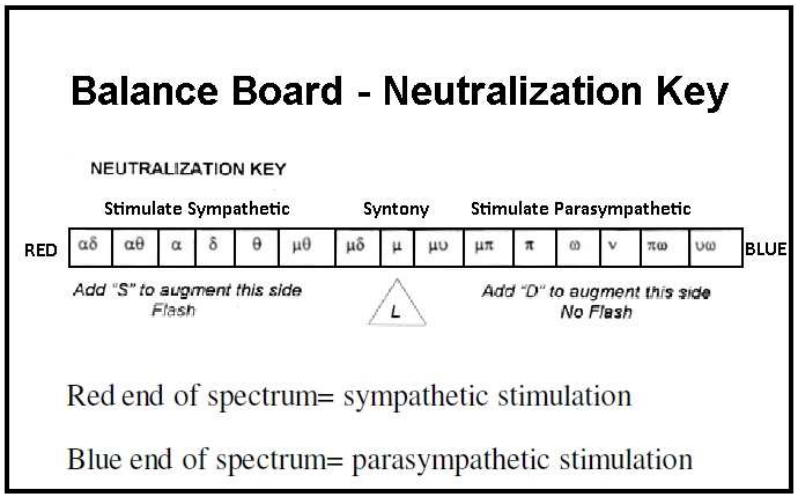

Fig. 1.2 Syntonic Optometry Balance Board (Collier, 2012. Curriculum 101, BOAF-EASO-CSO)

The most difficult and most important part in Syntonic treatment is the choice of filter to be used. If the wrong filter is choosen the results will not be correct and risks worsening the situation. There is no specific filter for treating myopia or amblyopia or asthenopia ect.. but frequency has to be chosen depending of the subject's characteristics. From this point of view, Collier's work has been appreciated because he sought to simplify the choice of a suitable filter according to the optometric data. You have to evaluate if the subject is eso or exo, if there is a vertical component and if emotional problems are involved. The following diagram 1.3 clarifies the association between optometric data and Syntonic filters (Collier 2011):

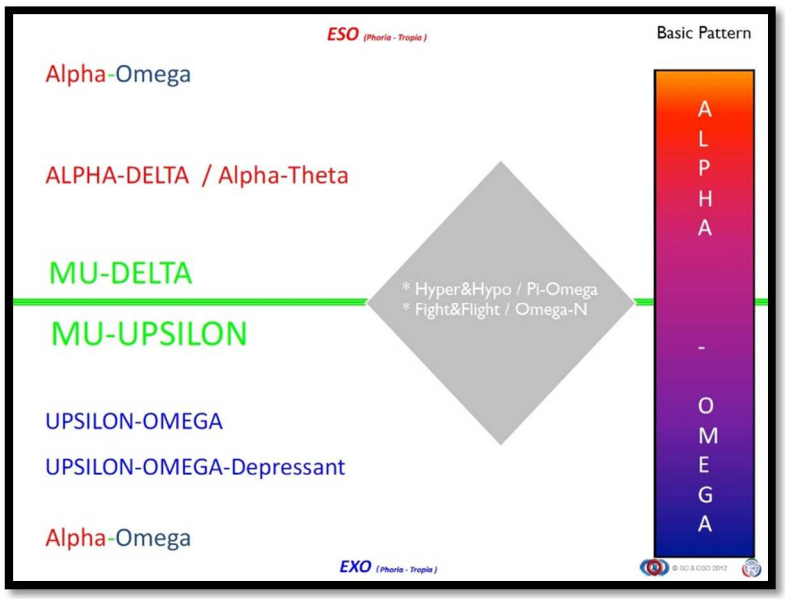

Fig. 1.3 Filter chart By S. Collier (2012)

The use of the scheme is intuitive, it is necessary to analyze the subject's story and associate it with the optometric data: for an Eso person we must look at the top of the schema. For an esophoric subject we should relax the accommodation and stimulate the base-In, i.e., giving a sympathetic stimulation that you obtain with an Alpha-Delta filter (Alpha-Theta for women) followed by Mu Delta-filter that is an equalizer for esophoric subjects. In case the subject is esophoric but associated with an emotional problem, the scheme contemplates the use of Alpha-Omega always followed by Mu-Delta.

However, for exophoric subjects it is necessary to stimulate accommodation and Base-Out that is obtained with the Mu-Upsilon filter or with the coupled Upsilon-Omega + Mu-Upsilon, even in this case if emotional problems are associated use Alpha-Omega first and follow Mu-Upsilon.

If the person has a vertical imbalance hypo or hyper use Pi-Omega filter followed by the stabilization filter Mu-Delta for esophoric individuals or Mu-Upsilon for exophoric subjects.

If the subject's main syndrome is emotional fatigue, especially if it is a fight & flight type, it is advisable to begin treatment with the Alpha-Omega filter (emotional fatigue) followed by the stabilizer filter as in previous cases. If this does not work use as a first filter Omega-N always followed by the stabilizer filter.

1.1.8 Wallace and the concept of the four syntonic syndromes

It was determined in the previous chapter that Spitler's studies initiated a line of research on neuro-electrical phenomena of ocular nature. Spitler gained the merit of identifying the neurological correlations between the retina and the hypothalamus, highlighting how the frequencies of light have the ability to balance the brain centers of some basic control functions, such as emotional, attention and the one linked to ocular motility. Allowing us to define a protocol of intervention in case of a deficit which alters the ocular mobility, the ability to focus, visual field disorders, visual discrimination, binocular function and the process of transmitting information.

Based on these results, a diagnostic protocol has been developed that organizes eye disorders based on the identification of the "four syndromes": the acute syndrome, the chronic, one linked to emotional fatigue and the so-called *"lazy eye"* (Wallace, 2009).

Wallace illustrates the characteristics of these four syndromes by analyzing their etiology and their symptoms.

The **acute syndrome** (also called Mu-Upsilon (μυ) Syndrome) is a characteristic of subjects with recent ocular-cerebellum problems caused by an infection, a head injury, hypoxia, heart attack or high fever. These symptoms are often associated with headaches, eye

sensitivity, bulb and orbital pain. From the diagnostic point of view, the acute syndrome is often accompanied by exotropia (from convergence insufficiency or by excess divergence), accommodative insufficiency , difficulties in ocular pursuits. The procedure requires the use of color frequencies to reduce neuralgia, such as Upsilon-Omega (violet) and Mu-Upsilon (blue-green) color filters. These filters are able to reduce inflammation and cortical and retinal congestion, acting on nerve sensation. Omega (blue) can be used as a motor depressant in case of spasm and nystagmus.

The **chronic syndrome** (also called Mu-Delta (μδ) Syndrome) affects subjects with chronic health problems or degenerative, organic, metabolic, toxic or those related to past traumas. Symptoms include constant fatigue, poor ocular motor skills, eye strain, headaches and photophobia. The diagnosis is based on esophoria or esotropia, pupil release, difficulties or excess of accommodation, convergence excess, reduction or alteration of the functional visual field: for example, if there is a reduction in the blue visual field it is likely to indicate liver problems. In this case Mu-Delta (yellow-green) filters, which act as stabilizers and physiological activating detoxifying processes is used. The Mu-Delta and Alpha-Omega (ruby) filters are often used if there is emotional instability (Wallace, 2009).

The third syndrome described by Wallace is **emotional fatigue** (also called Alpha-Omega (αω) Syndrome). It affects subjects presenting a state of exhaustion, mood alterations, and a negative attitude, associated with agitation or depression. Symptons include visual disturbances, asthenopia, allergies, headaches, asthma and fluid retention, while the diagnostic criteria include scarce ductions (especially adduction), exophoria accompanied by fatigue at near distance, pupil release, constriction of functional visual fields. The filters used in this case are Alpha-Omega (ruby), used for ten minutes and then substitute with Mu-Delta (yellow-green) filter, in order to balance the nervous system and assist the adrenals (Wallace, 2009).

The **lazy eye** syndrome (now called *Alpha-Delta* or excess of convergence syndrome) affects individuals who are usually dominant parasympathetic with manifestations such as esotropia or esophoria, reducing the functional field, suppression, ARCO (abnormal retinal correspondence), poor vergence, amblyopia. The lazy eye syndrome is treated by Alpha-Delta (red-orange) filters (often combined with Mu-Delta), which are able to stimulate the sympathetic nervous system. The combination of these filters is directed to create electrical activation in the cell membranes in order to overcome the synaptic strength which can be the cause of amblyopia, of ARCO and of binocular vision alterations.

In addition to these 4 syndromes, S. Collier (2012) proposed two other syndromes: Fight-or-Flight Reaction Syndrome and Hyper-Hypo Syndrome:

Fight or Flight syndrome involves people with social and emotional exhaustion, subjects who have sudden mood swings and often experience excessive tiredness and are extremely irritable. It is common in children with learning problems, socializing difficulties, difficulty in concentrating, and poor school performance. Symptoms include allergy, asthma, photophobia, asthenopia, headaches. Subjects may sometimes have either aggressive (fight) or anxious (flight) behavior. Diagnosis noted: alpha-omega pupillary response, exophoria due to fatigue or from strength esoforia, reduced ocular abilities, very small functional visual fields in some case, or extremely large in other cases due to the use of the Magno system instead of the Parvo. The treatment involves the use of a Alpha-Omega (ruby) filter associated with Mu-Delta (yellow-green) for eso subjects or Mu-Upsilon (blue-green) for exo subjects.

Hyper-Hipo syndrome affects people with post-traumatic emotional problems, with a tendency to keep their head inclined, stressed, and emotionally negative. In these subjects there is always a vertical phoria. Symptoms include asthenopia, dizziness, photophobia, hormonal disorders, inability to listen, tunnel vision. Diagnostic factors include vertical phoria either at far or near distance (near is more common), alpha-omega pupil, functional visual field reduction, and blind spots which are often different in each eyes. Collier recommends the use of the Pi-Omega filter, in some cases associate the filter with the use of a pen-light and the striped Bagolini filters with axes positioned at 90 ° and 180 °, thus the subject can monitor the vertical phoria during the treatment.

1.1.9 Parallel Processing in the Visual System

The visual system from the retina is divided into two or more ways: 90% of the ganglion cells are divided into M and P.

P cells are selective for wavelengths at high spatial frequencies and have a tonic response (slow sustained profiles); M cells, on the other hand, have high selectivity for low spatial frequencies, do not distinguish wavelengths, have transient response profiles, and Higher conduction speed.

The nerve fibers from different points of the retina are directed to different points of the geniculate nucleus and cortex, thereby recreating retinal map in the brain.

The lateral geniculate nucleus, is located bilaterally, and is composed of 6 layers each of which receives inputs from only one eye:

Layers 2,3 and 5 from the ipsilateral eye

Layers 1,4 and 6 from the controlateral

The cells of layers 1 and 2 are larger than the others, thus these two layers are then called magnocellular (they receive afferents from magnocellular ganglion cells). The other are

parvocellular cells (they receive afferents from parvocellular ganglion cells) (Silverthorn, 2007).

These two pathways have specific functions as see in Table 1.4:

PARVOCELLULAR	MAGNOCELLULAR
1. Most sensitive to high spatial frequencies: fine details. 2. Low sensitivity to contrast. 3. Central (foveal) vision dominant. 4. Responds during and after stimulus presentation. Longer response persistence. 5. Most sensitive to low temporal frequencies. 6. Sensitive to stationary or slow-moving targets. 7. Sensitive to longer wavelengths (e.g., Red). 8. Identification of shapes and patterns. 9. Involved in processing color information. 10. Responds subsequent to transient output and is dependent upon transient output.	1. Most sensitive to Low & middle spatial frequencies: large shapes. 2. High sensitivity to contrast. 3. Peripheral vision dominant. 4. Responds to onset and offset of stimulus. Short response persistence (transient). 5. Most sensitive to high temporal frequencies. 6. Responds quickly to moving targets (early warning). 7. Sensitive to short wavelengths (e.g., Blue). 8. Global analysis of incoming visual information. 9. Involved in perception of depth, flicker, motion, brightness, discrimination. 10. Prepares visual system for the input of slower detailed information that follows.

Tab. 1.4 Characteristics of Parvocellular and Magnocellular Subsystems

Layer organization is fundamental not only from the anatomical but also functional point of view. A disorder in the integration between layers results in less flexibility in visual attention.

The research of Searfoss entitled Visual Performance Fields (1994) and Loss of Visual Sensitivity in School Age Children (2000) also rank in this field.

Searfoss found that 20% of children between 3 and 10 years old have a reduction in functional visual fields that affect proper visual processing, with a progressive loss of integration between the fibers of the magno pathways and the affections of the parvo pathways.

Searfoss (2000) emphasizes that visual field deficits can be treated by syntonic phototherapy, since the latter, acting on cell biochemistry, allows a reorganization of the magno-parvo system.

The effect of the different wavelengths of light on the stimulation of Magno and Parvo systems has been documented: a red background inhibits the magnocellular response in

monkey (Dreher et al., 1976; Kruger, 1977; Schiller & Malpeli, 1978) and also in humans (Breitmeyer & Williams, 1990). More specifically, the Parvo system is mostly activated by high wavelengths (red), the Magno system is inhibited by the higher wavelengths while it is stimulated by the shorter wavelengths (blue light) (Breitmeyer & Williams, 1990; Williams 1991).

1.1.10 Morphological Analysis

Spitler (1941) in his treatise was inspired by the morphological analysis of Kretchmer's biotypes, which is based on the antagonism between the sympathetic and parasympathetic system: the hyper-activity of the one and the relative hypo-activity of the other produce different morphological typologies .

Spitler distinguishes three large morphological classifications based on the physical and mental characteristics of the subjects:

Pyknic P: parasympathetic dominant

Syntonic S: sympathetic and parasympathetic in balance

Asthenic A: Sympathetic Dominant

These divisions are very extreme and it is difficult to find a completely Pyknic or Asthenic subject but there will be a higher prevalence of some dominant characteristics for which Spitler made a further division into 5 categories:

Pyknic leaning towards Syntonic (abbreviated “P/S”)

Syntonic leaning towards Pyknic (S/P)

Syntonic leaning towards Asthenic (S/A)

Asthenic leaning towards Syntonic (A/S)

All are born Pyknic and then evolve after 5-6 years.

Collier (2011) recommends the following approach:

Syntonic Indication: a Syntonic type being mentally and physically well balanced is seldom handled syntonically except when they are presbyopic or have opacity conditions, and generally the frequency band Mu (equilibrator) is indicated.

Pyknic Indication: a Pyknic type being physically slow and sluggish, requires both mental and nervous stimulation. Therefore, one would generally use low frequencies that is towards the red end of the spectrum. Alpha (sensory stimulant), Delta (motor stimulant), Theta (intense motor stimulant) and combinations of these with other filters. If intense stimulation is required, filter “S” (stimulant) is added to the combinations.

Asthenic Indication: an Asthenic type being over-active both mentally and nervously, requires depressing or slowing down. Therefore, the higher frequencies (blue/violet end) of

the spectrum would be indicated. Omega (motor depressant), Upsilon (Intense sensory depressant), Pi (sensory depressant) and combinations of these with other filters are used. If a greater depressant is indicated filter "D" (depressant) is added to the combinations. However, a sensory depressant (Pi or Upsilon) combined with a motor stimulant (Delta) is sometimes indicated for Asthenics.

In Table 1.5 there is a diagram of the recommended filters:

ASTHENIC	PYKNIC
αδ = Alpha + Delta	αθ = Alpha + Theta
αυ =Alpha + Upsilon	απ = Alpha + Pi
αω =Alpha + Omega	αω =Alpha + Omega
δω = Delta + Omega	θω = Theta + Omega
δ = Delta	θ= Theta
μ = Mu	μ = Mu
μδ = Mu + Delta	μθ = Mu + Theta
μυ = Mu + Upsilon	μπ = Mu + Pi
υω = Upsilon + Omega	πω = Pi-Omega
υ = Upsilon	π = Pi

Tab. 1.5 Combination of filters based on morphology (CSO Class 102 Curriculum II)

1.2 Myopia

1.2.1 Definition and classification of myopia

Myopia has become a worldwide public health problem over recent years. Its prevalence varies among different ethnic groups, and with geographic locations and age, but it has been estimated that by 2020, there will be 2,5 billion cases of myopia, or one third of the world's population (Kempen, Mitchell & Lee, 2004, Wu et al., 2015). To date, there have been many studies and theories about its causes, development and prevention.

Myopia is defined as a refractive error in which parallel rays of light are focused in front of the anatomical plane of the retina when the eye is at rest (Duke-Elder & Abrams, 1970, Rosenfield & Gilmartin, 1998).

This condition can be caused by an alteration in the ocular structures, more precisely, by an increase in the length of the axial bulb (Grosvenor, 2002).

There are many forms of myopia and several different classification systems; the most common classification: - a system formulated by Grosvenor (1987) (congenital, juvenile, adult) - uses age of onset, but it can also be classified as a function of the magnitude of the defect itself (mild <3.00 D, average <6.00 D, high> 6.00 D).

Other types of myopia are also known, such as nocturnal myopia, which is caused by an increased accommodative response to low lighting levels; pseudo-myopia, which is caused by ciliary spasm, and myopia that is induced by pathological body conditions (Grosvenor, 2002).

1.2.2 Risk factors for myopia

Myopia can emerge in response to a set of environmental and genetic factors: it is defined as being acquired when it is characterised by a behavioural adaptation component and as being congenital when it is mainly characterised by a genetic and hereditary component. The hereditary component appears to be predominant relative to the environmental, for example, someone who has one myopic parent has twice the chance of becoming myopic, whilst having two myopic parents is associated with a five times greater chance of becoming myopic compared to a subject with no myopic parents (Jones et Al., 2007).

Other factors contributing to the development of myopia are posture and the movements undertaken during reading, like inclining the head ,or the way of holding a pen (fingers cover the tip of the pen or leave the tip visible), and intense effort rather than long duration (Hartwig et al., 2011, Li et al., 2015). In addition, the environment - spaces and brightness associated with proximal activities - have also proved to play a key role (Rosenfield & Gilmartin, 1998, Li et al., 2015).

One of the main theories was elaborated by Cohn (1867, 1886), according to which, a "use-abuse" of accommodation lays at the root of the myopic process.

An alternative theory however identified myopia as an adaptation strategy: short distance vision due to visual fatigue and stress; the body responds by making modifications to anatomical structures so that vision becomes more comfortable.

Excessive accommodation in fact, simulates a refractive condition similar to myopia (pseudo-myopia); the subject who is accommodating for too long can no longer relax accommodation in the near-distance transition, and find themselves in a situation of accommodative inertia. This continues until the long-term state of affliction causes (via chemical and biological processes that are still unclear) an anatomical structural alteration, so the eye becomes anatomically myopic and therefore better adapted to proximal activities (Rosenfield & Gilmartin, 1998, Li et al., 2015, Rossetti & Gheller, 2003).

Recent theories have claimed that certain types of food and eating habits contribute to the development or prevention of myopia, especially in the pre-adolescent and teenage years (Edwards, 1996, Katz & Lambert, 2011).

Another aspect that could affect on the onset and development of myopia is the subject's psychology. In 1948, Mull linked myopia with an introverted personality, emotional inhibition and a disinterest in motor activities. Prior to that, Bates, in 1920, described myopia as the individual's response to anxiety, stress and tension, whilst in 1988, Forrest defined the refractive state as a mirror of the mental status, and of the subject's attitudes and beliefs (Grosvenor & Goss, 1999). These theories have also been revisited more recently, and view myopia as a consequence of psychological conflicts and a high level of stress (Katz & Lambert, 2011).

1.2.3 Relationship between myopia and proximal activity

For several decades, the increase in education, and the development of technology and new equipment (Videos, TVs, smartphones, tablets, etc.) has brought with it many advantages, but has been accompanied by the need to spend a lot of time on proximal activities, not only at work and during school hours, but during leisure time activities too.

These habits require an unusual, non-physiological effort, that disturbs the delicate balance regulating our body's homeostasis; in fact, to conduct such activities, we are forced to spend many hours in a static position, which demands a major commitment on the part of the visual system, the muscles and the joints to maintain posture and intellectual functions.

As far as the visual system is concerned, it demands integration between accommodation and convergence: convergence is crucial for short distance observations,

allowing fixation on and viewing a single point, but this is always accompanied by accommodation, and myosis. Accommodation is the ability of the lens to change its dioptric power, allowing it to focus on objects placed at different distances from the retinal plane. Myosis involves a reduction of the physiological diameter of the pupil (Rossetti & Gheller, 2003).

These three components together form the accommodative or proximal triad, and can be defined as a syncinesia; in fact, it is possible for these to vary independently, but one is associated with the other: accommodation converges, convergence accommodates, and both functions induce myosis.

With vision, there are buffer zones that protect the visual process from stresses that create stressful situations. The close correlation between accommodation and convergence is such that stimulating one causes a reflex stimulation of the other, unless a buffering mechanism is somehow able to partially absorb the effect. Buffers are used to maintain visual homeostasis, by means of which accommodation and convergence can operate together, but with a certain degree of autonomy. According to Skeffington, hypermetropia represents a buffer that protects the focusing mechanism from convergence stimuli, and, in an analogous way, exophoria constitutes a buffer that protects the convergence mechanism from being stimulated by accommodation.

Single, clear, and comfortable binocular vision depends largely on this balance being maintained in the visual system (Formenti 2014).

The use of accommodation and convergence, if protracted and for long periods, contrasts with normal physiological standards, and buffer zones can no longer maintain homeostasis. The body responds to these stresses by activating the autonomic nervous system, which regulates the internal environment, controls all involuntary vital functions, and protects the body by defending it from stressful or dangerous situations.

Accommodation, as an involuntary movement, is controlled by the autonomic nervous system. The sympathetic nervous system responds by releasing adrenaline. The latter, in turn, has a cyclopleigic effect that provokes mydriasis, and thus displaces accommodation from the observed plane, resulting in a loss of visual quality. In response to this, the parasympathetic nervous system is activated, which puts accommodation on a fixed plane by convergence via a process referred to as eso-shift: the convergence is now closer to accommodation. As in the previous situation, this would again cause a loss of visual quality and binocular vision. To avoid this, the eyes actually diverge, and a new relaxation of the accommodation is made, thereby placing the subject's body into a sort of vicious cycle induced by visual stress (Collier, 2012).

For the visual system, such unsatisfactory conditions, which last for a long time, can interfere with the well-being of the entire body, affecting posture, motility, intellectual faculties, and may also cause visual dysfunctions related to accommodation, binocular vision and the appearance of refractive errors such as myopia (Formenti 2014).

And it isn't just poor posture that can affect vision; poor vision may force the subject to adopt a bad posture and lead to physical pains of various kinds.

1.2.4 Visual homeostasis

Considering everything that's been said so far, it's evident that proximal visual activity can influence the onset of myopia, although this theory has never been definitively proved by adequate scientific studies.

Syntonic filters, balancing the action of the autonomic nervous system, might allow action to be taken on the overall balance of the body, and allow some of the risk factors associated with the myopic process to be modified. Emotional aspects can also participate in the myopic process, and are one of the most important factors when choosing the frequencies of light to use in treatment.

Syntonic treatment is most likely to be successful if the subject has not yet developed a structural myopia: use of appropriate filters to balance the action of the autonomic nervous system on the visual system appear likely to be able to reduce the eso-shift causes of the myopia development.

Stable and non-progressive myopia is unlikely to benefit from Syntonic treatment; in a letter that Dr. Ruhpich wrote to his colleague, Dr Ruhndorf, he said:

"Myopia of the Progressive Type must be stopped before any lessening of myopia can be hoped for, and then it's hard to stop. Static myopia - purely stationary axial myopia, - does not decline under any of the frequencies I have worked with."

(From C.S.O.: found in the Oregon Academy of Syntonic Optometry papers from 1936. Undated letter).

Syntonic treatment would certainly be more successful if associated with visual training and advice on visual hygiene (posture, illumination, etc.).

One major aspect in treating myopia with syntonic filters is the action it exerts on the functional visual field. Expansion of the functional visual field, as a clear sign the treatment has been successful, is an extremely useful way of stimulating greater central-peripheral awareness in myopic subjects, who are generally more central than peripheral.

2 RESEARCH

2.1 Seletion and description of the subjects

The experiments were performed at my office in Italy, between December 2016 and May 2017. Treatment was offered to boys with overt myopia or initial myopia that had not yet been corrected, and were aged between 8 and 17 years of age.

With regard to the selection of candidates and the procedure I should follow, I consulted Stefan Collier (Dean of BOAF and a great syntonic therapy expert) who advised me only to treat esophoric myopic subjects because, on the basis of his own experience, subjects who had myopia with exophoria hardly ever responded to treatment.

To make this study as thorough as possible, I agreed to treat all kinds of myopias, both exophoric and esophoric, to facilitate comparison of the two sets of results.

A questionnaire was given to the families of the subjects, to ensure they would be available for the study for the entire duration of the treatment and to obtain their permission to use personal data in anonymised form for research purposes. All of the children whose parents gave their approval for this initiative were recruited for treatment.

13 children were enrolled for this study, 3 were later discontinued because they did not attend for therapy on a regular basis.

Initially, I attempted to provide the tools for families to undertake the treatment themselves at home, but since it was impossible to verify how the tasks had been performed, I found it preferable to perform all of the tests in my office, despite the fact these activities resulted in an increased workload for myself.

2.2 Methods and tools

2.2.1 Anamnesis

The possible tendency for myopia to progress was assessed first and foremost by interviewing the subjects and their parents. The anamnesis was intended primarily to assess the "clinical history" of the myopia (age of onset, average annual progression up to the current condition, presence of myopia in family, etc.), as well as to investigate the visual situation, the overall health and visual behaviour of the subjects (several bad visual habits emerged during school age, which often seemed to have a close link with the onset and progression of myopia).

At the post-five-week check-ups, subjects were asked to report any positive or negative changes they had experienced since starting the treatment.

2.2.2 Visual test

The following visual tests were performed at the start of the treatment and after it had ended:

- Natural visual acuity and with correction using a Mos 27 Polar optotype placed at 5 meters (www.dueffetecnovision.it)
- Near and far phoria (Maddox)
- Auto refractometry with a Canon RK-F1 device (average of 5 readings)
- Mono and binocular subjective refraction
- Accommodative amplitude

2.2.3 Syntonic specific tests

2.2.3.1 Pupillary response

The pupillary reaction test was carried out as recommended by Collier (2012): in a room with low lighting, a light pen was pointed at the pupil of the right eye while the subject fixed their gaze on a non-accommodative target at a distance. When the autonomic nervous system is in equilibrium, the pupil should contract and remain the same for the 15 second duration of the test. In the case of an Alpha-Omega pupil, the pupil contracts, but then regains amplitude and velocity depending on whether the sympathetic or parasympathetic nervous system is dominant. The test was repeated for the other eye and the data recorded using the following classification system:

0 = *Light stimulus - Pupil constricts - Pupil remain constricted*

1 = *Light stimulus - Pupil constricts - Pupil dilate - Pupil constricts again - Pupil remains constricted*

2 = *Light stimulus - Pupil pumps constantly (constricts and dilate non-stop)*

3 = *Light stimulus - Pupil constricts - Pupil dilate - Pupil remains dilated*

4 = *Light stimulus - Pupil remains dilated / Pupil show's no reaction*

Considering Alpha-Omega pupils with values from 2 to 4.

The test was repeated twice for each eye for a total of four measurements, the first time with the subject gazing at a non-accommodative object in the distance, and the second time observing a silvery ball close up.

This test was difficult to conduct, because it is not easy to note down every tiny movement of the pupil. I therefore thought of a way of using a smartphone, by pointing the LED light of the device, shielded due to its high intensity, into the eyes of the subject while

the camera recorded every pupillary change, and recorded them in a video lasting 15 seconds for each eye.

2.2.3.2 Functional visual field

To carry out this test, I used FCFTester software (www.fcftester.com) Ver. 2.72. This software allows you to use a computer and a monitor to perform the examination, as well as to store the results and superimpose them on the following ones.

Originally, a plastic mount was fitted onto the monitor to allow the eyes to be positioned 20 cm from the screen, in a central position, as shown in figure 2.1:

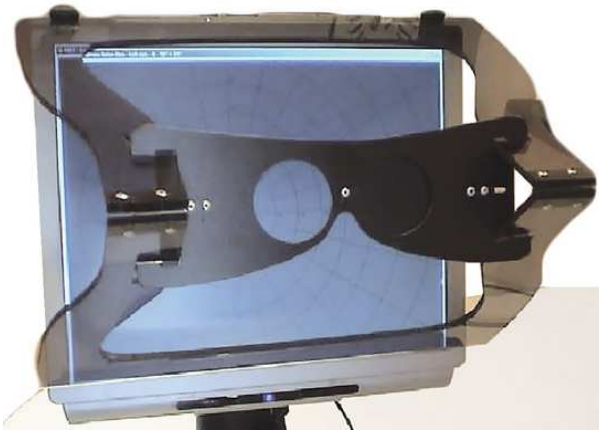

Fig. 2.1 Plastic support removed

Since the system for aligning the eyes on the fixed object seemed to be imprecise, I removed the plastic support and installed a chin rest onto an electrically operated raised platform to position the monitor in front of the subject at a distance of 20 cm from the eye being examined. To prevent the subject from moving their face (and consequently their eyes), instead of using a vocal alert, I used a button that the subject had to press when they correctly detected the target.

The monitor used was an Eizo Flex Scan S1721 with a black frame and VA panel technology, whose unique features allow wide viewing angle (H: 178 ° V: 178 °) without any alterations in colour or brightness. The monitor was connected to a laptop computer via a DVI-D digital connection, and used at maximum resolution (1280 × 1024).

With this system, the subject signalled their perception of the target independently and there were no obstacles between the examiner's eyes and the monitor. In this way I was able to check that the subject did not move their eyes during the examination, and that they kept

one eye on the fixed point, which is a fundamental condition for ensuring the test was performed correctly (see figure 2.2).

The examinations were always conducted in darkened rooms, because the monitor needed no lighting, and each one began by covering the right eye, with the left eye perfectly aligned with the fixed point. I asked the subject to keep their eyes fixed on the target and to press the button only when they could sense, with their peripheral vision, a point with the same colour and intensity as the target they were staring at. The stimulus used was a spot with a diameter of about 4.8 mm for coloured lights, and about 9.5 mm for the white light.

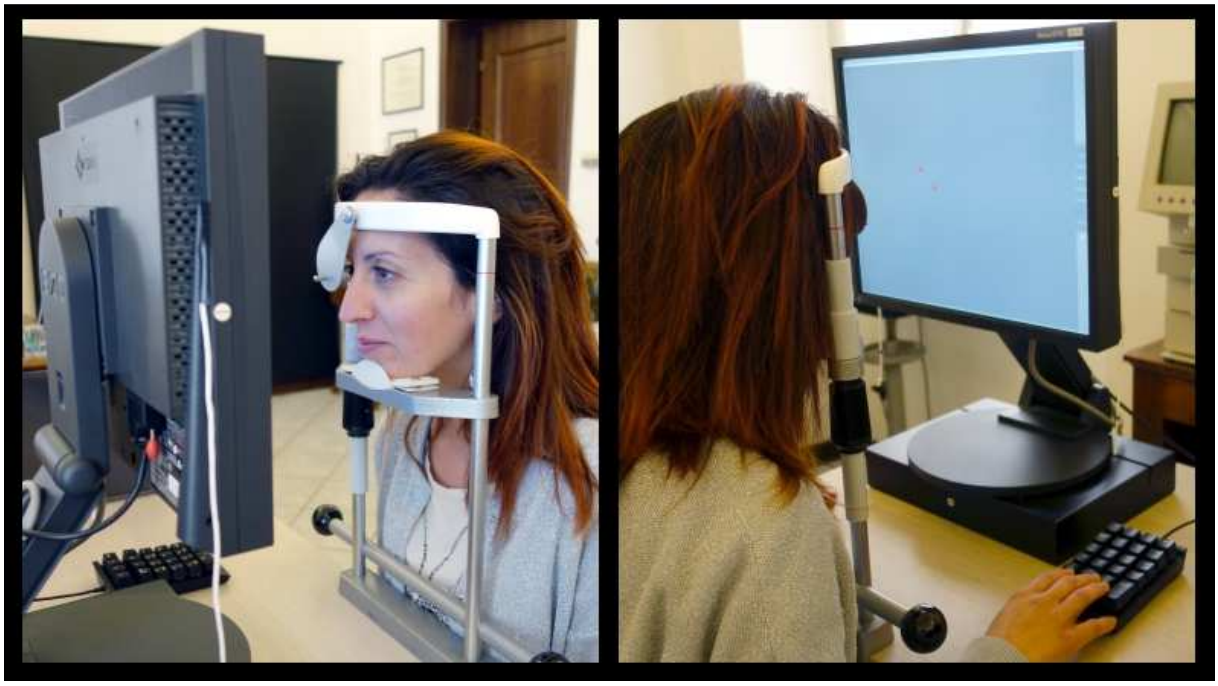

Fig. 2.2 Functional visual field analysis site

The procedure was repeated with the colours red, blue, green and white. The stimulus appeared casually on each of the eight meridians (every 45 °) for a total of 32 points i.e. 8 for each colour. After finishing the sequence for the visual field, and keeping the gaze on the target, we then proceeded to reveal the blind spot; in this case the stimulus used was a white point with a diameter of about 1.8 mm diameter, that started from the centre of the blind spot and was progressively moved. The subject had to press the button at the instant they perceived it. This stimulation was also repeated on all eight meridians.

With the monitor connected to a laptop, it was possible to monitor their performance on screen of laptop.

The results of the examinations were automatically recorded by the software, and saved on the computer, which was able to display it in either a graphical or numerical format.

2.2.4 The Syntonizer

The device used for treatment was Color Boy (see figure 2.3), manufactured by the Belgian company Optomatters (www.optomatters.com). Basically it consists of a light source with neutral shading at fixed power, which can be combined for using the syntonic filters.

Fig. 2.3 The Color Boy syntonizer: external and internal view

The subject was asked to look into a tube about half a metre long, and stare at the light source inside the instrument with specific filters fitted, all these treatments being performed in darkened room.

For the treatment, I adopted the 6-stage methodology recommended by S. Collier:

• The subject was asked to position themselves correctly in front of the device, so they felt comfortable and had both feet placed firmly on the ground. The subject was then asked to look into the instrument with the device turned off, without wearing any filters. The aim of this first stage was to relax the visual system.

• The subject was then asked to put on the selected filter and the syntonizer was turned on. The subject was then asked to look at the light source, to describe it (colour, intensity, colour uniformity, etc.) and to express any feelings he/she was experiencing (warmth, cold, pleasant, annoying, etc.).

• They were then asked to look at the four reflections formed on the walls of the instrument, and to check whether they were equally bright and colourful.

• On observing the light source, the subject should have been aware of the horizontal reflections that form on the side walls simultaneously. If one strip appeared higher than the other, the subject's head was moved from one shoulder to the other, until the two strips appeared to be at the same height.

• The subject was then asked to move their eyes from the central light towards the left reflection, then again to the centre, and this procedure was repeated for all of the 4 reflection positions. This sequence was repeated 10 times.

• With the subject still gazing into the instrument, it was turned off, and the filters were removed. The subject was then asked if they were aware of any post-image, (they should normally perceive one of the opposite colour to that used during the treatment). After the post-image had disappeared completely, the procedure was repeated after switching to the second combination of filters.

After using the second set of filters, the session was ended and the ambient light level gradually increased.

Normally, the treatment lasted 20 minutes, i.e. 10 minutes per filter when 2 filters were used, whilst for some subjects, I used 3 filters, and reduced the time of use for each filter so a total treatment time of 20-minutes was never exceeded.

The purpose of using the above procedure, as well as increasing visual elasticity, was also to make the treatment less tedious. Younger people find it harder to keep their eyes on the instrument, especially after a dozen sessions.

Every subject underwent three treatments a week for five weeks, for a total of 15 treatment sessions.

All of the treatments were performed without corrective lenses or contact lenses, with the subjects wearing goggles with syntonic filters fitted.

2.2.5 Syntonic Filtered Goggles

The filters used in the treatments were supplied by the American company Syntonac International LLC (www.syntonac.com) which manufactures a wide variety of syntonic filters.

I used cardboard-rimmed goggles with coloured filters placed in them, in accordance with the classifications used by the College of Syntonic Optometry (see figure 2.4).

These goggles are manufactured in three color frames: white, grey and black and two frame design: Foxy and Boxy.

The purpose of the coloured frames is that they act in various ways on the Magnocellular system (from: http://www.syntonac.com/products/):

• White frames provide a more stimulating impulse for Magno cellular processing.

• Grey frames gives a more balanced - neutral impulse for Magno cellular processing.

• Black frames provide a more relaxing impulse for Magno cellular processing.

• The frame design Foxy is general filter goggle. It allows a wider peripheral stimulation during therapy.

• The frame design Boxy is goggle specifically designed with a therapeutic component. It is designed to control the amount of light entering the eyes, helping to rebuild the structure in the injured visual system.

For the treatments I used the neutral type with grey frames, in the 'Foxy' version, that is, with standard frames.

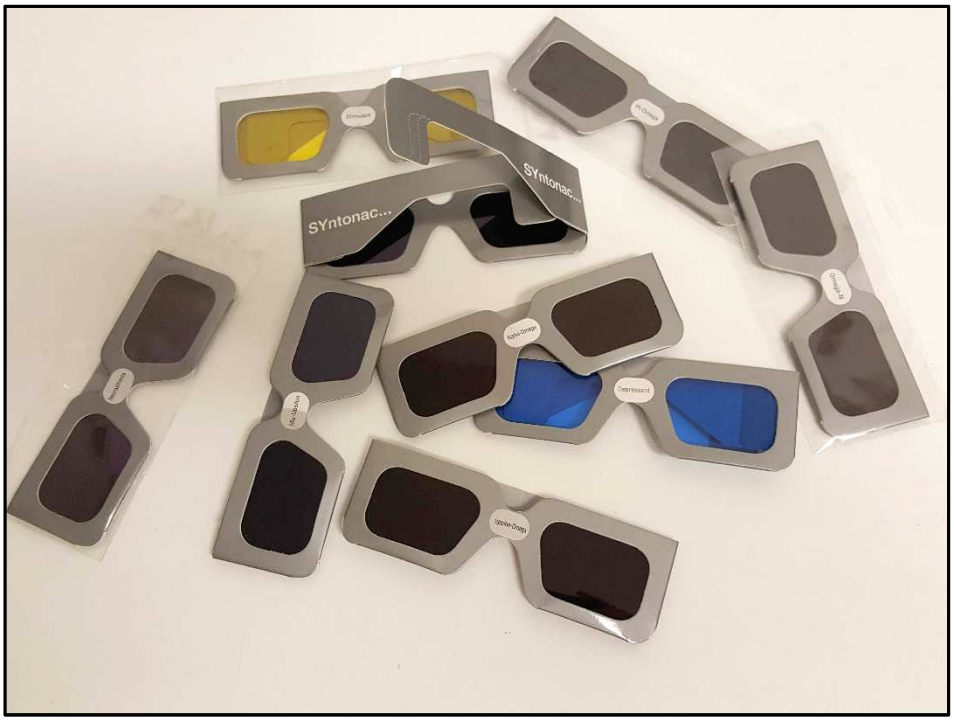

Fig. 2.4 Various types of syntonic glasses

2.2.6 Statistic analysis

The data obtained in the study of the functional visual field were processed with descriptive and inferential statistical analyzes. I chose to do only the statistical processing of the visual field because it provides a greater number of data, supporting the statistical analysis.

I calculated the main statistical indices of central trend and variability for white, red, green and blue colors. To increase the reliability of the statistical analysis I chose to add the data collected by the two eyes, so I have 20 samples for each color.

To test the significance of the data collected before and after Syntonic treatment, given the limited number of observations, Wilcoxon test was chosen. It is a non-parametric test since no assumptions are made on the distribution of the parameters studied. The observations

in a study of two dependent samples are numerically ranked from the largest to the smallest, without considering if data comes from the first or second sample.

Two hypotheses are made: in the first, called H0 or null hypothesis, the median of the differences between the data collected before and after treatment for each variable is equal to zero. In this case, the treatment had no effect on the subjects analyzed. The second hypothesis, called H1 or alternative hypothesis, is that the median of the differences is different from zero, so the treatment had effects on the group of subjects analyzed.

In the second case a tailed or two tailed test can be used: in the first case it is supposed that the syntonic treatment may affect the analyzed variables with a worsening or with an improvement of the obtained results (the variable is influenced only in one direction). In the case of a two-tailed test, the variable can be affected in both directions. In our case, therefore, not being able to predict whether treatment, after 5 weeks, results in improvement or deterioration in detected data, I chose to use the two-tailed test and the Wilcoxon test hypotheses are as follows:

- H0: median differences = 0
- H1: median differences ≠ 0

For each analyzed variable I calculated the differences between the data before and after treatment, I ordered increasingly and I calculated their ranks. At this point, thanks to the use of a program for statistical calculations, the parameter "z" is obtained as output, which is compared with the critical threshold values of tables "z". The statistical calculation program also provides a value called "p-value", which is the significance level. This value represents the probability of observing a test statistic equal to or greater than the value that is calculated from the sample when the H0 hypothesis is true.

If the "p-value" is greater than or equal to α (critical significance value, compared to the table), the null hypothesis is accepted, otherwise it is rejected. The critical value of α in our case is 0.05.

If the null hypothesis is true then there is no real difference between the samples, the sum of scores should approach to 0; if the sum of the differences is considerably different from 0, the null hypothesis can be rejected.

2.3 Description of variables

The group of subjects analyzed in my study consists of 10 children aged between 8 and 17, some with the beginning of myopia (4) or with myopia of a light degree (max 3 Dt.), the average age of participants was 12.8 ± 4.2 years. Young subjects were deliberately chosen

because usually myopia hasn't yet stabilized and although it is already structured, mechanisms that cause myopia progression are still present.

Here I have reported three graphs relating to the distribution of the 10 subjects according to sex (60% women, figure 2.5), age (figure 2.6) and ametropia entities (figure 2.7): 3 have an uncorrected initial myopia and 7 are wearing glasses.

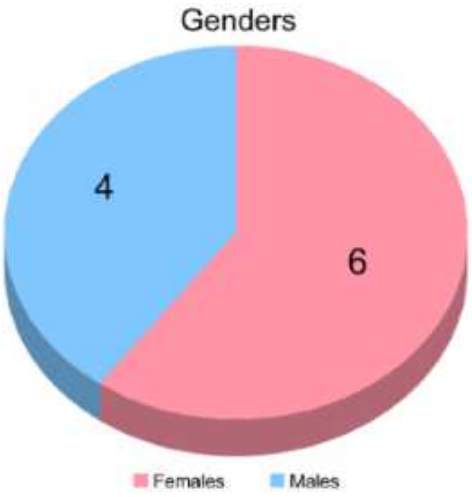

Fig. 2.5 Distribution of subjects by gender

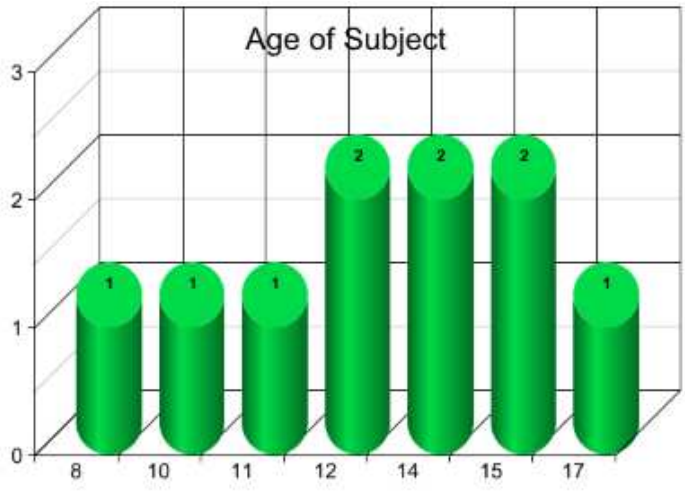

Fig. 2.6 Age distribution of subjects

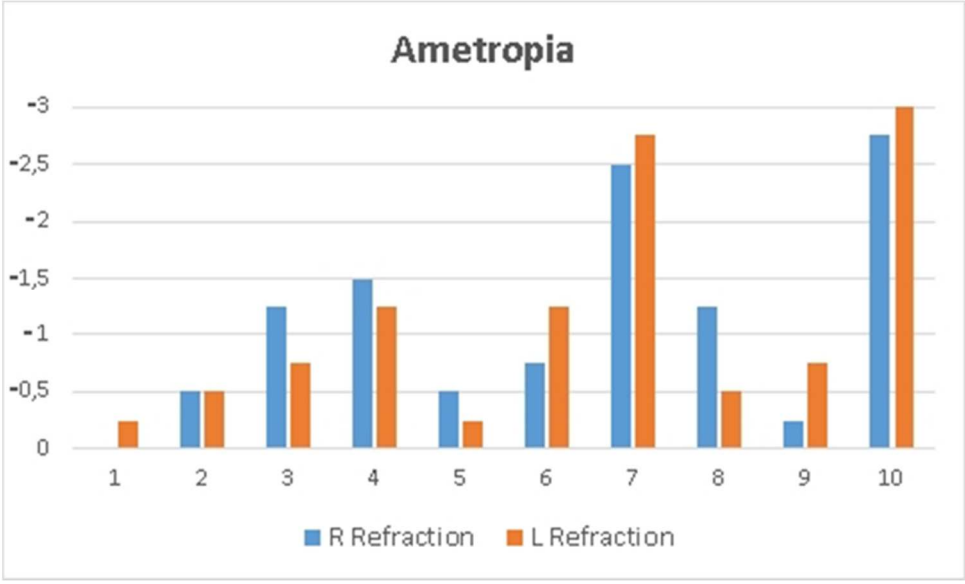

Fig. 2.7 Distribution of subjects according to the ametropia entities

The table 2.1 shows all the visual test values before treatment:

Tab. 2.1 Values measured before treatment

SUBJECT	AGE	SEX	RIGHT AUTOREF	LEFT AUTOREF	RIGHT REFRACTION	LEFT REFRACTION	R VA	L VA	FAR PHORIA	NEAR PHORIA	AA
1 LS	8	M	-0,12	-0,37	0.00	-0,25	1	0,8	2,5X	15X	7,5
2 CV	17	F	-0,75	-0,67	-0,5	-0,5	1	1	0,5x	2s	6
3 CT	15	F	-0,50 -1,25 10°	-0,50 -0,75 0°	-0,50 -1,25 0°	-0,50 -0,75 0°	0,8	0,8	5X	13X	6,5
4 BS	12	F	-2,12	-1,87	-1,5	-1,25	1,2	1,2	0	1S	6,25
5 RM	14	M	-0,5	-0,12	-0,5	-0,25	0,63	0,8	1S	5S	8,25
6 GV	15	M	-1,12	-1,75	-0,75	-1,25	1,2	1	5 X	15 X	7
7 FL	10	F	-2,75 -0,67 5°	-3,37 -0,50 170°	-2,5	-2,75	1	1	1X	3X	8
8 AS	11	F	-1,67	-0,5	-1,25	-0,5	1	1	1X	2S	3,5
9 BL	12	F	-0,25 -0,75 0°	-1	0,00 -0,50 0°	-0,75	0,8	0,5	1X	9S	4
10 RL	14	M	-2,87	-3,12	-2,75	-3	1	1,2	0,5X	3,5X	5

Subjects who do not use eyeglasses but start showing myopia were left without optical correction throughout the duration of treatment, so subjects 1, 5 and 9 had a start of myopia but had never used glasses , the visus reported in the table for these subjects refers to visual acuity (VA) achieved without correction. All others were wearing glasses of the measure shown in the table, in this case the visual acuity is reported with correction.

Even the phoria follows the same pattern: in this way the data represents a snapshot of the visual situation of the subjects before starting the treatment. None of the subjects use contact lenses.

The choice of filters for the treatment was done according to the visual and morphological characteristics of the subjects, table 2.2 lists the selected filters:

Tab. 2.2 Filters used for each subject

Subject	Filter
1 LS	αω(Alpha -Omega) + μυ(Mu-Upsilon)
2 CV	αθ(AlphaTheta) + μθ(Mu-Delta) + S(Stimulant)
3 CT	υω(Upsilon-Omega) + μυ(Mu-Upsilon)
4 BS	αθ(AlphaTheta) + μθ(Mu-Delta) + S(Stimulant)
5 RM	αδ(Alpha-Delta) + μδ(Mu-Delta) + D(Depressant)
6 GV	υωd(Upsilon-Omega-Depressant) + μυ(Mu-Upsilon)
7 FL	υω(Upsilon-Omega) + μυ(Mu-Upsilon)
8 AS	αθ(AlphaTheta) + μθ(Mu-Delta) + S(Stimulant)
9 BL	αθ(AlphaTheta) + μθ(Mu-Delta) + D(Depressant)
10 RL	υω(Upsilon-Omega) + μυ(Mu-Upsilon)

For the subject L.S. (1) I chose to use the Alpha-Omega filter because although he was the youngest he had a fragile emotional situation as the parents had just separated.

The first filter I used for subjects with esophoria at near was Alpha-Delta for males and Alpha-Theta for females followed by the filter Mu-Delta as the equalizer, to these I added a third filter to be used at the end of treatment, without the use of syntonizer, during subject visual relaxation. The third filter may be a Depressant or a Stimulant depending on whether the subject is Asthenic or Pyknic tendentious. Stefan Collier recommended this procedure to me.

For Exophoric subjects, which require a greater relaxation of the sympathetic nervous system, I used the Upsilon-Omega or Upsilon-Omega-D filters followed by the Mu-Upsilon balancing filter.

To simplify the reading of the tables and graphs, I called the data obtained before the treatment T0 and the data obtained after the treatment T1.

The syntonic specific tests are grouped in the table 2.3:

Tab. 2.3 Syntonic test results before treatment

Subject	*Pupil αω*	*Morphol. type*	*R White*	*R Red*	*R Green*	*R Blue*	*R Error*	*L White*	*L Red*	*L Green*	*L Blue*	*L Error*
1 LS	2	Pyknic	33,5	26,3	16,4	26,6	0%	30,8	22,1	16,3	28,3	36,5%
2 CV	3	Pyknic	22,4	12,4	7,4	17,7	0%	21,2	12,1	6,2	17,5	0%
3 CT	2	Asthenic	23,3	12,5	6,8	19,2	0%	23,4	12,3	6,8	17,8	0%
4 BS	1	Pyknic	25,8	8,1	7,3	17,4	0%	26	8,2	7,9	18,2	0%
5 RM	3	Asthenic	28,3	19	8,9	13,7	0%	28,8	20,5	9,2	14,8	0%
6 GV	2	Asthenic	29,3	18,7	11,1	21,1	0%	27,2	19,4	11,5	21,4	0%
7 FL	1	Pyknic	27,6	17,2	8,8	12,2	0%	27,2	17,2	8,5	12,1	0%
8 AS	3	Asthenic	22,5	19,1	12,8	19,5	7%	22,3	17,4	11,9	20,1	7%
9 BL	3	Asthenic	28	23,3	14,4	23,9	7%	28,6	22,8	14,5	24,5	8%
10 RL	2	Asthenic	25,1	16,2	10,8	15,5	0%	26,8	13,8	10,4	18	0%

The table shows the pupil reaction test, subject morphology, and functional field of view. The value of the field of view written in the table is an average value that was directly provided by the campimetry program. I chose to use the average value because it is simpler to manage and more suitable for a statistical analysis. The software detects errors that the person shows during the exam, such as not reporting a stimulus or reporting it too early, it finally reports the percentage of errors for each color. I have only reported the average error for each eye, the youngest person (8 years) is the only one who made a number of mistakes in the first test, in all other cases the errors are nil or minimal. Figure 2.8 is an image of the output provided by the program:

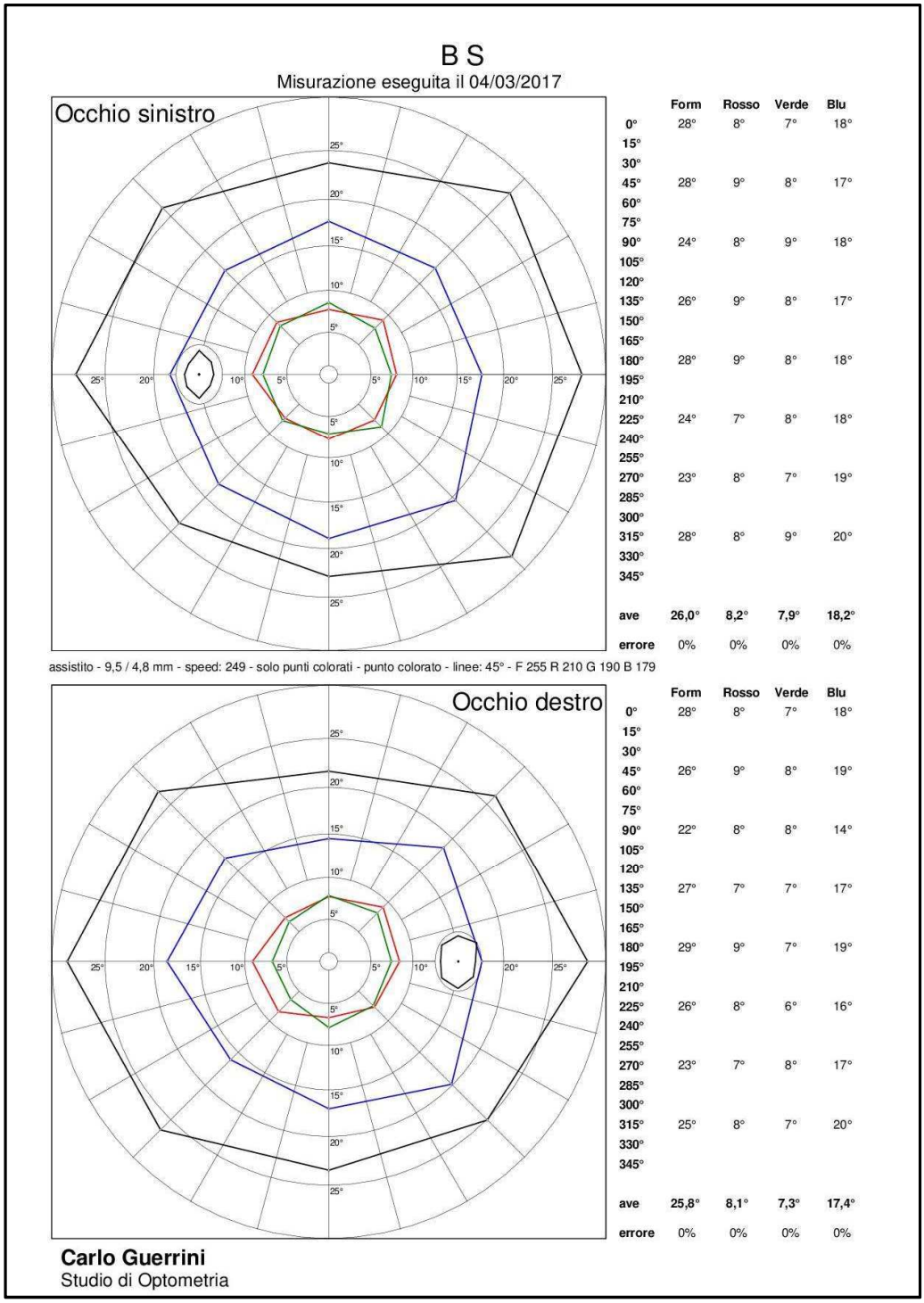

Fig. 2.8 Example of the result of a functional visual field test

As you can see, the program provides both the visual field graphic map and the numeric values for each color field, and also calculates the average value for each color. It is possible to superimpose the result of an examination on the same graph with another subsequently done to evaluate the differences. The date and the calibration values that were used to perform the examination are also reposted.

2.4 Results Analysis

2.4.1 Visual test

In table 2.4 we can see all visual tests performed at the end of treatment:

Tab. 2.4 The results of all visual test after 5 weeks of treatment

SUBJECT	AGE	SEX	RIGHT AUTOREF	LEFT AUTOREF	RIGHT REFRACTION	LEFT REFRACTION	R VA	L VA	FAR PHORIA	NEAR PHORIA	AA
1	8	M	-0,12	-0,25	0.25	0,25	1	1	2X	11X	7,5
2	17	F	-0,5	-0,37	0,25	0,25	1	1	1X	1X	6,5
3	15	F	-0,50 -1,37 5°	-0,50 -0,87 0°	-0,50 -1,25 0°	-0,50 -0,75 0°	1	1	4X	11X	6,5
4	12	F	-1,75	-1,63	-1,25	-1,25	1,2	1,2	0,5X	3X	7
5	14	M	0,25	0,5	0,25	0,25	1	1	0	0,5S	8,5
6	15	M	-1,25	-1,75	-0,75	-1,25	1,2	1,2	2,5X	14X	7
7	10	F	-3,00 -0,37 0°	-3,37 -0,25 175°	-2,5	-2,5	1	1	0,5X	4X	8
8	11	F	-1,67	-0,5	-1,25	-0,5	1	1	2X	2X	4,5
9	12	F	0,25 -0,25 0°	-0,75	0,25	-0,75	1	0,63	2X	4X	5,5
10	14	M	-2,87	-3	-2,75	-3	1,2	1,2	0,5X	4X	5,5

In table 2.5 I compare the data from autorefractometer before (T0) and after (T1) syntonic treatment. To simplify data analysis in cases of astigmatic values the cylinder was algebraically added to the sphere. In Figure 2.9 you can see the averages of the values on the graph, it is noted a reduction in the average value of myopia.

Tab. 2.5 Autoref data before and after treatment

Subject	*R Autoref T0*	*R Autoref T1*	*L Autoref T0*	*L Autoref T1*
1	-0,12	-0,12	-0,37	-0,25
2	-0,75	-0,5	-0,67	-0,37
3	-1,75	-1,87	-1,25	-1,37
4	-2,12	-1,75	-1,87	-1,63
5	-0,5	0,25	-0,12	0,5
6	-1,12	-1,25	-1,75	-1,75
7	-3,42	-3,37	-3,87	-3,62
8	-1,67	-1,67	-0,5	-0,5
9	-1	0	-1	-0,75
10	-2,87	-2,87	-3,12	-3
Average	-1,532	-1,315	-1,452	-1,274

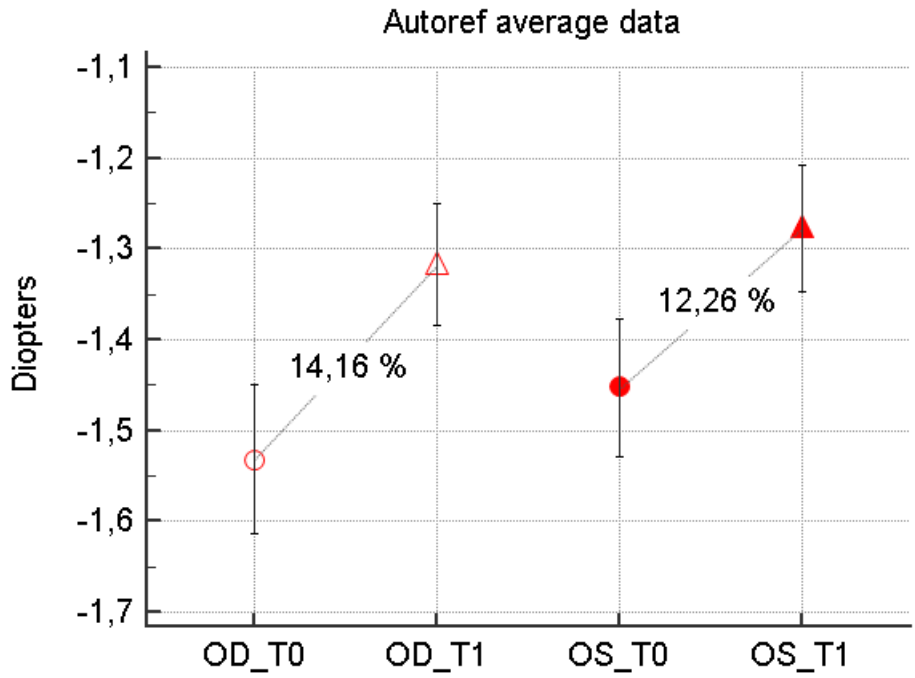

Fig. 2.9 Difference between T0 and T1 in autoref average data

In Table 2.6 I compare the variation of refraction before and after treatment.

Tab. 2.6 Refraction before and after treatment

Subj.	T_0 OD Refr.	T_1 OD Refr.	Var. OD	T_0 OS Refr.	T_1 OS Refr.	Var. OS
1	0.00	0.25	+ 0,25	-0,25	0,25	+0,50
2	-0,5	0,25	+0,75	-0,5	0,25	+0,75
3	-0,50/-1,25	-0,50/-1,25	=	-0,50/-0,75	-0,50/-0,75	=
4	-1,5	-1,25	+0,25	-1,25	-1,25	=
5	-0,5	0,25	+0,75	-0,25	0,25	+0,50
6	-0,75	-0,75	=	-1,25	-1,25	=
7	-2,5	-2,5	=	-2,75	-2,5	+0,25
8	-1,25	-1,25	=	-0,5	-0,5	=
9	0,00/-0,50	0,25	+0,50	-0,75	-0,75	=
10	-2,75	-2,75	=	-3	-3	=

In figure 2.10 I locate data on a histogram bar in order to highlight the differences between data:

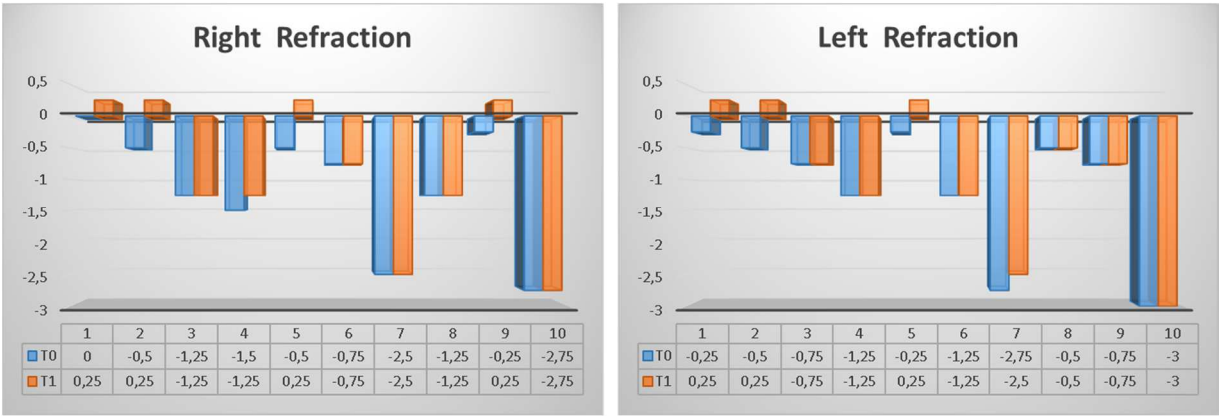

Fig. 2.10 Refraction before (T_0) and after (T_1) treatment in graphic form

Some subjects had refractive grade enhancements while in others there were no significant variations. I then divided the sample into two groups according to the phoria value before the treatment in order to verify the hypothesis of Collier who states the best results are obtained if the subject presents esophoria at near. The result is shown in figure 2.11:

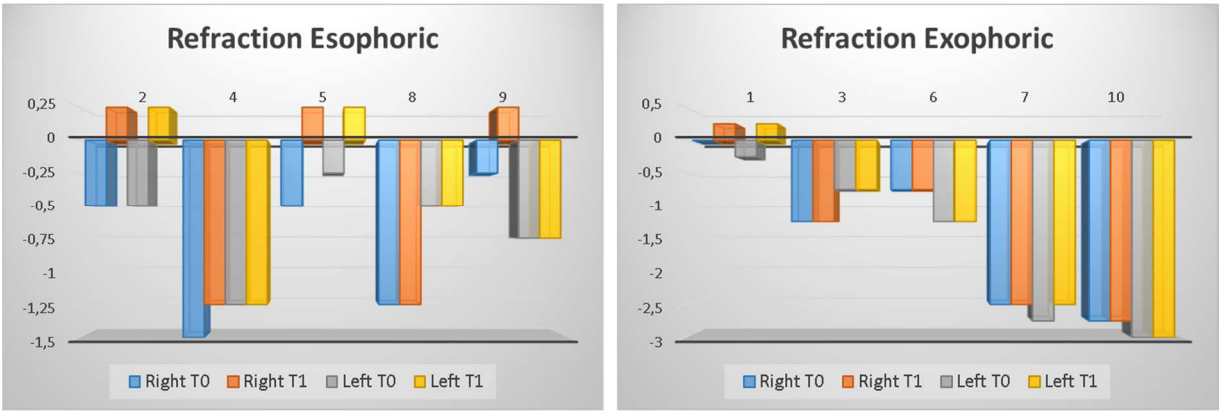

Fig. 2.11 Refraction analysis before and after treatment, differentiated between eso and exo subjects

The group is divided into exactly two subgroups of five subjects, although it is necessary to remember that observing groups with relatively small numbers, we can still consider how the tendency for improvement is more present in the esophoreal, in fact, four out of five subjects report a mono or binocular improvement compared to two of the exophorics .

Another aspect to be checked is the visual acuity before and after treatment (see Table 2.7):

Subj.	OD VA T_0	OD VA T_1	Var. OD	OS VA T_0	OS VA T_1	Var. OS
1	1	1	=	0,8	1	0,2
2	1	1	=	1	1	=
3	0,8	1	0,2	0,8	1	0,2
4	1,2	1,2	=	1,2	1,2	=
5	0,63	1	0,37	0,8	1	0,2
6	1,2	1,2	=	1	1,2	0,2
7	1	1	=	1	1	=
8	1	1	=	1	1	=
9	0,8	1	0,2	0,5	0,63	0,13
10	1	1,2	0,2	1,2	1,2	=

Tab. 2.7 Visual acuity before and after treatment

The visual acuity remained stable in 4 subjects and improved in 6 subjects.

In table 2.8 we analyze the accommodative amplitude:

Subj.	Acc.Amp. T0	Acc.Amp. T1
1	7,5	7,5
2	6	6,5
3	6,5	6,5
4	6,25	7
5	8,25	8,5
6	7	7
7	8	8
8	3,5	4,5
9	4	5,5
10	5	5,5
Average	**6,2**	**6,65**
Percentage increase: **7,26%**		

Tab. 2.8 Accommodative amplitude before and after treatment

As we can see, there are improvement values after treatment in 6 subjects, in the figure 2.12 you can see the average difference between before and after treatment which shows an improvement of the value of accomodation.

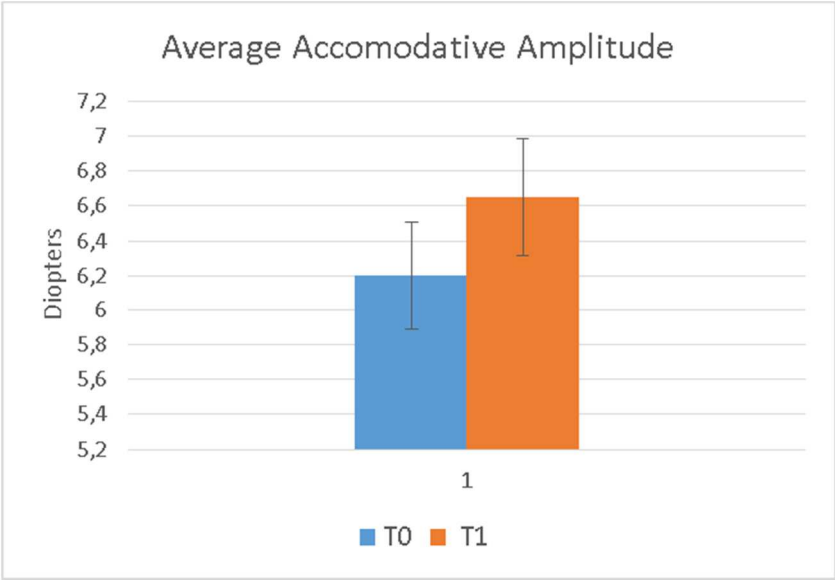

Fig. 2.12 Difference in average accomodative amplitude between T0 and T1

In table 2.9 we observe the changes in phoria:

Tab. 2.9 Phoria before and after treatment (X=EXO) (S=ESO)

Subj.	Far Phoria T0	Far Phoria T1	Near Phoria T0	Near Phoria T1
1	2,5 X	2 X	15 X	11 X
2	0,5 X	1 X	2 S	1 X
3	5 X	4 X	13 X	11 X
4	0	0,5 X	1 S	3 X
5	1 S	0	5 S	0,5 S
6	5 X	2,5 X	15 X	14 X
7	1 X	0,5 X	3 X	4 X
8	1 X	2 X	2 S	2 X
9	1 X	2 X	9 S	4 X
10	0,5 X	0,5 X	3,5 X	4 X

We can see how phoria has changed in all subjects, generally there has been a downward trend of BI in exophoric and a reduction of BO in esophoric with some cases where there has been a shift from esophoria in exophoria. This may indicate that the treatment has brought about a significant change in the visual balance of subjects and this is evident from the variations that the spatial localization system undergoes.

2.4.2 Syntonic test

I analyzed specific tests to evaluate the effectiveness of Syntonic treatment.

Independent nervous system analysis data are represented by pupillary reactions. The data reported in table 2.10 are rated with a score ranging from 0 to 4 following the method of College of Syntonic Optometry as explained in chapter 2.2.3.1. The score 0 and 1 is normal, while the values 2,3 and 4 are out of the norm and indicate an alpha-omega pupil. Table 2.10 shows the test results before and after treatment, a + is indicated for each level of improvement in the last colum.

Subject	*T0 αω*	*T1 αω*	*Variat.*
1	2	1	+
2	3	1	++
3	2	2	=
4	1	1	=
5	3	2	+
6	2	2	=
7	1	1	=
8	3	1	++
9	3	1	++
10	2	1	+

Tab. 2.10 Results of the pupil reaction test before and after treatment

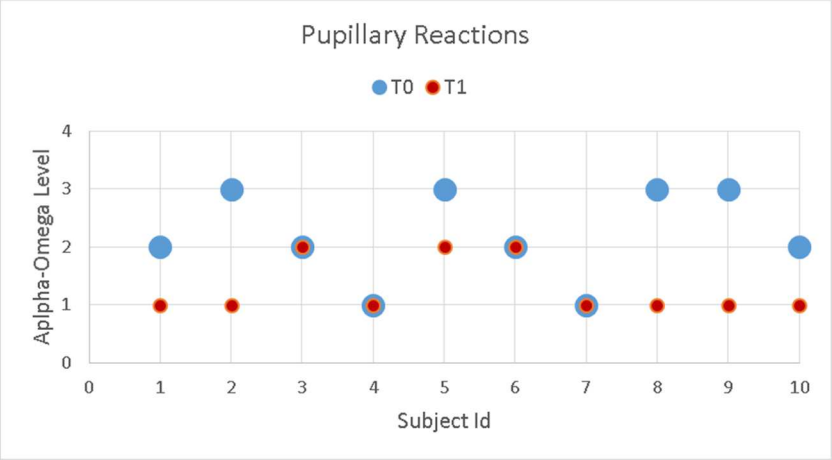

Fig. 2.13 Pupillary reaction data in graphic form

In Figure 2.13 we can see the data in graphical form, it can be noticed that 5 subjects over 10 have improved. Improvement data suggests that subjects after treatment achieved a better balance between the sympathetic and parasympathetic nervous system. The data is even more significant because two of the 4 subjects (4 and 7) who did not gain any improvement had a level 1 pupillary reaction that is not considered an alpha-omega pupil before treatment started.

The results of functional field tests are showed in table 2.11 and 2.12

	Right Eye							
Subj.	White T0	White T1	Red T0	Red T1	Green T0	Green T1	Blue T0	Blue T1
1	33,5	34,6	26,3	24,7	16,4	16,6	26,6	27,2
2	22,4	25,3	12,4	16,3	7,4	9,7	17,7	18,9
3	23,3	31,7	12,5	20,8	6,8	10,1	19,2	18,6
4	25,8	31,3	8,1	18,4	7,3	13,9	17,4	23,5
5	28,3	31	19	21,4	8,9	9,9	13,7	20,3
6	29,3	32,7	18,7	21,3	11,1	15,8	21,1	24,2
7	27,6	30	17,2	23,2	8,8	11,3	12,2	18,4
8	22,5	27,5	19,1	22,3	12,8	13,4	19,5	23,5
9	28	29	23,3	24,6	14,4	14,6	23,9	23,4
10	25,1	29	16,2	20,6	10,8	9,9	15,5	17,5

Tab. 2.11 Data obtained from the functional visual field for right eyes

	Left Eye							
Subj.	White T0	White T1	Red T0	Red T1	Green T0	Green T1	Blue T0	Blue T1
1	30,8	33,8	22,1	27,2	16,3	16,7	28,3	26,5
2	21,2	31	12,1	19,4	6,2	8,5	17,5	20,7
3	23,4	31,2	12,3	19,8	6,8	9,7	17,8	18,2
4	26	31,2	8,2	19,2	7,9	14	18,2	22,4
5	28,8	30,9	20,5	22	9,2	9,8	14,8	18,9
6	27,2	32,5	19,4	21,4	11,5	16	21,4	22,5
7	27,2	30,5	17,2	23,8	8,5	11,5	12,1	18
8	22,3	24,3	17,4	22,9	11,9	14,3	20,1	24,7
9	28,6	27,9	22,8	24,2	14,5	14,5	24,5	24,6
10	26,8	28,7	13,8	19,7	10,4	9,4	18	16,3

Tab. 2.12 Data obtained from the functional visual field for left eyes

In the table 2.13 I compare the visual field values before and after treatment to verify the percentage changes, the last line shows the average improvement for each color:

Subj.	*Right White*	*Right Red*	*Right Green*	*Right Blue*	*Left White*	*Left Red*	*Left Green*	*Left Blue*
1	3,28%	-6,08%	1,22%	2,26%	9,74%	23,08%	2,45%	-6,36%
2	12,95%	31,45%	31,08%	6,78%	46,23%	60,33%	37,10%	18,29%
3	36,05%	66,40%	48,53%	-3,12%	33,33%	60,98%	42,65%	2,25%
4	21,32%	127,16%	90,41%	35,06%	20,00%	134,15%	77,22%	23,08%
5	9,54%	12,63%	11,24%	48,18%	7,29%	7,32%	6,52%	27,70%
6	11,60%	13,90%	42,34%	14,69%	19,49%	10,31%	39,13%	5,14%
7	8,70%	34,88%	28,41%	50,82%	12,13%	38,37%	35,29%	48,76%
8	22,22%	16,75%	4,69%	20,51%	8,97%	31,61%	20,17%	22,89%
9	3,57%	5,58%	1,39%	-2,09%	-2,45%	6,14%	0,00%	0,41%
10	15,54%	27,16%	-8,33%	12,90%	7,09%	42,75%	-9,62%	-9,44%
Average	14,48%	32,98%	25,10%	18,60%	16,18%	41,50%	25,09%	13,27%

Tab. 2.13 Percentage improvement in visual field data after treatment

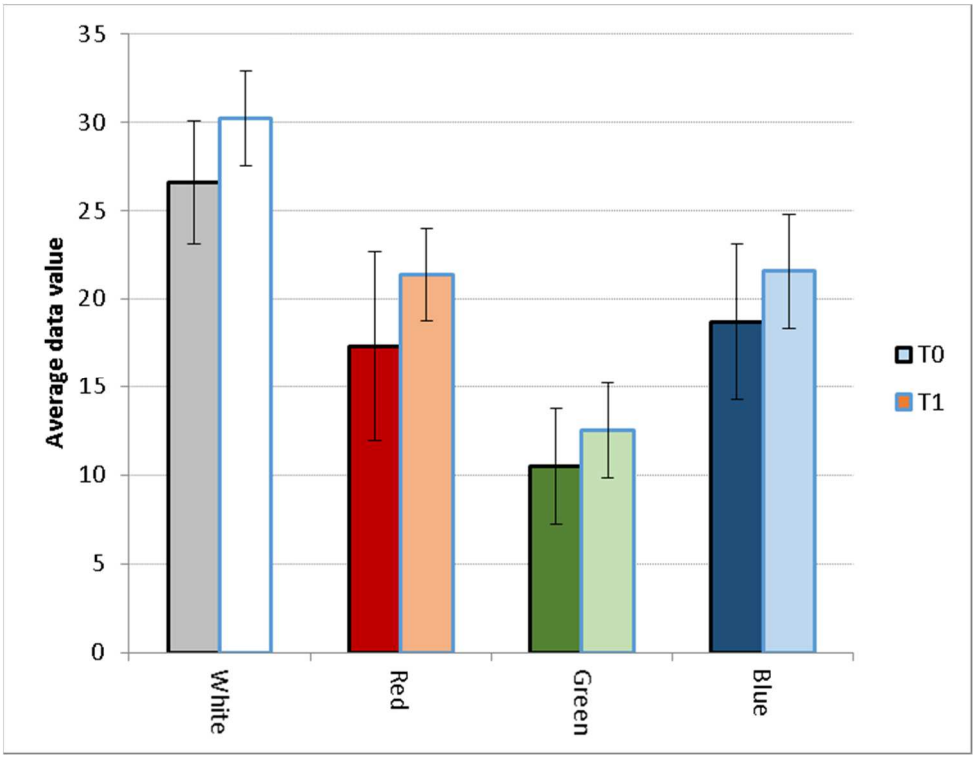

Fig. 2.14 Visual field data: averages difference between T0 and T1

It is noted in table 2.13 that 100% of subjects achieved improvements after 5 weeks of treatment. In two subjects the improvement was limited, while in all others the difference was noticeable.

By comparing the average values for each color of all subjects before and after treatment, as shown in figure 2.14, we can see how there is an increase in the functional field of view in all colors.

The results obtained in the Wilcoxon test (see table 2.14, 2.15, 2.16, 2.17) confirm the high significance of the data: the value of the obtained parameter z is lower than the critical threshold value (-3.8826 for white, -3.7706 for red, -3.2797 for green, -3.0053 for blue) and the p-value is significantly less than the critical 0.05 value (0.0001 for white, 0.00016 for red, 0.00104 for green, 0.00262 for blue).

These two indices allow us to reject the null hypothesis H0 (data not changed significantly between the initial and final checks) and allow us to say that the Syntonic treatment produced visual field improvements.

Tab. 2.14 Wilcoxon signed rank test for color white

White T0	White T1	Result Details
33.5	34.6	
22.4	25.3	W-value: 1
23.3	31.7	Mean Difference: 1.1
25.8	31.3	Sum of pos. ranks: 1
28.3	31	Sum of neg. ranks: 209
29.3	32.7	
27.6	30	Z-value: -3.8826
22.5	27.5	Mean (W): 105
28	29	Standard Deviation (W): 26.79
25.1	29	
30.8	33.8	Sample Size (N): 20
21.2	31	
23.4	31.2	**Result 1 - Z-value**
26	31.2	The Z-value is **-3.8826**. The p-value is **0.0001**
28.8	30.9	The result is significant at p≤ 0.05
27.2	32.5	**Result 2 - W-value**
27.2	30.5	The W-value is 1. The critical value of W for N = 20 at p≤ 0.05 is 52
22.3	24.3	Therefore, the result is significant at p≤ 0.05
28.6	27.9	
26.8	28.7	

Tab. 2.15 Wilcoxon signed rank test for color red

Red T0	Red T1	Result Details
26.3	24.7	
12.4	16.3	W-value: 4
12.5	20.8	Mean Difference: 0.63
8.1	18.4	Sum of pos. ranks: 4
19	21.4	Sum of neg. ranks: 206
18.7	21.3	
17.2	23.2	Z-value: -3.7706
19.1	22.3	Mean (W): 105
23.3	24.6	Standard Deviation (W): 26.79
16.2	20.6	
22.1	27.2	Sample Size (N): 20
12.1	19.4	
12.3	19.8	**Result 1 - Z-value**
8.2	19.2	The Z-value is **-3.7706**. The p-value is **0.00016**
20.5	22	The result is significant at p≤ 0.05.
19.4	21.4	
17.2	23.8	**Result 2 - W-value**
17.4	22.9	The W-value is 4. The critical value of W for N = 20 at p≤ 0.05 is 52
22.8	24.2	Therefore, the result is significant at p≤ 0.05
13.8	19.7	

Tab. 2.16 Wilcoxon signed rank test for color green

Green T0	Green T1	Result Details
16.4	16.6	
7.4	9.7	W-value: 13.5
6.8	10.1	Mean Difference: 0.73
7.3	13.9	Sum of pos. ranks: 13.5
8.9	9.9	Sum of neg. ranks: 176.5
11.1	15.8	
8.8	11.3	Z-value: -3.2797
12.8	13.4	Mean (W): 95
14.4	14.6	Standard Deviation (W): 24.85
10.8	9.9	
16.3	16.7	Sample Size (N): 19
6.2	8.5	
6.8	9.7	**Result 1 - Z-value**
7.9	14	The Z-value is **-3.2797**. The p-value is **0.00104**
9.2	9.8	The result is significant at p≤ 0.05
11.5	16	
8.5	11.5	**Result 2 - W-value**
11.9	14.3	The W-value is 13.5. The critical value of W for N = 19 at p≤ 0.05 is 46
14.5	14.5	Therefore, the result is significant at p≤ 0.05
10.4	9.4	

Tab. 2.17 Wilcoxon signed rank test for color blue

Blue T0	Blue T1	Result Details
26.6	27.2	
17.7	18.9	W-value: 24.5
19.2	18.6	Mean Difference: 0.08
17.4	23.5	Sum of pos. ranks: 24.5
13.7	20.3	Sum of neg. ranks: 185.5
21.1	24.2	
12.2	18.4	Z-value: -3.0053
19.5	23.5	Mean (W): 105
23.9	23.4	Standard Deviation (W): 26.79
15.5	17.5	
28.3	26.5	Sample Size (N): 20
17.5	20.7	
17.8	18.2	**Result 1 - Z-value**
18.2	22.4	The Z-value is **-3.0053**. The p-value is **0.00262**
14.8	18.9	The result is significant at p≤ 0.05
21.4	22.5	
12.1	18	**Result 2 - W-value**
20.1	24.7	The W-value is 24.5. The critical value of W for N = 20 at p≤ 0.05 is 52
24.5	24.6	Therefore, the result is significant at p≤ 0.05
18	16.3	

This result, despite the small number of subjects observed, shows a positive trend as regards to the effectiveness of Syntonic as a therapy to use with subjects with reduced functional fields.

2.5 Discussion

I do not deny that there have been several problems during the research, first of which the choice of the light frequency which needs to be suitable for the subject treatement. I have followed the methodology that Collier refined, but the variables in play are many and only experience and profound knowledge of the neurological mechanisms underlying the visual process and the ability to properly interpret the information collected on the subject lead us to a correct choice.

The second difficulty, especially in young people, is that after initial enthusiasm the treatment is monotonous, so it is often necessary to try and make the treatment as pleasant as possible, for example, we read stories to younger children during treatment, with others we accompanied the treatment with music of their liking, the important thing is to make the session enjoyable and entice them to the next session.

Another difficulty is due to the fact that this type of therapy is little known in our area and is practically unknown to the public and is therefore difficult to explain and propose as the only therapy to be use on its own. It is much better if supported by other VT exercises. In this regard, the visual field test helps us to show the effects of the therapy after a few sessions, which is why I chose to use an electronic field instead of manual ones. First of all, it is much faster and less boring for subjects to undergo the examination, it also has a function that visually allows us to compare the initial exam with one performed after a few sessions, which permits us to explain the positive effects of the treatment to subjects or parents, enabling them to continue treatment with more enthusiasm.

The overall objective of my study was to evaluate the effects that Syntonic treatment might have on myopia subjects. More specifically, the treatment was initially structured so that it also included weekly home-based sessions. I then chose to do all the therapy in my study by limiting the number of sessions to a total 15, that is, 3 for each of the 5 weeks of treatment to ensure that subjects performed the exercises correctly. However, it would be desirable, in a syntonic therapy cycle, to provide a part of home-based treatment to increase the number of treatments. This visual training exercise, although still relatively unknown and used in clinical practice, compared to other types of therapy, has all the preconditions for being an effective optometric tool, as it allows the subject to reach more visual balance.

Two parallel paths have been dealt with in the objectives: on the one hand, Syntonic's effectiveness in obtaining improvements in traditional optometric tests (VA, refraction,

amplitude amplitude) have been evaluated, on the other hand, the effects that the treatment can produce in the specific functional visual field test.

Therefore, the significant results obtained with regard to improvements in functional visual field data are considered to be particularly important.

Interestingly, attention is drawn to a further fact: in 3 subjects with mild myopia (n.1,2,5) there was a complete regression of myopia and even more interesting is that while two of the three subjects had never used correction, subject No. 2 was wearing glasses, albeit discontinuously, for more than a year.

Girl n. 9 only had an improvement in one eye but VA data improved in both eyes allowing her to continue not using glasses and is currently still in therapy with Syntonic associated with flexibly accommodating and VT.

Two other subjects achieved marginal improvements in one eye, but the refractive data is unimportant if taken individually as, especially in subject 4, there has been a net increase in the functional field of view and in the amplitude of the accommodation, moreover, parents expressed remarkable appreciation as their child is calmer and more relaxed at home.

Another interesting point is that there was a greater Syntonic effect on esophoric subjects compare to exophoric subjects confirming what S. Collier had suggested that achieving refractive enhancements on exophoric myopics and stabilized myopia is much more difficult. This works in favor of the theory that at the beginning of functional myopia there is an eso-shift as seen in the chapter on myopia.

The study was conducted on a small number of subjects for which it is not possible to demonstrate the effectiveness efficacy of syntonic treatment on myopics but surely the data is very encouraging and leads to more insight on the subject.

CONCLUSIONS

1. My research has shown that in some cases of mild myopia or the beginning of myopia Syntonic treatment may be effective. Statistically, given the small number of subjects being treated, it is not possible to generalize and be certain of the refractive result for myopia treatment.
2. The treatment is clearly more effective on myopia with esophoria than on exophoric myopia. This evidence would require further investigation but suggests that a careful selection of the subjects chosen for treatment significantly increases the success rate.
3. Data on accommodative amplitude and visus were also improved in subjects where there was no refractive improvement.
4. During the study, two less well-known but widely used investigative techniques were used by syntonic optometrists: pupillary reactions and functional visual field. My tests also statistically showed that the treatment had effect. The functional field of view increased in all 4 colors in all subjects demonstrating the effectiveness of the treatment in extending the perceptive field of the subjects.
5. Spitler at the end of his treatise "The Syntonic Principle" publishes a series of statistical data on 3067 treated patients. There were 68 myopia cases with a 67.65% success rate in stopping or reducing myopia, without specifying other data. In my research the result is slightly lower. Spitler's research also revealed 172 cases treated to increase the functional visual field with a 88.89% increase. In my research the increase in the field of view is even slightly higher.

FINAL WORD

There is remarkable clinical literature on syntonic but little scientific research, thus more accurate research on a larger number of subjects would be opportune..

In the case of myopia, it would be a good idea to do a trial by selecting myopia of medium to high degree but with only esophoric subjects to verify the percentage of success.

We all know how difficult and uncertain the VT is about the regression of myopia, the techniques that work on the slowdown of myopic progression such as orthoteratology and multifocal soft contact lenses are more effective. In this regard, the syntonic phototherapy associated with VT could give excellent results both in the regression of myopia in the initial and mild stages.

My results obtained in the functional visual field are very interesting, since this test technique is not very well known, it would be advisable to verify its effectiveness not only associated with syntonic but also with the technical traditions of VT and possibly also in relation to the ophthalmic lens prescription

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