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SYNTONICS AND PRESBYOPIA

MASTER THESIS

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ANOTĀCIJA

Maģistra darbs uzrakstīts angļu valodā uz 50 lpp. Tas satur 28 attēlus, 3 tabulas un atsauces uz 27 literatūras avotiem.

Pēdējos gados sintonika kā metode ir kļuvusi pieejamāka un pielietojamāka redzes uztveres optometristu vidū. Metodi pielieto, lai sabalansētu simpātisko un parasimpātisko nervu sistēmu saskaņotu darbību, pielietojot dažādu krāsu filtrus.

Darba mērķis bija novērtēt sintonikā pielietoto filtru iespējas sākotnējās presbiopijas ārstēšanai.

Darbā tiek analizēti pacientu dati par sintonikas iedarbības efektivitāti sākotnējās presbiopijas gadījumos.

Redzes asums, bet novērtējot to bez tuvuma aditīva, akomodācijas amplitūda un zīlītes α - ω mērījumi uzrāda statistiski nozīmīgi atšķirīgus rezultātus pirms un pēc sintonikas pielietošanas. Ietekme ir arī uz formas redzes funkcionālo lauku, kā arī uz funkcionālo redzes lauku, ja tiek stimulēta ar sarkano, zilo un zaļo gaismu.

Atslēgas vārdi: sintonika, fototerapija, filtri, redzes treniņš, uzvedības optometrija

ABSTRACT

This thesis is written in English on 50 pages. It contains 28 figures, 3 tables and 27 references.

Syntonic Optometry has become, in recent years, increasingly an instrument of visual re-education among behavioral optometrists and it consists in balancing the sympathetic nervous system with the parasympathetic system using different colored filters.

The aim of this work is to verify whether using only Syntonic filters to treat presbyopia, it is possible to detect any significant variations in the subject undergoing treatment.

The research consists in analyzing a selected population of young presbyopic subjects, before and after a treatment with Syntonic exercises.

Visual acuity near but not addition, accommodative amplitude and pupil α - ω data show statistically significant differences after syntonic treatment. Moreover, syntonic treatment improves visual functional field in form, red, green and blue aspects.

Keywords: Syntonic, phototherapy, presbyopia, filters, visual training, behavioral optometry.

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INTRODUCTION

At the beginning of the 40s, neuroscience development and the study of the chromatic spectrum allow to define the principles of the so-called Syntonic phototherapy. This approach consists of a therapy that uses color light to attune and balance the visual system, with particular attention to subjects with strabismus, amblyopia, and difficulties of accommodation, convergence, learning and eye motility.

Syntonic Optometry has become, in recent years, increasingly an instrument of visual re-education among behavioral optometrists. Its rediscovery and its application in visual training is due in particular to the College Syntonic Optometry. This institution, created in 1930 by the founder Harry R. Spitler, father of Syntonic, laid the foundations for helping to solve not only visual defects, but also to relieve the sufferings of subjects afflicted with not only ocular pathologies. What strikes from the courses held by Stefan Collier, behavioral optometrist and member of CSO, is the apparent simplicity of the Syntonic principle, that is, "tuning": balancing the sympathetic nervous system with the parasympathetic system using colored filters of different wavelengths. The use of colored filters of chromotherapy and chromopuncture is not only a prerogative of optometrists, but also of other professionals. The application of this rehabilitation methodology achieves results by using more and more information derived from non-optometric research but also from other disciplines: neurology, psychology, physiology, neuroscience etc.

The **aim of this work** is to analyse the characteristics of Syntonic Optometry, focusing on the treatment of young presbyopic subjects. In particular, this research aspires to verify whether using only Syntonic filters to treat presbyopia without any other visual training tool, it is possible to detect any significant variations in the subjects undergoing treatment. Syntonic Optometry consists on a therapy that, thanks to colored filters, uses the bright spectrum as visual balance agent.

Researches on photometry and colorimetry field demonstrate that nervous structure of the eye transmit specific light frequencies. These frequencies induce specific biochemical processes, promote a stimulating or inhibiting action on sympathetic and parasympathetic nervous system. Thanks to the use of different colored filters, this action is able to balance the endocrine system and acts on brain areas, that represent the basis of some essential functions of the visual system.

Scientific literature on Syntonic phototherapy, by now very wide especially in anglosaxon world, confirms how light stimulation allows acting on some dysfunctions and pathologies not only eye-related, strengthening and reducing some common visual disorders incidence.

Therefore, Syntonic Phototherapy represents a very helpful support intervention to other optometric rehabilitation techniques, that are able to increase speed and efficiency to solve difficulties.

Following all these premises, it is possible to explain which are **the tasks of this thesis** work:

- To evaluate the influence of Syntonic on standard visual parameters (addition, accommodative amplitude, visual acuity at near).
- To evaluate the influence of Syntonic on functional visual parameters (functional visual field, pupil alpha-omega parameter).

The methodology I have adopted to conduce this research consists in the random selection of some patients from my database; I personally examined these subjects in 2016. Ten people agreed to participate in the Syntonic Optometry program. I got from ten other patients the chance to be examined two months after their last visual inspection to use the information collected as a control sample.

The innovation of this work consists in researching and evaluating any changes and modification in the conditions of close vision, in subjects of 40-50 years old, using the visual training technique known as Syntonic Optometry.

This work is composed by two main parts: in the first part I have studied the principles of syntonic, its history and its applications; in the second part I explained my field research, showing, with a critical approach, the results get from the use of Syntonic Optometry on a sample of my patients.

1. REVIEW OF LITERATURE

1.1 Syntonic phototherapy principles

1.1.1 Historical notions

As it is well known, at the beginning of all earthly things there was light. Light is the source of life. The expression “let there be light” is at the beginning of the first day of Genesis. In all religions, light has been and is still a sign from God or the divinity itself. The color and light are one. Now the light is considered by physicists a form of energy, but for thousands of years was considered the opposite of the dark. Color therapy was known in prehistoric Peru, Mexico, in ancient India and China. The color still has an important role in the diagnosis of Chinese medicine.

Hippocrates and Galen, Greek physicians, knew light therapy. Aristotle was the first to say that lights propagates in waves.

In 1672, Isaac Newton using a prism was the first pioneer to discover that the light, in her visible incident spectrum, breaks up into the colors of the primary ray of the iris. In 1676, Ole Römer was the first to measure the light speed, giving rise to the science that studies the physical characteristics of the light: the optics.

First scientific approaches to the light and her properties appear almost in the same period; writers and philosophers as Shakespeare and Descartes perceived the importance of the light not only as a physical phenomenon, but also the relation between light and human essence. They discovered that the eyes take the light to the body, the mind and the spirit and they represent an access way to allow the integration of the human being with his essence, with the outside, with the universe.

The German philosopher and author Goethe, in 1840, published his work “Theory of colors”, where he shows for the first time in the story, the influence that colors have in our life at different levels: physical, mental and emotional. Starting from this point, it is born a new approach to study the light and her effects on the human life. In the second part of the XIX century, it started in a systemic and deepened way the study of the light and her interaction with the mankind. The scientists and precursor of these aspects are Ghadiali, Loeb, Pleasonton, Pancoast and Babbit.

In Italy, a Sicilian doctor, MD Antonino Sciascia, who lived a century ago, discovered the phototherapy and he was the precursor of the radiological sciences. He used a colored light, called *photocauterio*, with which he cured, with such success, his patients and he was considered the “miracle doctor”.

At the end of XIX century, the Dane Niels R. Finsen studied the effects of the sunlight, conveniently filters, on the treatment of skin lesions caused by viruses, smallpox in particular. The radiations of the red part of the spectrum were useful to heal smallpox lesions. Finsen received the Nobel Prize in 1903.

Syntonic phototherapy may be defined as a therapy that, thanks to colored filters, uses the bright spectrum as visual balance agent. The College of Syntonic Optometry defines the Syntonic as “the branch of ocular science dealing with the application of selected visible light frequencies through the eyes”. Etymologically, the word “Syntonic” comes from the Greek *synton(os)*, that literally means stretched together and, at a physical level, indicates a state of being adjusted to a certain wave length, an agreement or tuning between the time period of an apparatus emitting electric oscillations and that of a receiving apparatus.

The syntonic represents a branch of the behavioral optometric science that uses specific chromatic frequencies for therapeutic purposes, to treat particular visual dysfunctions. Indeed, the optometric procedure shows that the Syntonic, both independently or linked to other therapeutic protocols, represents:

- an alternative approach for pathology non-treatable with standard procedures;
- a coadjuvant treatment for typical medical-local, pharmacological or surgical therapies (Collier, 2010).

In particular, the Syntonic belongs to the “energy medicine” and it is a non-invasive technique, with a stimulating approach to improve visual correction and equilibrium, using bright filters that act on mind-body interaction. A particular diagnostic protocol has been elaborated; it organizes the eye dysfunctions depending on an acute syndrome, a chronic syndrome or a syndrome related to emotional fatigue (Ingersoll et al., 2011).

The aim of the syntonic phototherapy is to stimulate brain biochemical properties through visual system and through retina-hypothalamus-brain connection. Several studies confirmed that neurotransmitters, at the presence of a light source of different colours, induce a biochemical response, acting on dynamics of fixation, accommodation and convergence.

Historically, the Syntonic started in the 1920s, thanks to Harry Riley Spitler, the one who gave the name to the Syntonic Optometry, and he studied the clinical application of specific bright frequencies in the optometric practice (Griffin, 1980). Spitler conducted several researches on the role of the eyes in the photo-transduction and on the incidence of the light and of the colors on biological and biochemical functions, verifying that many bodily, mental/emotional and visual ailments are caused primarily by imbalances in the autonomic nervous and endocrine systems (Griffin, 1980). His studies focused on the ability of the optical-neurological structure to transmit the bright stimulus, through the retinal-hypothalamic

tract, up to specific brain areas, that supervise the oculomotor system and the emotional reactions of the subject. In this way, it is possible to determine a rebalancing of the eye dysfunctions and of the brain centers that regulate humor and emotions.

The chromatic activity stimulates the cellular structure of the body and affects nerves and organs. Over the centuries many healing techniques have been developed using the light: color therapy, chromopuncture, light baths, helio therapy, helio color therapy, Aura-Soma®, Klarstein light LED color changing humidifier aroma therapy, chakra system, etc.

From a scientific point of view, all these techniques are considered pseudosciences, but there are also neurosciences, photobiology, in particular, which is a scientific study of the interaction of the light on living organisms (Karu, 1989). Researches on photobiology field demonstrate that human organism is really easily influenced by the light; these studies demonstrate also that through a proper use of light, it is possible to influence the organism until it changes its rhythms (Oschman, 2001). One of the most famous methods to manipulate organism rhythms is the one developed by Charles Czeisler of the Brigham and Women's Boston Hospital. Czeisler, who collaborates also with NASA, developed a technique that, changing high levels of illumination (10.000 lux) with periods of totally dark, it is possible to modify human circadian rhythms (the rhythms of our physiological functions within 24 hours) (Oren & Terman, 1998). These therapeutic techniques are applied and have been used for the treatment of diseases and are applied "externally" on the body. Only the Syntonic Optometry uses light directly through the eyes.

The birth of College of Syntonic Optometry in 1993 and the Spitler's essay "the syntonic principle" of 1941 represent the starting point of the Syntonic Optometry. This definition refers to the ability of some chromatic frequencies to create a new tuning or balancing in some visual and behavioral functions. The application of some bright frequencies and the use of the eye as a neurological vehicle allow to act on brain structures and to correct eye dysfunctions, working on their mechanical and neurological origins (Wallace, 1999; Ray & Wallace, 2001). While red light is able to stimulate sympathetic nervous system with his low energy and high wavelength, grey light (medium wavelength) is a physiological balancing factor and indigo (high energy and short wavelength) in a parasympathetic system activator. In particular, Spitler conduces a research on 3067 subjects treated with a syntonic approach (Syntonic Effectivity: a statistical compilation of ocular anomalies handled by applying the syntonic principle). 90.7% of this population reacts positively to the treatment, demonstrating that retinal-hypothalamic request can induce positive effects on some visual pathologies and on emotional-behavioural equilibrium (Spitler, 1941).

During the 50s, some studies related to syntonics theory show that vision is subject to a learning process and it is possible to define individual programs to correct the imbalances and to strengthen visual abilities. All these studies drive to the creation of the so-called vision therapy and to the definition of the behavioral care of vision, visual training or VT (behavioral vision care).

During the 60s and the 70s, Syntonics system has been further improved thanks to Charles Butts. He confirmed the action of the bright spectrum on the sympathetic nervous system (red light) and on the parasympathetic one (purple light), identifying different chromatic intermediate scale, able to act through the neurochemistry of the retinal-hypothalamic tract. Furthermore, Butts elaborated a new diagnostic protocol for the visual disorders and a new methodological approach. Patients were evaluated starting from their symptoms, thanks to a specific case history, the OEP (Optometry Extension Program) points, pupil responses, visual field analysis and other tests (Campbell & Murphy, 1998).

The studies conducted in the 80s and in the 90s confirmed that some light frequencies, transmitted through the nervous ocular structure, are able to work at a biochemical-neurological level, and to correct even serious visual deficiencies. In particular, Kaplan (1983) and Liberman (1986) demonstrated that a short Syntonics treatment is able to considerably improve mobility, visual precision and peripheral vision. These researchers underlined how some performance problems are due to lower sensitivity of peripheral vision, that can be improved thanks to the Syntonics Optometry (Bailey, 1980).

Development of optometric phototherapy studies promotes the creation of tuners, supported by the College of Syntonics Optometry, to increase studies on light frequencies, more appropriate to chromotherapy treatment. In the second half of the 90's and at the beginning of the new millennium, the study of visual dysfunctions and emotional-behavioral dimension continues. In particular, on the first aspect, Ray and collaborators (1999) studied the effect on convergence and accommodation of the exposition of some subjects to yellow filters for three months.

Accommodation is the ability of the eye to modify the refraction and the position of the visual axis, to maintain clear retinal images and keep them in the macular site, when an object, fixed at a distance, is moving closer.

Opposite processes occur when a close fixed object moves far; the synkinesis of the accommodation, of the convergence and of the miosis represent the complex phenomenon of the close-up vision. The accommodation is the modification of the dioptric power, that is possible thanks to increase or decrease in curvature of crystalline and in the thickness of his central portions. Accommodation is due to ciliary muscle contraction or relaxing and it is

activated by a blurry retino-cerebral image (accommodation is measured in diopters, that means it is the reciprocal of the fixing distance, in meters).

Convergence is a disruptive movement that happens thanks to a same synchronous adduction of the eyes and it allows a close encounter of visual axes. The closest point on which eyes can fit is the near point of convergence; usually it is closest to the near point accommodation and generally it does not change with age.

In the clinical practice, it is normal to consider the near point below 10 cm (the unit of measure of convergence is the metric angle; numerically this unit is the reciprocal of the fixing distance in meters). For the clinical determination of the convergence, a common pen-light is used as light source; approaching it in the median plan, while eyes are fixing in symmetric convergence, it is determined the distance to which the reflection on the cornea no longer centers on the two pupils, because one eye deviates from the outside.

Ray and collaborators (1999) verified how the Syntonic is particularly useful both in the presence of accommodative convergence, that is caused by the accommodation effort, and in the inverse phenomenon, that is the accommodation with a convergence effort. They demonstrated that accommodation and convergence significantly improve thanks to the use of colored filters and the positive effect persists even after the suspension of their use. Yellow filters would also improve the perception of movement (Stein et al., 2000).

For what concern psychiatric disorders, the discovery of seasonal depression has paved the way for a wide-ranging experimentation of light stimulation, expanding knowledge of the effects of light on the neurological system. These studies relate to the theory that low frequency light stimulates the sympathetic nervous system, and the high frequency light stimulates the parasympathetic one.

1.1.2 Biochemical and neurological premise on Syntonic Phototherapy

The syntonic operating mechanism is based on some discoveries, made by neuroscience in their first phase of development. Neuroscientists verified that the neurological structure of the eye is a way through which, thanks to biochemical reactions, the transmission of information between retina and brain leads to physiological and neurological reactions. This suggested that it was possible to act in order to correct visual defects, ocular mobility disorders and particular psychological states, thanks to the visualization of colored light sources (Wallace, 2009).

Syntonic is based on the fact that the optical section is made up of a bundle of optical fibers, which originate from the chiasm. Each optical section has a backward pathway, that is divergent in comparison to the chiasm, until it reaches the geniculate lateral body and it

represents the terminal portion of the second afferent or conductive neuron. The lateral glandular body is an oval nucleus, located at the side of the thalamus pulvinar and from which begins the third afferent or conductive neuron.

Gratiolet's optical radiation consists of the set of nerve fibers that, from the geniculate body, lead to calcarine fissure and represent the continuation of the third afferent or conductive neuron. Optical fibers, when they left the Gratiolet radiation, mediate in the white substance above and below the calcarine fissure, and end in contiguous grey matter. The cortical area, called striped area, extends from the tip of the occipital lobe to the rear end of the crown of the calyx body and corresponds to the contour of the calcarine fissure, opening the internal face of the cerebral hemisphere.

The striated area represents the central receptor of elementary visual sensations. The parastriated and the peristriated visual areas, however, preside over the interpretation and integration of sensations with other cortical activities, thus creating complex perceptions (psycho-visual function).

The central nervous system and the autonomous nervous system manage the control and the regulation of various ocular physiological activities.

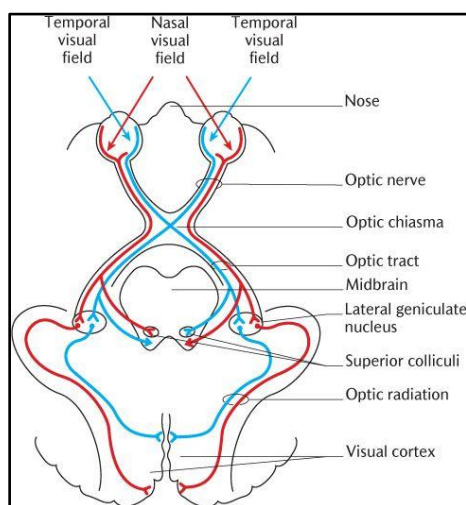


Fig. 1.1 Diagram that represents the visual pathways¹

The central nervous system, in addition to overseeing the visual sensory function (optic nerve) and the sensitive function (trigeminal nerve), presides over the movements of the eyelids and the ocular globe (Fig.1.1). Also the autonomous nervous system presides over the motor activities and vegetative activities too (Moncada, 2007).

Through this complex retinal-cognitive structure, visual stimuli arrive at the encephalon and, inside of it, the limbic system that includes the hypothalamus (which produces several

¹ <https://pocketdentistry.com/18-the-cranial-nerves/>

neurohormones and controls the action of the pituitary gland), the hippocampus (which plays an important role in memory, learning and emotion expression) and the amygdala (which elaborates emotional responses based on acoustic and visual stimuli). In particular, the light, in the form of nerve impulses, arrives to the cerebral cortex and to the hypothalamus (Fig. 1.2). The hypothalamus contributes to the regulation of homeostasis and participates, through its coordinating centers, in controlling some of the major vegetative and metabolic functions.

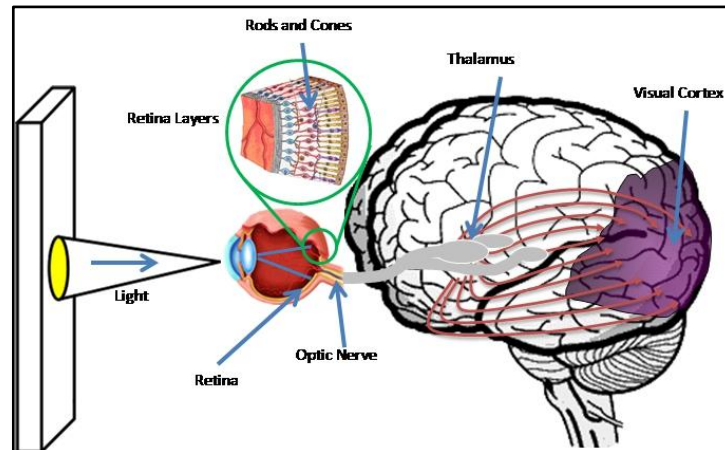


Fig 1.2 Graphic representation of the visual pathway in the brain²

Therefore, neurosciences highlighted the importance of the limbic system as a superior integrative center of visual perception and cognitive-emotional processes. This has paved the way for the study of the integration between visual processes and visio-emotional stimulation reactions. The neurological investigation also established a relationship between color perceptions and limbic system responses, confirming how the use of filters represents a possible treatment of pathologies related to emotional dynamics, such as depression, sleeps circadian disorders, etc...).

1.1.3 Mode of operation of the colored light therapy

As already mentioned, Syntonic represents a non-invasive treatment based on the light spectrum abilities to activate neurochemical processes, that can create a balance. In fact, light spectrum is used as a visual and emotional balancing agent: colored light works on neurotransmitters through the retinal-hypothalamic connection, inducing a biochemical process that results in a balancing and syntonic response.

Recent studies have shown that the energy generated by the light field, intended as photo-energy stimulation, interacts with the magnetic field of the eye, promoting a series of therapeutically relevant eye and biochemical reactions (Collier, 2010). This mechanism also

²

<http://www.keywordsuggests.com/ojELrM8eyBj4fxrj%7C18AWJeQMMCKsrx5Hvroz35kJWsf2daKC0yRPMLnbM92NzGDwWhIXuO7Vxgg%7CWIZNmuugw/>

integrates with neurological and endocrinological effects produced by visual stress. Therefore it can be said that physiological and emotional-psychological reactions can be induced by the vision of specific colors.

In particular, some studies demonstrated that syntonics therapy can determine four types of changes:

- Physical: the crystalline changes its shape to a greater or lesser degree depending on the color, so as to determine correct focusing on the retina.
- Chemical: different color lights produce different effects on rhodopsin; different colors light results in a molecular modification due to the saturation of the photoreceptors of the retina.
- Physiological: visual stimuli interact with the retinal photoelectric properties until a reaction with a conical shortening is determined: the stimulation reaction is transmitted to the reflex arc to the visual centers in the visual cortex (processing of information acquired by the Parvo-Magno visual system) which, in turn, produces a series of reactions, though intricate, are well-known (Collier, 2010).
- Psychological: the endocrine system regulates the tonicity and irritability of the vegetative system; this explains why the light can have a significant impact on the mood of a subject (Karu, 2000).

1.1.4 Mode of balance between retina and hypothalamus

The syntonics practice involves the use of specific filters for each particular type of pathology and therapeutic intervention. The diagnosis is based on the subject's clinical history, on the current symptoms, and on the results of the diagnostic examinations.

The duration of the treatment varies from one to two months, and it is usually composed by three to five sessions per week. The standard phototherapy program consists of a series of twenty sessions of twenty minutes each, to be realized as a stand-alone visual therapy program or as complementary to other techniques (Gottlieb & Wallace, 2001). Treatment success should be evaluated based on the positive evolution of the symptoms, behavior on the subject (mood, attitude, propensity to sociality), performance (school and expressive), and changes in the results of functional optometry tests (Gottlieb & Wallace, 2001).

Syntonics optometry elaborated, in particular, a diagnostic protocol that organizes eye dysfunction based on the identification of "four syndromes": acute syndrome, chronic syndrome, related to emotional fatigue syndrome, or the so-called "lazy eye syndrome" (Wallace, 2009).

The acute syndrome is common to subjects with a clinical history or symptoms that highlight recent cerebral-ocular problems, resulting from an infection, a cranial trauma, anoxia, high heart failure and high fever. These symptoms occur with headache, ocular hypersensitivity, bulb pain, and orbital area. The intervention requires, first of all, the use of chromatic frequencies that reduce the neuralgic sensation, such as indigo and blue-green color filters. These filters are able to reduce inflammation and cortical and retinal congestion by acting on the neuralgic sensation. For what concern diagnostic, acute syndrome is often accompanied by exophoria (either due to convergence or excessive divergence), orbital pain, headaches, spots or dark spots in the visual area, visual field alterations, inability to move the pupil in a linear and regular way, and finally abnormal pupillary responses to light (Wallace, 2009).

The chronic syndrome, on the other hand, is characterized by chronic or degenerative health problems that are organic, metabolic, toxic or related to previous trauma. Symptoms include a constant fatigue, loss of visual tonicity, asthenopia, headaches and photophobia. Diagnosis is based on visual field alteration (with a sensible reduction), exophoria, accommodation difficulties and alterations in the visual fields of red/green and blue. In this case the syntonics prescribes the use of yellow-green filters, which act as physiological stabilizers and activates detoxifying processes. Yellow-green filters are often associated with indigo-red or ruby-color if there is also an emotional instability (Wallace, 2009).

The third syndrome, quoted by Wallace, is the so-called emotional fatigue. It affects subjects with a state of exhaustion, mood alterations, and a negative attitude associated with agitation or depression. Symptoms may include visual impairment, asthenopia, allergies, headaches, asthma and fluid retention, while diagnostic criteria include low ocular reactivity and exophoria. Filters used in this case are ruby and Russian-indigo, used in combination for ten minutes and subsequently replaced by yellow-green filters, in order to balance the sympathetic and parasympathetic through adrenaline support (Wallace, 2009).

Finally, lazy eye syndrome is treated with red-orange filters, which are able to stimulate the sympathetic nervous system in the treatment of exotropia or amblyopia. The aim of the combination of these filters is to create electrical activation in cell membranes in order to overcome synaptic resistance to the origin of the amblyopia, abnormal retinal correspondence, and binocular vision alterations.

Syntonics action is also based on a balancing action of the two components of the vegetative nervous system, the sympathetic and the parasympathetic system. These two components, though they have antagonistic functions, serve to maintain the physical-psychological balance of an organism. The aim of Syntonics Optometry is to rebalance the two poles of the sympathetic and parasympathetic system both at a neurovegetative and psychological level,

restoring harmony in the dynamic energy activity (which is the origin of visual pathologies and emotional imbalances), through biochemical reactions caused by the colored filters (Wallace, 2009).

S. Collier added two other syndromes:

1. Omega-Neurostenic syndrome or the Fight-or-Flight reaction; it is highlighted particularly in subjects tending to social and emotional exhaustion and are treated with red-orange filters combined with blue-green and yellow-green ones.
2. Pi-Omega or Hyper-Hypo syndrome; it describes subjects with tendency to post-traumatic emotional component with inclined head; in addition to other features there is always a vertical perforated detector from far and/or near. Red light (low energy and high wavelength) stimulates the sympathetic nervous system, while blue-indigo light (high energy and short wavelength) stimulates the activities of the parasympathetic nervous system. The first one controls cardiovascular functions related to cardiac activity and blood pressure; the second is responsible for the neurovegetative activities related to nutrition (Collier, 2010).

1.2 Syntonic phototherapy application and tools

1.2.1 Syntonic optometry application

The syntonic practice allowed us to identify a series of intervention fields where Syntonic is able to intervene in the rebalancing and correction of the visual field. This concept refer to the strabismus and the amblyopia (both characterized by a decrease in the field in the two eyes), to the correction of eye motility, to the Tourette syndrome (especially present in children and promoting a 15 degree visual field diameter restriction). As Gottlieb and Wallace observe, 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" (Gottlieb & Wallace, 2001).

As previously reported, preferred intervention areas of Syntonic are of three types: strabismus and ocular motility disorders, mood-related pathologies and reading difficulties and learning.

A first field of intervention is related to the dysfunction of the fixation and the visual field. Ocular kinematic pathologies are numerous and some of them result from incorrect fixation. This last term is used to indicate the stable holding of the image of the observed object on the fovea. Stability of fixation is only apparent: in the reality a "stable" fixation is the sum of a complex motor activity, represented by nystagmus and by rapid movements (saccadic) and slow movements (tonic). Therefore, due to the fixing movements the image of the object

observed is constantly oscillating within the cones in the fovea. If that were not the case, retinal images would disappear for local adaptation.

In addition to fixation, the situations handled with Syntonic relate to the anomalies of the field of vision, that is the part of the outside which, for a given distance of fixation, is perceived without moving the eye or the head. The dysfunctions may concern both the fixation field (the area within the central fixation is possible by moving the eye and holding fixed the head), and the practical fixation field (the fixation field achievable by the movement of the eyes and the head).

The following list summarizes the possible operating areas of the syntonic:

- strabisms: diplopia, confusion, abnormal retinal correspondence, abnormal binocular vision;
- amblyopia;
- heterophore;
- esotropies: intermittent, congenital, accommodative;
- exotropy;
- hypertrophy;
- pathological nystagmus;
- myopia;
- dynamic pupil abnormalities;
- some corneal and scleral disorders;
- vascular retinopathies.

In recent decades, optometric practice widely used syntonic also in the correction of certain learning disabilities, such as dyslexia and autism (Fan & Takaheshi, 2009).

Finally, some recent techniques focused the attention on the efficacy of Syntonic in the treatment of mood alterations and seasonal depressions. This approach emphasizes how the hypothalamus is the seat of the dynamic patterns of emotion. In the presence of a stimulus that can trigger an emotion, these patterns are released from cortical inhibition and give rise to peripheral (including ocular) manifestations, whose signal is postponed to the cortex. The action on the sympathetic and parasympathetic nervous system allows to re-balance the energy flows that regulate the main vital activities, acting positively on the mood and on the causes of depressive phenomena.

1.2.2 The use of optometric photometry in visual dysfunctions

In the first part of this work it has been highlighted how the Syntonic tends towards to work in the specific field of eye motility disorders (Wallace, 2009). This specialization is determined by the fact that the use of colored filters can significantly improve functional visual fields by increasing the visual area, functional field size, and visual memory (Larkin, 1980).

The etiology of ocular motion defects is related to optical, sensory, motor, and psychological impediments. Optical impediments are often the basis of childhood strabismus; two retinal images different for shape and sharpness are inadequate for proper melting and they favor concomitant deviation of the eye with the least valid image. These optical obstacles are represented by high refractive defects, anisometry, aniseiconia and anatomic optic, acquired and traumatic opacities of cornea and crystalline and macular lesions.

Sensory impediments include congenital and acquired alterations of the visual pathways to the cortex. Motoric impediments can be static, kinetic and neurogenic. Static obstacles are of anatomical nature (asymmetry of the orbits, bulge deformations, exoftalm, inflammatory and neoplastic processes of the orbit, etc.). Kinetic obstacles refer to the accommodation-convergence ratio and are the most common cause of accommodative strabismus. In general, the continued use of accommodation promotes the development of an exophoria and then of an exotropia.

The central impediments to the realization of binocular perceptions have a great influence in determining the anomalies of eye motility. This is a failure to activate the fusions located in the middle brain. A reduction in binocular vision efficiency can occur as a result of a depression of cerebral activity (fatigue, debilitating diseases, poisoning, coma, etc.); often in the children, hyperexcitability (febrile illnesses, etc.) can cause the transformation of a latent strabismus into an evident one.

1.2.3 Accommodative deficits, retinal and corneal pathologies treatment.

Studies conducted in the new millennium, largely promoted by the College of Syntonic Optometry, highlighted the benefits promoted by syntonic treatment on a series of deficits. Russian medicine often uses chromotherapy in childhood myopia, using low-intensity red filters and infrared light directed on the limbic sclera of each eye for six minutes, during ten consecutive daily sessions (Avetisov & Khoroshilova-Maslova, 2005). Other researchers use similar transscleral treatments to reduce eye strain.

Even more serious ocular pathologies have been successfully treated by using syntonic phototherapy.

Studies conducted in recent years have also highlighted how Syntonic shows great potential in the treatment of three of the leading causes of blindness: glaucoma, macular degeneration, and cataracts (Ivandic & Ivandic, 2008). This includes restoring vision in macular degeneration and cataract, and reducing intraocular pressure in normal and ocular hypertensive patients (Gottlieb & Wallace, 2010).

Syntonic promotes a double action. On the one hand, it aims to act on the functional dimension of the pathology, promoting the correction of the anomaly through a solicitation of the nervous structure and activating biochemical processes that can promote an accommodation dynamics. On the other hand, it works on the vascular system, as the eye is the only area of the human body where the vascular system is directly exposed to light. In a single session, syntonic treatment is able to radiate a large volume of blood by acting on vascular functions that carry neurochemical agents, sensitive to light, to and from cells and organs. Blood also contains photoreceptive molecules that absorb light radiation and use it to regulate various chemical activities. Studies conducted by Russian researchers have shown that light is able to interact with cellular metabolism: a) stimulating the production of important neurohormones for mood regulation such as dopamine, noradrenaline and serotonin; b) activating the cytochrome C oxidase photoreceptor, which generates ATP, that is energy. In this way, light promotes dendritic growth, regenerating those "branches" of neurons (dendrites) that have been damaged by deficiency or lesions, or neural degeneration (Karu, 2000).

In addition to the view, researchers proposed different types of access to illuminate the affected cells, that are the non-visual opsins located in the brain. It was proposed to use the sight and the ear canal at the same time. The light stimulation through the visual-ear canals activates a non-visual opsin, the encephalopsin, which operates on some neurochemical substances in brain areas such as the front cerebellum, the trunk of the brain, and the lower temporal area producing more quantities of hormones such as melatonin, noradrenaline, serotonin and dopamine, involved in mood disorders.

1.2.4 The problems of learning and dyslexia

Optometric practice has been widely used in recent decades even in the context of correcting specific learning disabilities.

Specific Learning Disabilities (SLD) refer to instrumental reading, writing or calculation difficulties. Difficulties may arise when a child reads in a not fluent way or making mistakes, he does not seem to remember or understand what he reads, writes in a not understandable way or with spelling mistakes regarding substituted, omitted or inverted letters (Zorzi, 2010).

In subjects with dyslexia, it has been highlighted that eye movements are those of a child who is learning to read. Dyslexics fix the written text for longer than normal readers and have regressions in series (this phenomenon has been called a *reversed staircase pattern*). In practice, the dyslexic performs a sequence of regressions to re-read a letter or part of a word that he omitted or jumped due to the anomaly. It is also possible that some subjects see the letters of the text upside-down and regressions induce to read the opposite. These subjects have a slower horizontal readability from left to right, both in monocular and binocular. Instead, they have a higher speed in vertical reading (top to bottom). In conclusion, dyslexic has some major oculomotor disorders that ophthalmology has tried to solve with different methodologies (Zorzi, 2010).

Among the different approaches to treat learning problems, Syntonic has a significant role through colorimetry and colored filters. The technique of colorimetry, through the use of colored lens, inaugurated in the second half of the nineteenth century to reduce visual asthenopia during reading. This approach was resumed in the 80s and 90s of the last century. Subjects with dyslexic manifestations were treated with colored lenses and acetate sheets, which act differently on the visual system (Evans, 1997).

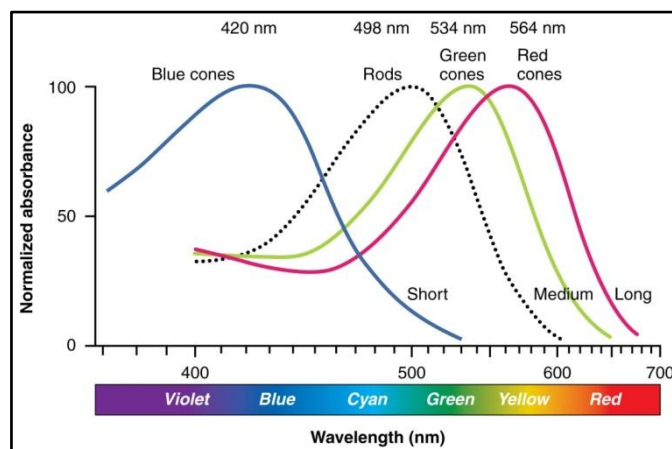


Fig 1.3 Absorption strips of the three types of cones.³

The study of colors took to the conclusion that, although the magnocellular system is not involved in color discrimination, it perceives brightness through the inputs it receives from all three types of cones: S = short or blue, M = medium Or green, L = long or red (Fig. 1.3 and 1.4).

³ <http://oerpub.github.io/epubjs-demo-book/content/m46577.xhtml>

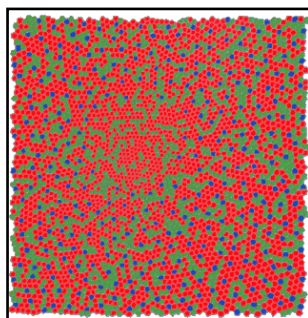


Fig 1.4 Distribution of the three types of cones in the fovea. The S cones, those for the blue, are in a clear minority.⁴

The magnocellular system is also more sensitive to yellow light. The yellow filters, therefore, would be able to cut the low wavelengths and normalize the inputs of the L and M cones by improving the efficiency of the magnocellular system and, through it, the verges, the convergence and the accommodation (Zorzi, 2010). Even blue and green filters make it easier reading for dyslexics subjects. Some researchers believe that the synonyms allow to improve the convergence and the accommodation both during the treatments and after the use of the filters (Williams et al., 2003).

1.2.5 Pupil response evaluation

Evaluation of pupil behavior is extremely important before, during and after syntonics treatment. This evaluation is performed with a light pen projected on the ocular bulb of the subject in question, in a low lightened room. This test allows to evaluate how the autonomic nervous system is working in a well defined moment. The CSO defines pupil behavior in Alpha-Omega.

The iris gets sympathetic and parasympathetic innervation. Sympathetic nerves innervate the muscles of the pupil dilator and inhibit the accommodation. The parasympathetic nerve fibers (from Cranial Nerve III) innervate the muscles of the pupillary constrictor (sphincter), as well as the ciliary apparatus for accommodation. During normal waking state, the sympathetic and the parasympathetic are active. They also affect the reflections of both emotion and environmental illumination. The increased light produces a higher parasympathetic tone and therefore the contraction of the pupil also stimulates the accommodation for a sharp close vision. With age, the pupil's average size decreases. About 25% of individuals have asymmetric pupils (anisocoria) with a difference usually less than 0.5 mm in diameter, which should be considered when attaching asymmetry to the disease, unless there are other signs of neurological dysfunction.

⁴ https://www.cis.rit.edu/people/faculty/montag/vandplite/pages/chap_9/ch9p1.html

1.2.5.1 Alpha-Omega pupil

Dale A. Fast, OD, identified that pupil examination is an important part of the evaluation of a patient who should be considered for treatment with Syntonic Optometry. One of the most useful tests is the alpha-omega pupil test ($\alpha\omega$). This term was suggested by Dr. Paul Johnson after reading Dr. Dutton Brewer's paper about the pupil working mechanism, in 1934. This professional test is a good indication of how the autonomic nervous system is operating at that time. This test indicates if in a person is dominating the sympathetic or parasympathetic system, and in particular, indicates an eventual inadequate adrenal function. To administer the test, a pen-light is pointed directly and kept on a patient's eye while he is fixing a target at distance without accommodating. Normally, when the sympathetic and parasympathetic system are in balance, the pupil narrows and maintains the initial size forced for about ten seconds if the light is not altered. With an alpha-omega pupil, the pupil tightens and then dries again. The speed and amount of dilation are based on the dominance of the sympathetic system compared to parasympathetic one.

Stefan Collier and Egon Weiler (2010) developed a particularly meticulous evaluation model: far, close with graphic characters or silver ball, with low illumination, or with a normal ambient-light.

- 0=bright stimulus, myosy and pupil remain contracted;
- 1=bright stimulus, myosy, the pupil dilates, re-engages and stays contracted;
- 2=the pupil pumps constantly;
- 3=bright stimulus, myosy, the pupil dilates and remains dilated;
- 4=bright stimulus, the pupil remains dilated and shows no reaction.

The reactions number 2, 3 and 4 could be defined Alpha-Omega pupil reactions.

1.2.6 Visual functional fields

Survey of the characteristics of the visual field is commonly used in optometry and ophthalmology to evaluate and investigate the presence of field defects or possible pathologies.

In Optometry Syntonic, the evaluation of the functional visual field has the purpose of:

- highlight and demonstrate the presence of visual functional deficits;
- respond to the important question during visual treatment: is it working?

This allows us to assess whether we are using a wrong frequency and if the frequency is sufficiently powerful.

Examining the visual functional field is the most valued and sensitive tool in any rehabilitative treatment and performed in all cases where visual problems are highlighted.

The visual fields that are measured in Syntonic Optometry are:

- functional field /color field
- perceptive/movement field
- blind spot.

The study of functional fields is the most accurate and sensible tools to evaluate the progress during Syntonic treatment, and allows to discover and demonstrate visual functional deficiencies that, if present, are definitely visual defects.

The visual functional field does not highlight pathologies and does not indicate the most suitable color frequencies.

The *red color field* represents the efferent visual projection: Visual Eye Projection, with the emotional, physical and psycho-educational components

The *blue and green color fields* represent visual projection with differences in the areas of the visual field.

Reducing, limiting, and narrowing the functional visual field of individual colors or colors in combination, represent and induce different effects:

- for the red, it represents a chronic condition (circulatory congestion/high blood pressure, intestinal stasis, constipation, a high lipid/fat diet, diabetes implicating circulatory compromise, chronic fatigue, adrenal dysfunction, reading difficulties related to magnocellular pathway defect and poor symbol recognition. The emotions are depression or grief associated with loneliness, survival, grounding, material attachments, abuse, excessive appetite);
- for the green constriction, it represents an acute condition (focal infection affecting choroidal/retinal vasculature usually related to infections of the teeth, tonsils, or sinuses, exogenous or endogenous poisoning, tissue edema in the pulmonary or cardiac region, immune dysfunction possibly thymus related. The emotions are bitterness, grief, anger, self-centeredness, loneliness, and lack of forgiveness)
- for the red-green interlace, it represents general toxemia either from the psychological or physiological balance stand point;
- for a red-blue constriction it concerns the horizontal meridians only – low fusional reserves;
- for a red-blue-green constriction, it represents (possibly motion also) physical (head) trauma; emotional trauma; high fevers and chronic illness;

- for a blue constriction, it means psychological stress (heart problems or adrenal exhaustion is associated with energy loss due to internalization of tension; headaches, especially migraines; loss of abstract attitude: inability to learn, muddled thinking, narrow-mindedness, poor reasoning; lacking self-awareness and conscience).

The white color allows to detect the peripheral structure of the central visual field. Even white color, but with a lower diameter of the target is used to detect the size of blind spot.

On the market there are several systems to detect the functional visual field.

1.2.7 Morphology of subjects treated with Syntonic Optometry

The choice of Syntonic filters for treatment, is based on the dominance of the sympathetic system or the parasympathetic system.

In the treatment with Syntonic Optometry, three types of subjects are categorized morphologically based on the study of "Kretchmer Biotypes", which frame the subject on the basis of their physical and mental characteristics. In order to choose filters, it is considered in some situations if the patient is male or female (Collier, 2010).

The classification of the subjects according to the Kretchmer Biotypes is:

- Pyknic (P): Parasympathetic predominating
- Asthenic (A): Sympathetic predominating
- Syntonic(S): Sym-Parasympathetic Balanced

Syntonic subjects are treated only in particular situations, while Asthenic and Pyknic subjects are treated with filters lightly different, as shown in the following table 1.1:

Table 1.1

Filters adopted by Asthenic and Pyknic subjects

Asthenic (A)	Pyknic (P)
$\alpha\delta = \text{Alpha} + \text{Delta}$	$\alpha\vartheta = \text{Alpha} + \text{Theta}$
$\alpha\upsilon = \text{Alpha} + \text{Upsilon}$	$\alpha\pi = \text{Alpha} + \text{Pi}$
$\alpha\omega = \text{Alpha} + \text{Omega}$	$\alpha\omega = \text{Alpha} + \text{Omega}$
$\delta\omega = \text{Delta} + \text{Omega}$	$\vartheta\omega = \text{Theta} + \text{Omega}$
$\delta = \text{Delta}$	$\vartheta = \text{Theta}$
$\mu = \text{Mu}$	$\mu = \text{Mu}$
$\mu\delta = \text{Mu} + \text{Delta}$	$\mu\vartheta = \text{Mu} + \text{Theta}$
$\upsilon\omega = \text{Upsilon} + \text{Omega}$	$\pi\omega = \text{Pi} - \text{Omega}$
$\upsilon = \text{Upsilon}$	$\pi = \text{Pi}$

These evaluations are not always clear though typically classifiable (Spitler, 1941).

1.2.8 The filters

A rule used in Syntonic Optometry, considered to be very important, says that “vision is like a balance axis.” The consequence of this rule is to find for each type of treatment, filter or filters to achieve balance.

The classification and identification of filters varies according to the manufacturers, some propose them by giving the name of the colors, others use letters of the Greek alphabet.

Spitler (1941) classified the eleven filters as follows, using greek alphabet letters (Tab. 1.2).

Table 1.2

Classification of filters by Spitler (1941)

Name	Symbol	Color	Problem related
ALPHA	α	Red	Sensory, Stimulating
DELTA	δ	Amber	Stimulating, Motoric
THETA	θ	Yellow	Stimulating, Motoric, Intense
MU	μ	Green	Equilibrator or Balancer
PI	π	Brilliant Blue	Depressor, Sensory
OMEGA	ω	Intense Blue	Depressor, Motoric
UPSILON	υ	Dark Blue	Depressor, Sensory, Intense
LAMBDA	λ	Indigo	Lightweight, Depressor, Motoric (rarely only with α)
DEPRESSANT	D	Purple blue	Depressor, combined with other filters to increase the effect
STIMULANT	S	yellow	Stimulating, with other filters increases the stimulating effect
NEURASTHENIC	N	purple	Usually used with neuroasthenics subjects or with other depressants

Larry Wallace classified the problems in “Syndromes”, and for each type of syndrome he uses a specific filter to solve the difficulty:

1. Mu-Delta Syndrome (Chronic) Physiological Stimulator
2. Mu-Upsilon Syndrome (Acute) More Intense Sensory Depressor Equilibrator

3. Alpha-Delta Syndrome (Excess Convergence) Strong Stimulating Sensory and Stimulating Motor
4. Alpha-Omega Syndrome (Emotional Fatigue) Emotional Stabilizer.

S. Collier added two more Syndromes:

1. Omega-N Syndrome, fight or flight;
2. Pi-Omega Syndrome, hyper or hypo.

The combination of different filters provide effective and resolute results (Collier, 2010) (Fig. 1.5).



Fig 1.5 Diagram and filters description, useful to verify the history of a testing case and the optometrical data (Collier, 2010).

ALPHA red light, high wavelength, motor sensory and sensory for the sympathetic nervous system, reduces the parasympathetic characteristics. OMEGA blue light, short wavelengths, depressants, motor and sensory depressants, stimulates the activity of the parasympathetic nervous system or decreases the characteristics of the sympathetic. Filters placed in the middle MU green, red and blue light, are described as balancing or balancing (Collier, 2010) (Fig. 1.6).

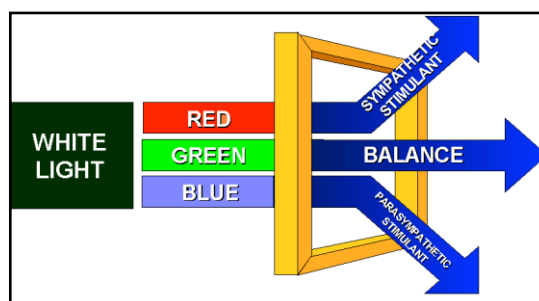


Fig 1.6 Graphic representation of filters and their influences (Collier, 2010).

The use of these filters increases the response basic IN, base OUT, stimulates or relax accommodation, increases level of attention and oculomotor control, speed of movement and perception, reduces crowding and visual discomfort and distortion (Wilkins et al., 2009).

1.3 Presbyopia

The capacity of humans to accommodate diminishes with age, and is particularly generally reduced by 50 years. The condition of being unable to accommodate is known as presbyopia. The progression of presbyopia can be measured by determining the amplitude of accommodation that is the difference between the optical power of the eye when fully accommodated and when fully disaccommodated, conventionally measured in diopters.

Presbyopia from the Greek "presbys" old and "opos" eye, is not a disease but a physiological condition of the visual apparatus that affects all subjects.

Presbyopia is linked to a loss of efficiency of the accommodative system due to several factors related to ciliary muscle: atrophy with loss of strength, shape variation, size variations.

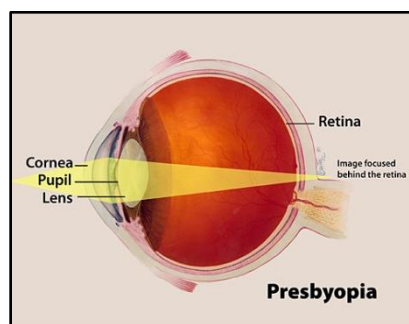


Fig 1.7 The pathway of the light in a presbyopic subject.⁵

Presbyopia is a visual disorder characterized by the difficulty of clearly seeing nearby objects; This condition is considered physiological because it is age-related. The first symptoms usually occur between 40 and 45 years old and it depends on the decrease in crystalline elasticity, resulting in a reduction in focus (Fig. 1.7).

Presbyopia is an inevitable phenomenon that involves men and women, glasses and non-users alike.

The discomforts of presbyopia are usually experienced as a transient state of fatigue. In the reality something is changing: a specific function of the eye system, the accommodation, which is responsible for the ciliary and crystalline muscle activity, shows variations.

⁵ <https://nei.nih.gov/health/errors/presbyopia>

To focus sharply at the various distances of observation, it is required to accommodate: the more you approach an object and the greater is the amount of focus required for a precise view. In the age of presbyopia the eye loses that ability due to anatomical variations considered physiological, and this implies the inability to focus at close and intermediate distance. The presbyter complains of discomfort in reading, in manual work (painting, modeling, embroidery), but is able to read road signs, watch movies, etc...

Statistically after forty years old, but this data is not common to all human races, the ability to focus is reduced, causing discomfort in observing small details. Usually, the subjects who engage in intense visual activity closely are the first who notice his change; the first symptoms occur when the subject is very tired in the evening.

To reduce the effort, the subjects looks for a position to read more and more distant, hence the attempt to distance the newspaper by stretching his arms, as far as he can; another way to reduce the effort is to look for larger writing characters or increase the intensity of the lighting.

The problem of presbyopia manifests first in the incorrect hypermetropic subjects, as a difficulty in offsetting the dual condition simultaneously, and then in the emmetrops. In myopic subjects this difficulty appears later; it is initially "hidden" by the peculiarity of this defect: the accommodative necessity is partly or wholly replaced by the myopic degree.

In young individuals the crystalline is elastic, it easily changes shape to the distance of focus. Over the years, there is a gradual hardening of the structure and the crystalline loses its elasticity; the result of this is the progressive reduction of accommodative capacities.

Presbyopia can be classified in relation to the age of occurrence or the extent of its manifestation in three groups:

The "*young presbyte*", aged between 40 and 50, shows the first symptoms of difficult vision in reading and observing details during an extended engagement; he flexibly uses the correction because he is still able to read without glasses in bright conditions such as under a lamp or at the sunlight on the beach.

The "*stabilized presbyte*", aged between 50 and 60, has the constant need for a close correction in all activities to have a clear vision; this subject will be forced to change the lens often until he reaches a certain stability of the visual problem.

The "*elderly presbyte*", over 60 years of age, has the inability to see sharp except with the stable use of the correction.

This visual disorder must always be correct with lenses suitable to provide a distinct vision, without fatigue and stress.

Different types of ophthalmic lenses can be used: monofocal, bifocal, at depth of field, multifocal; the ideal solution is the use of progressive lenses, the high quality that allows clear vision at different distances.

Usually the presbyopia compensation is done by adding to the usual far correction, a positive power lens whose optical effect allows focusing at a definite distance. Other tools of compensation are bifocal, trifocal, degressive, progressive lenses, and contact lenses with the use of bifocals, multifocals or monovision.

There are other methods to compensate presbyopia with surgical techniques: crystalline surgery with insertion of multifocal intraocular lenses (IOLs), or laser refractive surgery (PRK or LASIK), relaxation techniques and specific exercises thanks to yoga techniques, electrostimulation of the ciliary body for presbyopic subjects with a defect not exceeding 1D. Other possibilities to act on presbyopia, to delay or prevent it, are Visual Training (VT) techniques. With the "no glasses" method, Dr. Ray Gottlieb uses Syntonic Optometry associated to visual training techniques.

2. RESEARCH

2.1 Participants

In this work, I used the Syntonic Optometry methodology for treating presbyopic subjects aged between forty and fifty. I have randomly selected 20 subjects from my database. All these subjects consented to undergo this treatment, in order to verify the possible reduction or slowing of presbyopia. The selected population was subdivided into two subgroups: ten people represented the control group and ten people were treated with the syntonic therapy, thus representing the experimental group. I looked at the subjects by extrapolating some data to be able to verify the variations after twenty treatments with the Syntonic filters.

The novelty of this research is to verify, with this first representative sample, only presbyopic subjects. As documented in previous studies, several colleagues treated presbyopic subjects without having thoroughly analyzed the learning difficulties or the effects of Syntonic Optometry on cognitive functions (Lieberman, 1986; Kaplan, 1983).

To realise this experiment, 20 subjects have been selected randomly in a healthy population. The selected population is composed by 40% males and 60% females (Fig. 2.1), Caucasian individuals (Italian nationality), subjects of age between 40 and 50 years old (Fig. 2.2).

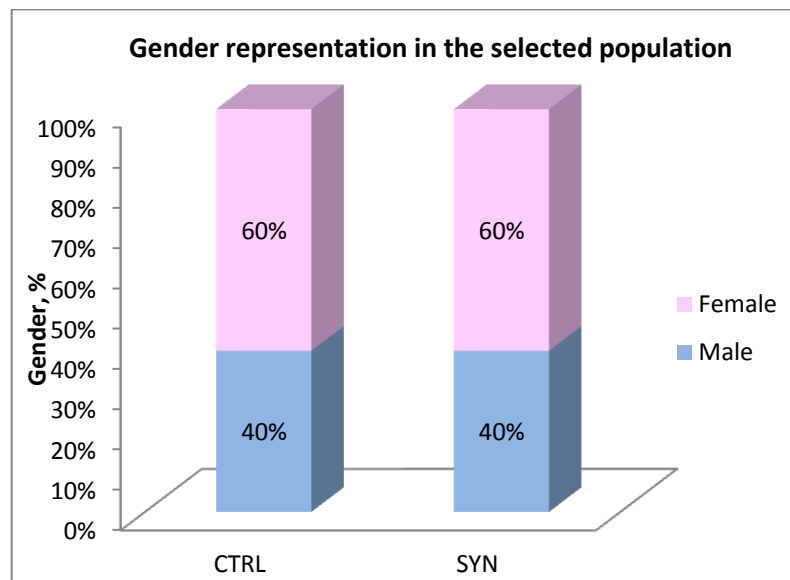


Fig 2.1 Graph represents the gender distribution (in %) of the population analysed in this research: CTRL is the control group, SYN is the syntonic group.

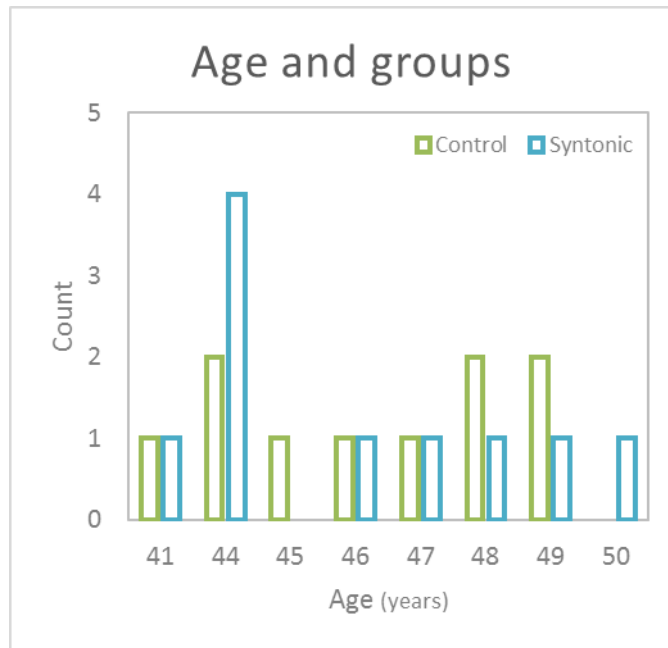


Fig 2.2 Graph represents the age (in years) of all the subjects analysed in this work. In green it is indicated the control group, in blue the syntonic group.

All the subjects are presbyopic, myopic, farsighted or astigmatic. The figure 2.3 represents the characteristics of all the subjects belonging to control group. In particular, in the red dotted box, we can see the average of Spherical Equivalent (SE) refraction.

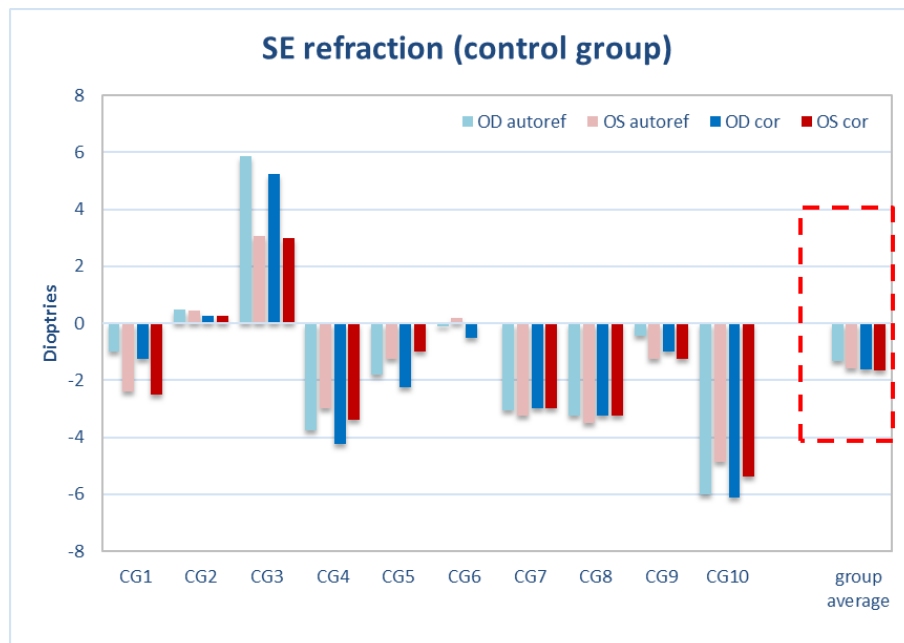


Fig. 2.3 Histogram that represents the SE refraction in control group. Light blue and pink indicate the OD and the OS autorefractometer respectively; blue and red indicate the OD and OS correction respectively. In the red dotted box is represented the average values of the group.

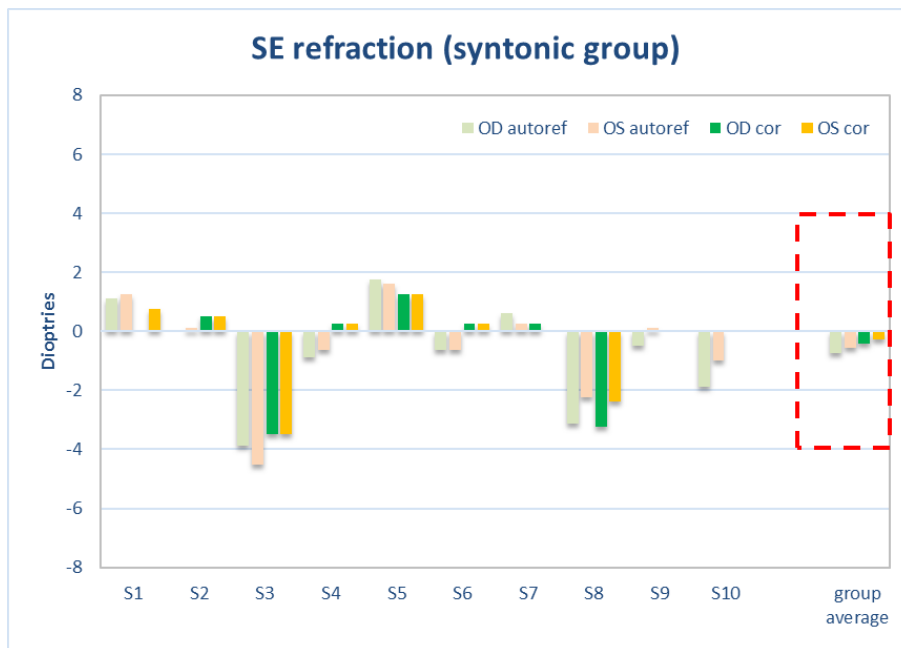


Fig. 2.4 Histogram that represents the SE refraction in syntonic group. Grey and pink indicate the OD and the OS autorefractometer respectively; green and orange indicate the OD and OS correction respectively. In the red dotted box is represented the average values of the group.

The data indicated in the two red spotted boxes in figures 2.3 and 2.4 indicate the average values of the two groups analysed in this thesis work. The differences of these values are not statistically significant for what concern autorefractometer. Only in case of correction, as shown in figure 2.5, subjects of control group are more myopic than those of syntonic group ($p < 0.05$).

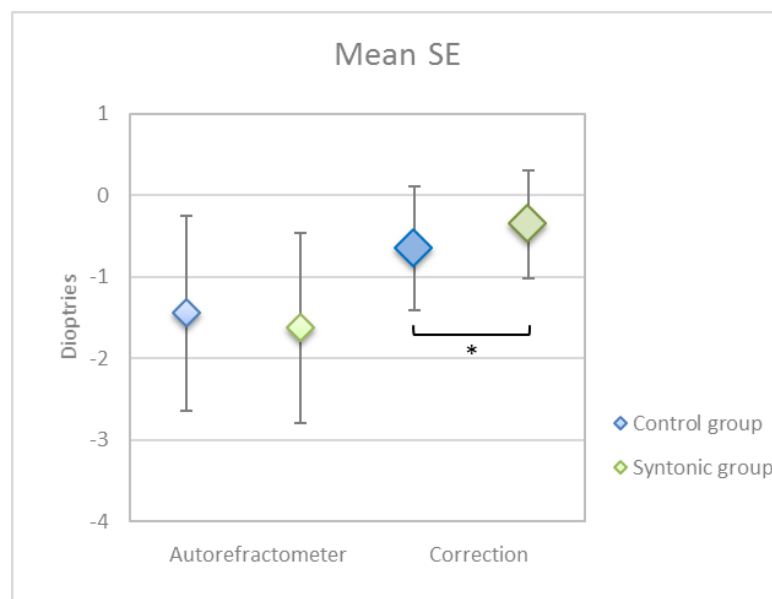


Fig 2.5 Graph that represent the mean of spherical equivalent refraction of control and syntonic group tested. There is a little difference between control and syntonic group of used correction. Control group's average correction is more myopic.

Before starting the experimental procedure, all the subjects have signed a privacy release.

2.2 Methods and instruments

2.2.1 Optometric exam

All the 20 subjects have been analysed twice through an optometric exam. The first exam has been useful to determine the starting point. The second exam has been done about 20 days later, to reveal any differences and changes in the sample subjects.

The exam consists in a first anamnesis and a collection of informations concerning corrective lens in use and motivation that induces the subjects to participate to the experimental program.

The optometric exam continues with the following analysis: horizontal phoria detection, near and far retinoscopy, autorefractometer, keratometry, near and far corrective analysis, accommodative positive and negative reserves, cover test (near and far CT). Furthermore, special attention is dedicated to these following analysis: visual functional field, pupil alpha-omega exam, push-up test and visual acuity at near and far. In particular, from far, the subjects have been analysed with their eventual corrective lenses, while from near, the visual acuity of the subject has been measured with no correction.

2.2.1.1 Visual functional field

Visual functional field is performed one eye at a time. In the analysis of these presbyopic subjects no lens is used; all the subjects work as they naturally see from near.

To collect this analysis the identified population is subjected to a test with a Computerized Functional Colour Field Tester (CFCFTester), RAINBOW-FLASH CVBA. This instrument enables a quick, efficient and reliable measurement of functional visual fields. Thanks to this instrument the Module Field (functional campimetry), the Color Fields (red, blue, green) and the Blind Spot can be accurately measured.

The software program is accompanied by a top-piece removable hardware, and is easily installable and calibrated on any computer monitor (Fig. 2.6). Settings can be customized and saved: screen contrast, color brightness, size and speed of moving dots, display of meridians, etc (Fig. 2.7).



Fig 2.6 Picture of the instrument used to measured the visual functional field.



Fig 2.7 Typical screen of the software with all the different adaptable parameters.

Optionally, additional grey spots can be added on each meridian to compensate the movement awareness. The program provides a minimum and maximum estimate and test duration estimation for the selected settings.

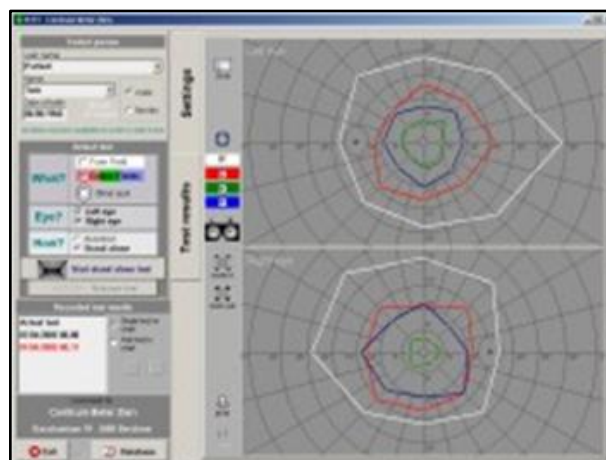


Fig 2.8 Example of graphical representation of visual field of a patient.

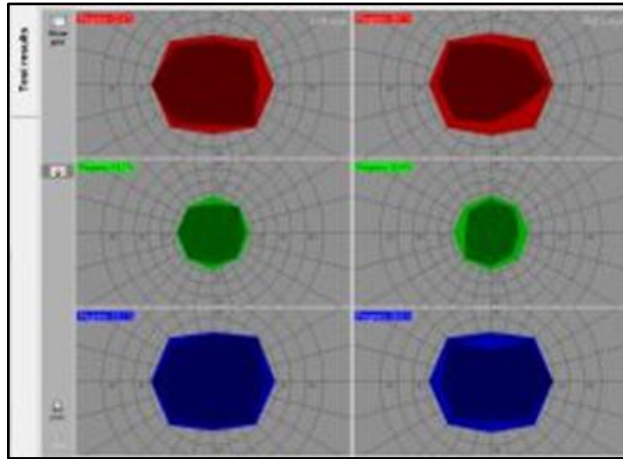


Fig 2.9 Comparison of two different evaluation of functional field belonging to the same patient in two different moments.

The fields can be measured in assisted mode or in an autonomous way. The overlapping of the images allows to measure the percentage (positive or negative) of visual field changes (Fig. 2.8 and Fig. 2.9). The patient is instructed to look at a central stimulus (a changing number from 0 to 9 appears randomly in the white target at the center of the monitor). The patient is invited to tell to the optometrist if and when a different number in the central target or a moving color spot appear in the monitor he is fixing, as shown in the figure 2.10. Sometimes number and color appear together and the patient know that it is more important to tell to the optometrist the color appearing. The optometrist records the values.

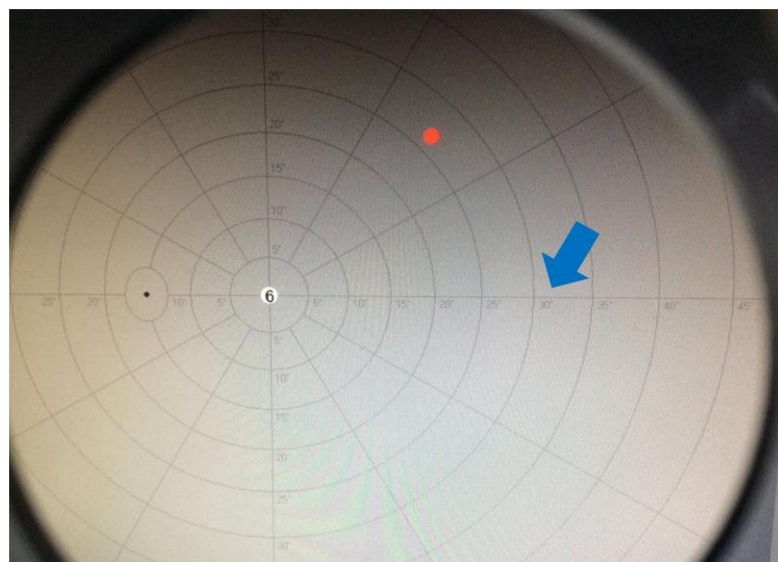


Fig 2.10 Picture of the video visualized by the patient during the test. The blue arrow indicates the meridian 30°.

Measurements are taken on a meridian frequency 30° . Incorrect measurements can be deleted and will be automatically retested when the test resumes. A patient file is automatically created and all measurement fields can be stored and compared with previous measurements. All measured fields can be superimposed to visualise treatment progress in Light stimulation, syntonics and vision stimulation. Measured fields can be printed out in different ways, showing the coloured graphs, with or without a list of each measured meridian. To use this program it is required a Windows operating system and any monitor from 15inch and bigger, however an adjustable 17inch TFT screen is preferable.

2.2.1.2 Pupil Alpha-Omega field

Pupil field is one of the most important analysis useful to evaluate the condition of a subject, candidate to a Syntonics treatment, thanks to Alpha-Omega pupil evaluation.

In a low lighting room, a common pen-light has to be directed on the pupil of the subject; meanwhile the subject is focusing on a far non-accommodative target, that consists in a projection of letters (no bigger than 5/10), at a distance of 5 meters.

During all this exam the variation of pupil diameter is observed. The measure of the pupil diameter is performed using a subjective method, following the characteristics described in the paragraph 1.2.5.1.

2.2.1.3 Push-up test

Push-up test is an exam that measures the amplitude of accommodation under binocular conditions and it is critical to reveal the distance at which the subject reports a blur.

In this analysis, the subject is invited to read a written text with 0,62 M characters (a measure that corresponds to the J4 value of the Jaeger Eye Chart), Fig. 2.11, at the Harmon distance (the appropriate working distance for near work, that consist in the distance comprises from the elbow to the knuckle of the middle finger of each subject).



Fig. 2.11: The Jaeger eye chart used to test the vision at near.⁶

2.2.1.4 Visual acuity at near and far

This analysis consists in testing the ability of the subject to read simple letters at different distances. For the near test it is used the Harmon distance, with no correction; for the far test it is used a common projector that shows letters at a distance of 5 meters with correction.

All these young presbyopic subjects were at their first optometric exam. For this reason they did not have any type of correction, moreover, myopic subject, also if astigmatic, worked we no correction to have a uniform comparable population, considering that the aim of the work is to analyse the presbyopic aspect.

2.2.2 Syntonic exercises

The 20 selected subjects have been divided into 2 subgroups:

⁶ Adapted from <https://www.desertcart.ae/products/10544089-prestige-medical-jaeger-eye-chart>

- Control group, 10 people that don't perform Syntonic exercises between the two optometric exams (paragraph 2.2.1)
- Syntonic group, 10 people that perform Syntonic exercises between the two optometric exams (paragraph 2.2.1).

The subjects of Syntonic group have been randomly selected, within the group of 20 people, to conduct Syntonic exercises. Both the control and the Syntonic group present quite the same characteristics and, for this reason, the two groups are comparable.

A mu-epsilon filter (frequency equivalent color: blue-green), Optomatters or Syntonac, and a common pen-light, have been distributed to each chosen person.

Following some simple rules, all these subjects have been invited to use these two instruments to perform Syntonic exercises, according to Collier indications (Collier, 2010).

The subject, with no corrective lens, in a low lighting room, has to wear the specific filter and to carry out push-up movements (Harmon distance to broken fusion), as if the subjects is exposed to ocular muscles evaluation.

This exercise has to be repeated for 5 minutes a day, for 20 consecutive days.

Each subject has confirmed the repetition of the exercise at home, on his own, for all the times required by the experiment.

2.2.3 Filters

In the subjects analysed in this work, it has been used the Stefan Collier indications, as explained below:

- Five minutes Mu-Upsilon with a light pen moved with push-up movement;
- The subject should not wear any optical correction;
- Treated subjects should be exophoric closely;
- Twenty consecutive applications are required;
- At the end of the treatment, a verification test is performed, using the same initial methodology.



Fig 2.12 Example of paper glasses useful to exercise with Syntonic Optometry

Each subject was provided with a pair of paper glasses with the specific filter required for the exercises, similar to those in the figure 2.12.

2.2.4 Statistical analysis of data

All the data collected from the selected population, as described in paragraphs 2.3.1 and 2.3.2, have been elaborated and analysed with the statistical analysis “Mann-Whitney test” or “Wilcoxon test”. Moreover, for each class of data it has been calculated the standard deviation.

2.3 Results and analysis of data

To investigate the possible effects of syntonic treatment in presbyopic subjects, the attention has been focused on the analysis of addition, accommodative amplitude, visual acuity near, and visual functional field to investigate any changes on these aspects before and after the exercises (methods described in paragraphs 2.3.1 and 2.3.2).

The control group (CTRL) consists of ten subjects that have been tested twice with an optometric exams. The two exams took place about twenty days away. Meanwhile, the subjects of the syntonic group (SYN), received similarly the optometric examinations and between one and the other the subjects exercised the syntonic treatment.

T0 indicates the data collected at the first examination; T1 indicates the data collected at the second examinations, that in the case of SYN group means the results of the subjects after the syntonic treatment.

The selected population (20 subjects), then divided into two subgroups, presented overlapping characteristics at the starting point T0.

Moreover all the errors recorded during the examination of the subjects belonging to the different groups are overlapping (data not shown); this aspect does not create any particular or problematic bias in the interpretation of the results presented below.

All the selected subjects have been classified according to the three types of personalities: Pyknic, Asthenic, Syntonic. The three categories were uniformly represented. No changes was recorded in any subject between the first measurement T0 and the second one T1.

2.3.1 Analysis of additive power, accommodative amplitude, pupil alpha-omega and visual acuity at near in control and syntonic groups

As shown in the histogram below, the analysis of additive power in the subject of the control group (soft green bars) shows the same results both in the first collection of data at T0, and in the second one at T1 (Fig.2.13); no statistically significant differences have been highlighted in the analysis of data (ns).

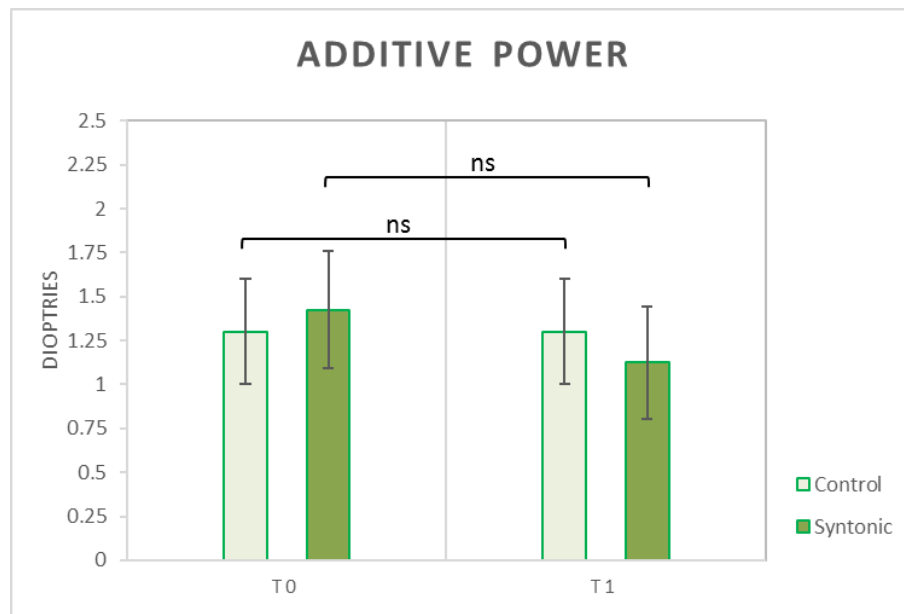


Fig 2.13 Diagram that represents the additive power (measured in dioptries) of the subjects of the control group (soft green) and subjects of the syntonic group (dark green), at the first exam and about twenty days later (T0 vs T1).

Differently, the measurement of the additive power at the end of the treatment with syntonics optometry (dark green bars) highlighted many changes in the data collection between T0 and T1 examination, anyway the statistical analysis performed with Mann-Whitney test did not underline any significant difference (ns).

This analysis recorded a reduction of the value in the 60% of the subjects of the SYN group, as shown in the figure 2.14. However, the reduction observed does not present a statistically significant difference, as pointed out thanks to statistical analysis ($p > 0,05$).

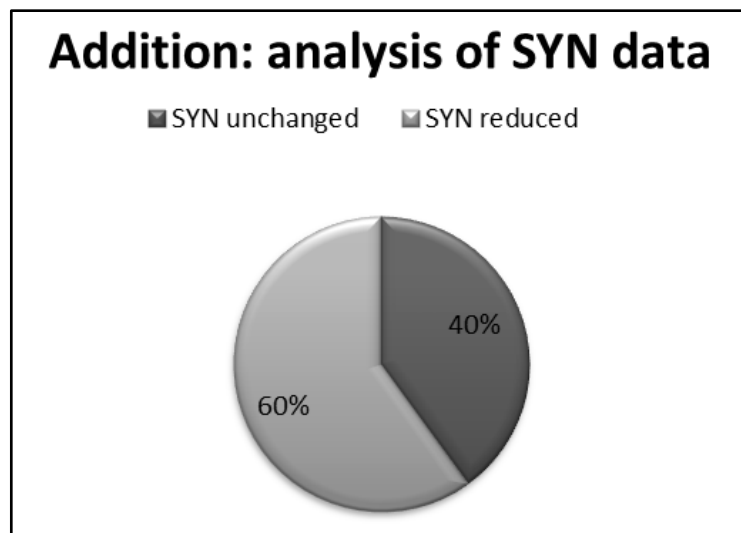


Fig 2.14 Graphic representation of the additive power in syntonics population (in light grey it is indicated the percentage of subjects unchanged from T0 to T1; in dark grey it is indicated the percentage of subjects with a reduction in addition values from T0 to T1).

Similar results have been observed in the analysis of accommodative amplitude. In fact, as shown in the diagram below, subjects of control group (light purple) show the same values at the starting point T0 and at the following test taken in T1 (fig. 2.15).

Instead, the data collected from the analysis of SYN group (dark purple) indicate a growth of dioptres values in T1 compared to T0, but this difference is not statistically significant (ns).

Also if some of the values in T1 of syntonics group are different from the values revealed in T0, the Mann-Whitney test shows p value $> 0,05$, highlighting that these differences are not statistically significant, also if 70% of the population analysed shows changes, as reported in the diagram below (fig. 2.16).

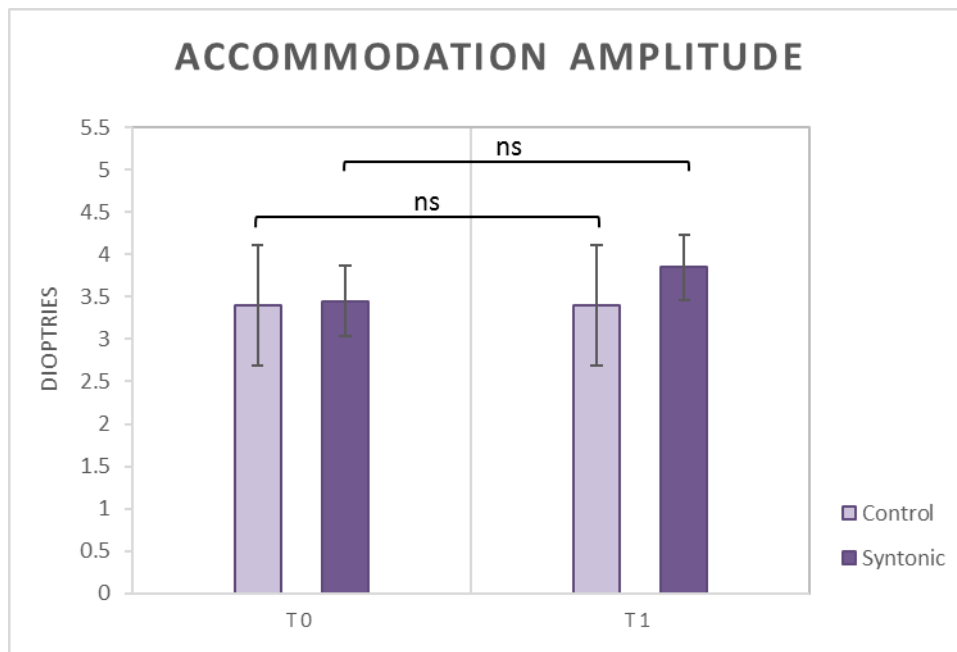


Fig 2.15 Diagram that represents the amplitude accommodation value (measured in dioptres) of the subjects of the control and syntonic groups at the first exam (T0) and about twenty days later (T1). The average group results show not statistical significant difference (ns) before and after syntonic treatment ($p=0.098$) using Mann Whitney test.

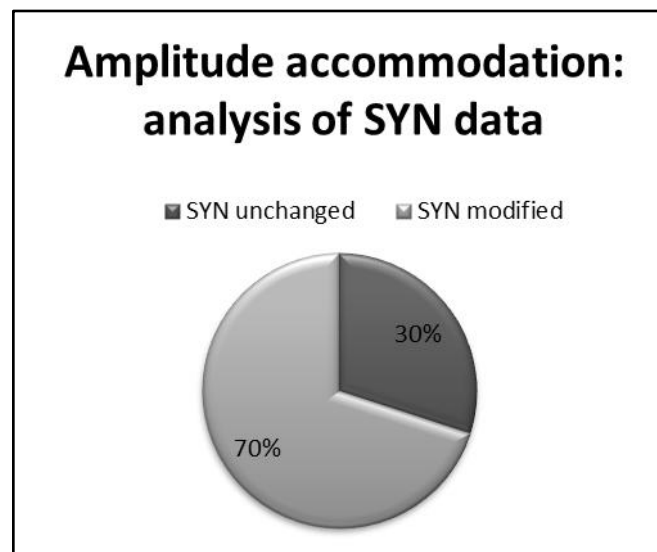


Fig 2.16 Graphic representation of the amplitude accommodation changes in syntonic population (in light grey it is indicated the percentage of subjects unchanged from T0 to T1; in dark grey it is indicated the percentage of subjects with a modification in amplitude accommodation values from T0 to T1).

Similar to the results just shown, also the pupil alpha-omega evaluation let conclude that there are some changes recorded in syntonic group, comparing T0 and T1, but this changes concern only the 20% of the subjects analysed and these data are not statistically significant (Fig.

2.18). The CTRL group does not present any changes and all the values of T0 are confirmed in T1 (Fig. 2.17).

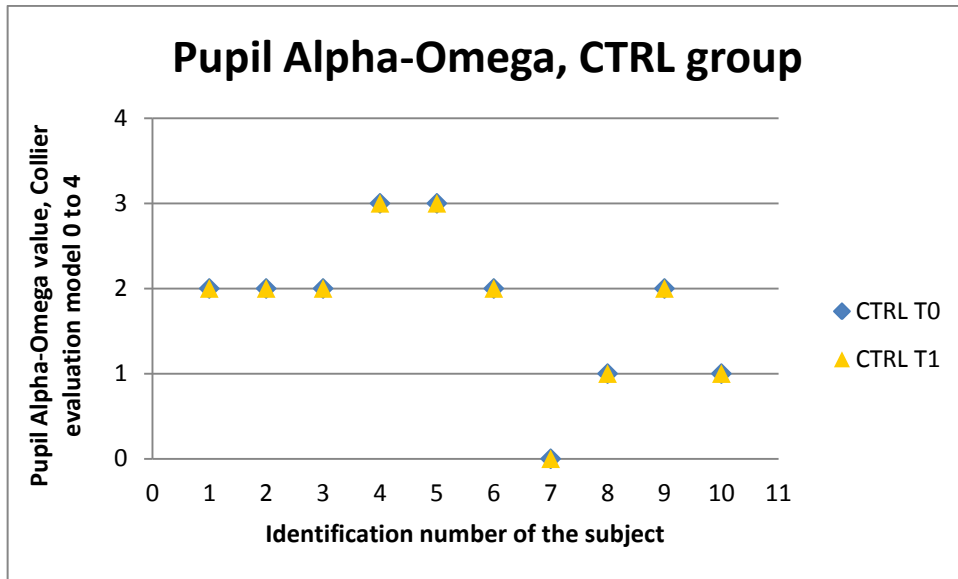


Fig 2.17 Diagram that represents the pupil alpha-omega values (measured with the Collier evaluation model, a scale from 0 to 4) of the subjects of the control group at the first exam (T0, in blue) and about twenty days later (T1, in yellow).

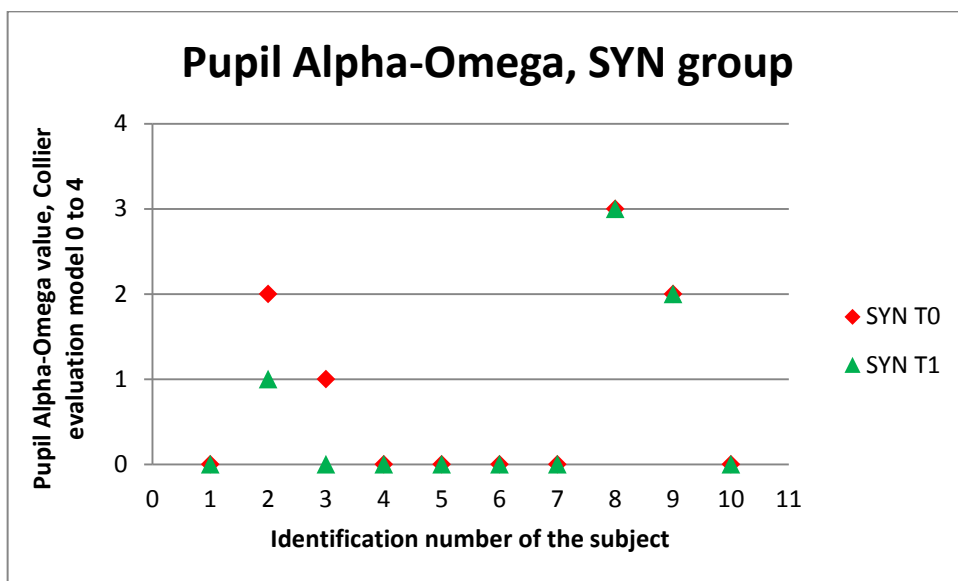


Fig 2.18 Diagram that represents the pupil alpha-omega values (measured with the Collier evaluation model, a scale from 0 to 4) of the subjects of the syntonic group at the first exam (T0, in red) and about twenty days later (T1, in green).

Another important aspect analysed is the visual acuity. All the values of the visual acuity at near recorded in the analysis of the subjects are shown in the figure 2.19. It appears

immediately clear that there are no differences between the values of T0 and T1 in the control group, marked in light blue.

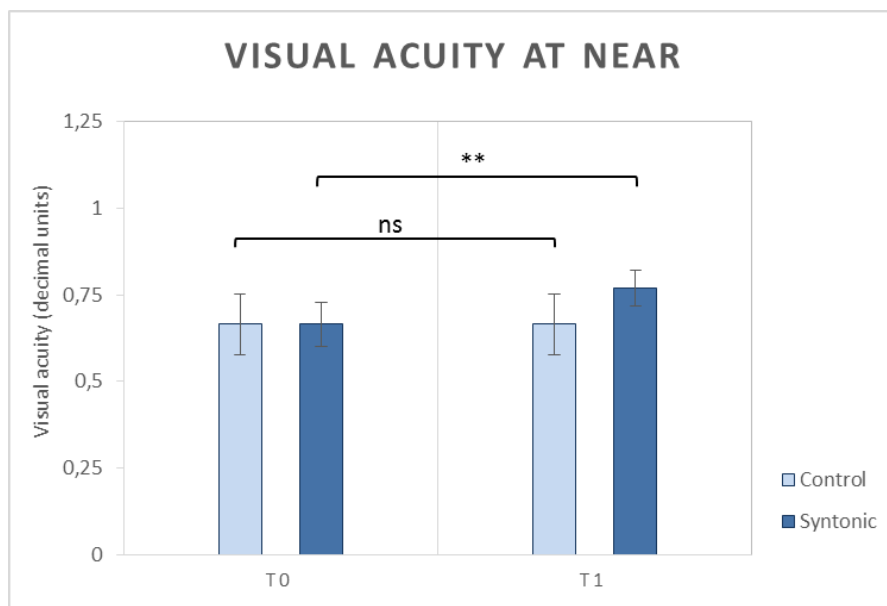


Fig 2.19 Diagram that represents the visual acuity near values of the subjects of the control and syntonic groups at the first exam (T0) and about twenty days later (T1). For syntonic group improvement in visual acuity are statistically significant ($p=0.002$) comparing individual data and using Wilcoxon test.

On the opposite side, in the syntonic group, represented by the dark blue bars, we can observe several differences in the recorded values. In particular, more than 50% of the subjects treated with Syntonic optometry shows an increment of the visual acuity at near, comparing T0 data and T1 data. The improvement of the acuity recorded in many subjects is, at least, more than one point. Furthermore, these variations represent an important result in the light of statistical analysis, that points out a $p<0.01$ (statistically very significant).

2.3.2 Analysis of form, red, green and blue parameters of visual functional field

The visual functional field is a very important aspect to consider in the study of subjects treated with Syntonic Optometry.

In this work, four different aspects related to visual functional field at near have been analysed: form, red, green and blue. All the data have been summarized in the following diagrams (fig. 2.20 and fig. 2.21).

As usual, two groups have been compared: the control group and the syntonics group. For each group several data have been collected pertinent to form, red, green, blue aspect at T0 (bars with grey frame) and T1, about twenty days later (bars with black frame).

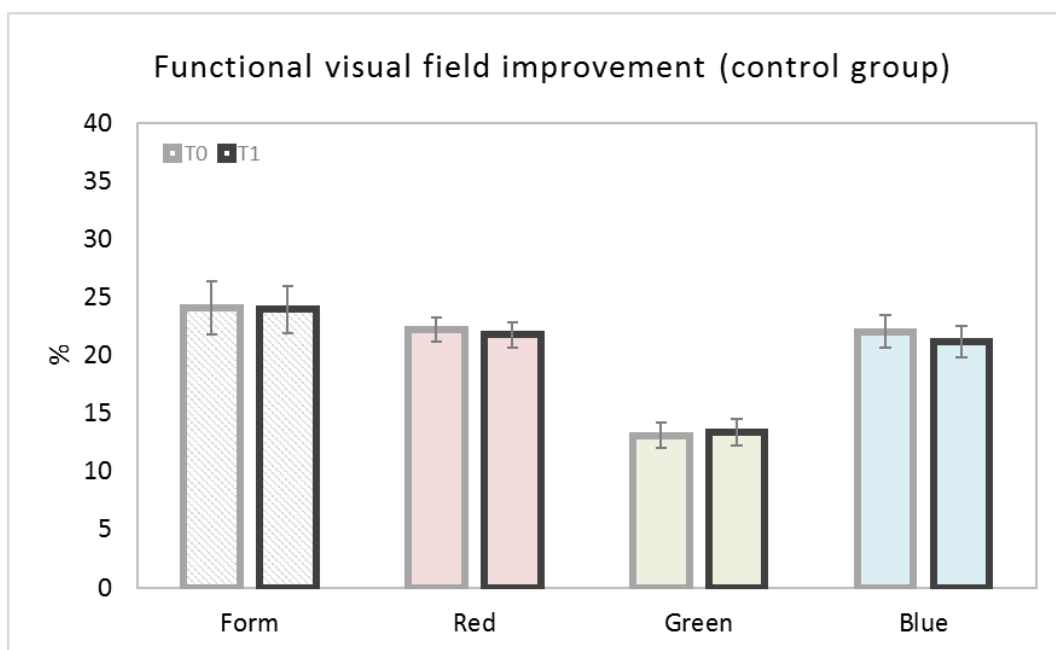


Fig 2.20 Histogram that represents all the % values of the visual functional field of control group. The four parameters analysed are form, red, green and blue. Bars with the grey frame indicate the measurement taken at the starting point (T0); bars with the black frame indicate the measurements taken after about twenty days (T1). The differences between T0 and T1 bars are not statistically significant.

In control group (fig. 2.20) also if there are few differences, these differences are not statistically significant in any of the 4 parameters considered; while in the syntonics group, important increments have been observed (fig. 2.21). In particular, also if one of the four parameters analysed did not show a statistically significant result, three parameters indicate important changes. In fact, form, green and blue parameters (indicated with striped white bars, light green bars and light blue bars respectively), but not red parameter (indicated with light red bars) show statistically significant growth of the values, with a $p < 0.05$.

All these results show that Syntonic Optometry importantly and effectively acts in the correction of young presbyopic subjects, already with a single treatment cycle.

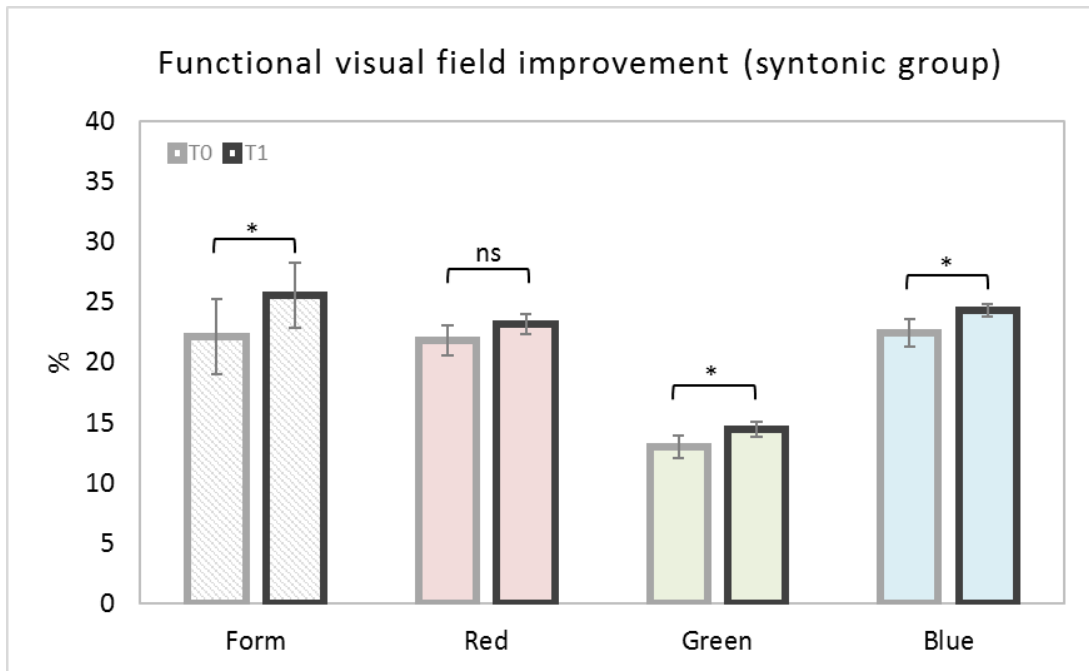


Fig 2.21 Histogram that represents all the values (%) of the visual functional field of syntonic group. The four parameters analysed are form, red, green and blue. Bars with the grey frame indicate the measurement taken at the starting point (T0); bars with the black frame indicate the measurements taken after about twenty days (T1). The differences between T0 and T1 bars are statistically significant for form, green and blue parameters, but not for red one.

Table 2.1

Individual improvements are seen for syntonic groups, but not for control group. Table with p-values.

Functional visual field		
Individual improvement after 20 days		
	Control group	Syntonic group
	p-value	p-value
Form	0.32	0.02
Red	0.08	0.03
Green	0.25	0.01
Blue	0.008*	0.05
*for blue light is decreasing in visual field parameters Wilcoxon test (one tale)		

In the table 2.1 we can observe the statistical analysis of individual improvement of functional visual field in control group and in syntonic group. It appears clear how all the four parameters measured are statistically significant in syntonic group (numbers highlighted in red); in fact, all the p value are ≤ 0.05 . Different is the situation in the control group, where p values are not statistically valid.

2.4 Discussion

In the decades there has been a consistent increase in the number of optometrists who use the syntonics approach in the treatment of visual disturbances and learning. This increase is partially linked to the widening of optometric phototherapy research and partly to the fact that local or pharmacological therapy of certain pathologies requires a rehabilitation and functional rehabilitation phase that can be effectively performed by syntonics technique.

This work attempted to illustrate how syntonics treatment is used referring to a very wide range of pathology: from the dysfunction of ocular mobility (strabismus, amblyopia, heterophobia, exotropia), myopia, dynamic pupil abnormalities and some corneal, scleral, and retinopathies. Syntonics intervention has a predominantly regenerative function of biochemical, vascular and functional equilibrium. It is, in fact, an approach that, by transmitting light to the retina-hypothalamus, promotes adaptive and accommodative neurological reactions, trying to restore a proper eye contour function.

Moreover, in recent years, an interesting field of syntonics is the seasonal nature of mood disorders. The cause of seasonal depressions is identified, in addition to genetic factors, in some biological hypotheses such as alteration of melatonin and some neuroendocrine abnormalities that alter the functioning of the hypothalamus. Acting on the sympathetic and parasympathetic nervous system, the use of colored filters can restore a balance of the energy flows that govern the vegetative mechanisms, that are the basis of mood changes.

As various filter combinations are associated, their use is particularly effective in several syndromes (Wallace Larry). The efficacy of Syntonics does not only produce positive results in the eye-vision component. But engagement is felt both in the physical and the psychic constituents, in the totality of the subject being treated.

Before starting this work, I thought I could find without any difficulty patients willing to be subjected to Syntonics treatment, but I was denied. The treatment was performed without costs for the subjects treated. Women have been much more available than the male component (surely the aesthetic aspect prevails over the functional one). The sample of subjects examined for both groups was subjected to a wide optometric evaluation, but for the purpose of statistical calculations I extracted and analyzed in particular the functional visual field, the evaluation of the pupil Alpha-Omega, the amplitude accommodation with push-up method and the visual acuity at near.

Many interesting results have been highlighted, also if the population considered in this work is not so wide. The selection of the subjects has been done randomly and the two groups,

compared in all the duration of the research were comparable at the starting point. This let me validate the results.

Many parameters have been measured during the two optometric exams to which each patient has been subjected. In particular I focused on additive power, accommodative amplitude, pupil alpha-omega and visual acuity near. For each of these tests, the subjects that did not exercises with the Syntonic phototherapy, those belonging to the control group (CTRL), do not show any changes in the values from the first to the second examination (T0/T1). On the contrary, some of the patients belonging to syntonic group (SYN) show different values on T1, compared to T0. Sometimes these differences affect more than half of the patients (it is the case of amplitude accommodation (70%), additive power (60%), visual acuity at near (60%)). Unfortunately, such differences are not always statistically significant, and further in-depth researches are required. However, in this work, the observation of visual acuity near and visual functional field have already shown significant evidences. In fact, the improvement of the acuity recorded in many subjects treated with Syntonic Optometry (SYN group) is at least more than one point for each eye and these changes are statistically very significant ($p < 0.01$).

Moreover, the average of three of the four parameters analysed in visual functional field recorded a statistically significance of $p < 0.05$. It is the case of form, green and blue parameters. While the average of red parameter does not show important differences, the other three parameters strongly improve in syntonic group from T0 to T1. This means that already a single cycle of syntonic exercises works on visual field of young presbyopic people, while patients of control group present the same values at T0 and T1. Moreover, the analysis of individual improvement after 20 days show statistically significant changes in all visual functional field of syntonic group.

These results allow me to conclude that Syntonic Optometry is a powerful instrument to act on young presbyopic subjects and this research represent an important starting point for further future studies on this promising field.

CONCLUSIONS

The results of this thesis work let conclude that:

1. Syntonic treatment did not have influenced additive power, accommodative amplitude, pupil alpha-omega parameters in young presbyopic people.
2. Syntonic treatment improved an individual visual acuity at near in the subjects that perform the Syntonic exercises for at least 20 days. The small changes (0.1 in decimal system) are statistically significant.
3. Subjects treated with Syntonic Optometry show important changes in individual visual functional field, in particular, statistically significant differences have been recorded in form, red, green and blue parameters.
4. These results indicate that Syntonic Optometry is a powerful instrument to act in the young subjects with presbyopia. In particular, the specific Mu-epsilon filter used in this research has been efficacy. Moreover the study of visual functional field is the most sensitive and accurate way to evaluate progresses in visual training and all these aspects are important for the balance system.

FINAL WORDS

Rereading this work has allowed me to find solutions that could be applied in a further in-depth study of presbyopia with the help of Syntonic.

- The sample should be increased to give greater significance to the research you are going to perform.
- Another element I consider to be useful in order to better research on presbyopia, is to increase the analysis of optometric parameters detected before and after the application of Syntonic. Among these, it could be statistically evaluated:
 - i. star Van Orden;
 - ii. positive and negative fusions;
 - iii. binocular vision breakage and recovery;
 - iv. Brock rope.
- Check the visual acuity for three and/or six months at a distance, as the subjects examined perceive, but surely check it out after one year from the first Syntonic treatment.
- Check the possibility of repeating treatments with the cycles of twenty applications after three, six or twelve months
- Analyzing the six syndromes, the choice of filters seems a simple fact; but this is not exactly so. If I used only one filter for presbyopia, other combinations and solutions are often used for other situations. The Syntonic College of Optometry may be responsible for standardizing the various procedures with specific application protocols.
- The environment where the sessions are held with the Syntonic filters, in addition to having a low illumination, should be "wrapped up" by sweet and enveloping music such as that used in relaxation or meditation techniques: not only eyes are involved in light, but also the sense of hearing. It results that breathing is also involved for a greater relaxation of the whole organism.

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I certify with my signature, that researches has been conducted independently, there have been only used only in reference list mentioned sources of information, and electronical copy correspond to printed version.

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Reviewer: docent, Dr.phys. Aiga Švede _____

Thesis is submitted in Department of Optometry and Vision Science _____

Dean's authorized person: _____

Thesis is defended in State examination commission session _____.

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