Some considerations regarding the use of protective lenses in computer activities

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Abstract. *Spectral analyzes of radiation harmful to human health over time have highlighted the wavelength components of the spectrum of compound white light (sunlight) that contributes to the deterioration of the visual health of human eyes. Extensive research of national or international research centers has led to the design of constructive variants of visual protection systems presented and developed through specific patents by companies producing such devices. Starting from these general considerations, in this paper are presented some aspects regarding the use, in the activities carried out daily on the computer, of the goggles of protection glasses to the blue and ultraviolet radiation and not only. In the first part of the paper are analyzed the effects on the components of the visual system regarding the penetration of ultraviolet (UV) type A and B radiation in the eyeball, radiation harmful to visual health. In the second part of the paper are proposed working hypotheses for the development of a system for evaluating (measuring) the degree of protection of spectacle lenses in the case of using blue and UV radiation in computer activities. In the final part of the paper are presented the observations and conclusions of the use of these fundamental principles of construction of an evaluation-measurement system and the implementation methods in current practice in specialized offices.*

Keywords: UV radiation, measurement, lenses.

Introduction

The electromagnetic spectrum covers a quantum of electromagnetic waves from radio waves to gamma radiation, with the increase of photonic energy as the wavelength decreases (fig.no.1). In this range, called the optical domain, UV radiation covers the range of 100-380 nm and visible radiation covers the range of 380-780 nm..

***UV**: UV radiations, **HEV**: Visible light with strong energy, **LEV**: Visible light with low energy*

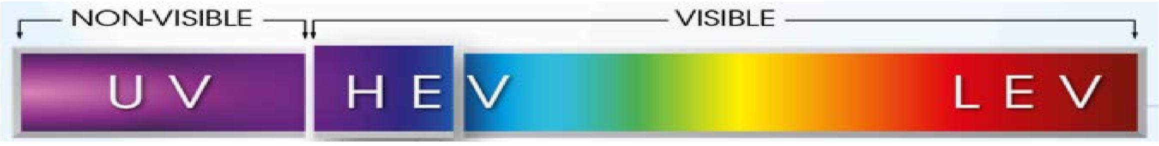

Figure no. 1. Scheme of the wavelength spectrum of the optical domain
Source: [https://www.mieducation.com/pages/controlling-light-transmission-reflection-and-absorption-by-spectacle-lenses]

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High energy visible light (HEV) has wavelengths in the range of 380-495 nm and is commonly known as blue light and accounts for 25-30% of visible sunlight. Blue light is located at the beginning of the visible spectrum and includes harmful blue-violet light (415-455 nm), as well as blue-turquoise light (465-495 nm), absolutely useful for visual health.

Light radiation is the most powerful synchronizer of the human biological clock, because the turquoise light stimulates various structures of the brain, especially when a substance called melatonin is produced.

This substance is responsible for regulating sleep-wake cycles, and in inadequate light conditions, the human biological clock desynchronizes, leading to neurological and physiological imbalances, such as:

- Attention disorders
- Sleep disorders
- Mood swings
- Memory loss
- Variation in body temperature

Blue-Turquoise light is also needed to stimulate the pupillary photo-motor reflex which is the natural protection of the retina against overexposure to light radiation. It is known that blue-turquoise light stimulates the pupillary reflex, especially around wavelengths of 480 nm, because the pupillary contraction is maximum. Without the pupillary reflex, the retina is overexposed to the harmful effects of blue-violet light.

As it is known, blue light radiation is present everywhere: outdoors: the sun's rays emit blue-violet light throughout the year, regardless of the weather (sunny sky, cloudy, rainy weather, etc.); indoors: the light in indoor spaces has changed dramatically in recent decades.

Thus, blue-violet light is increasingly present through LED technology: incorporated in the most modern lighting and display systems, especially computers, tablets and new models of smartphones or bulbs with compact fluorescent light. In addition, there is an "invasion" of screens in many new contexts: store lighting, billboards etc. It can be said that there is a real "light pollution".

The term "light pollution" is often used to describe this trend in the environment and is generally defined as excessive, misdirected or invasive artificial light. Light pollution is a major side effect of urbanization and industrial civilization. Its sources include outdoor and indoor lighting, advertising, commercial properties, offices, factories, headlights and illuminated sports venues.

It is a more severe phenomenon in highly industrialized, densely populated areas of North America, Europe, Japan and Southeast Asia. This trend has accelerated as technology has progressed and countries have continued to grow.

The result is that many people feel that they are constantly exposed to different types of artificial light.

From the point of view of spectacle wearers, this situation has important consequences. New visual problems, such as reflections on lens surfaces, optical scattering caused by stains or scratches, and parasitic images induced by multi-reflections on lenses have become commonplace.

This leads to increased visual discomfort, forcing wearers to find new alternative strategies. Glasses manufacturers study and analyze indoor and outdoor lighting, identifying many key factors and information about consumers. This leads to a rethinking of the way antireflex treatments are designed, precisely to limit these visual problems.

Theoretical aspects regarding exposure and protection to blue light

As presented in the literature, invasive light causes behavioural changes that human subjects consciously adopt or not. Thus, 1 in 2 glasses wearers is bothered by the reflections on the lenses, and the impact on daily activity is strong and lasting. A number of spectacle wearers - 49% adjust their head position; on average 33% of them change their body posture and 25% of spectacle wearers take their glasses off from time to time.

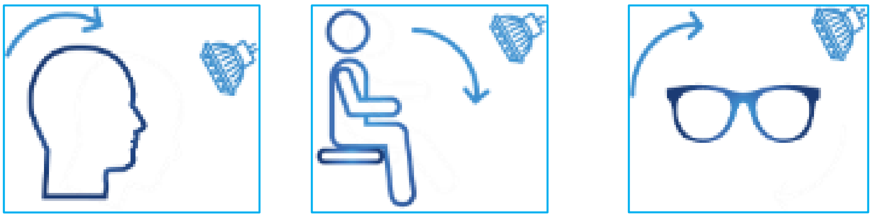


Figure no. 2. Ways to adjust the position of the head, body or the use of glasses
Source: [GfK - Quantitative study 2016 - USA, Spain, India, n = 2406 carriers between 25-65 years]

A wealth of clinical data are needed to assess the level of risk by exposure to and protection against blue-violet light.
The essence of the problem is succinctly stated in the words of Prof. Wolffsohn, "it is very difficult to measure exactly how much light we receive."
While the sun is a major source of blue light and "sunlight is harmful due to its intensity", long-term exposure to artificial lighting based on LED technology is a very recent and rapidly evolving phenomenon. It is "a very different concept, we face less intensity, but long lasting". (Baillet G., 2016).
As part of the spectrum of the visible range, blue light passes through the anterior media of the eyeball, reaching the retina and due to its higher energy level than other wavelengths in the visible spectrum is a potentially harmful factor for retinal sensitivity. Depending on the conditions of exposure (light intensity, duration, periodicity) can induce different types of reactions, including photochemical lesions (Rozanowska, M., 2009). Laboratory experiments have shown that blue light is harmful (Sparrow, JR, 2000) and, in particular, it has been shown that exposure to violet blue light with a maximum peak centered at 435 +/- 20 nm can induce the destruction of macular cells, or even irreversible forms of loss of function in the retinal pigment epithelium (RPE), located in the outer layer of the retina (Arnault, E., 2013).
These forms of dysfunction contribute to the process of degradation and aging of the eyeball and can lead to the development of pathologies such as AMD (Age-Related Macular Degeneration).
The impact of exposure to blue-violet light depends on the amount of total light reaching the retina: retinal irradiance, which is characterized by the radiant flux (power) received by the retina per unit area.
These values vary depending on the transmission through the ocular optical media and - more importantly - on physical factors, such as the position of the eyelids, which limit the visual field and pupillary diameter, causing the ocular dosimetry to become a much more complex process than it is in general (Sliney, D.H., 2001, 2005).
Physiological structures, attachments to the eyeball, such as the eyelids and eyelashes, offer some protection against intense light. The pupil also contributes by using the photomotor process of feedback-type constriction to reduce the amount of light entering the eyeball. While the transmission of UV radiation is blocked in healthy

adults mainly by the previous environments, cornea and lens, the blue light passes through these structures thus reaching the sensitive structures such as the retina.
The amount of blue light that reaches the retina depends on the age of the human subject, because, during life, there is a degradation accompanied by a form of "yellowing" of the lens that would usually provide some absorption in the blue-violet spectrum. As shown by various experiments (Behar-Cohen, F., 2015), children are most exposed to harmful blue light because they have a larger pupil diameter, a lower concentration of macular pigment and the amount of blue light that reaches retina is 65%, while for adults it is 40%.

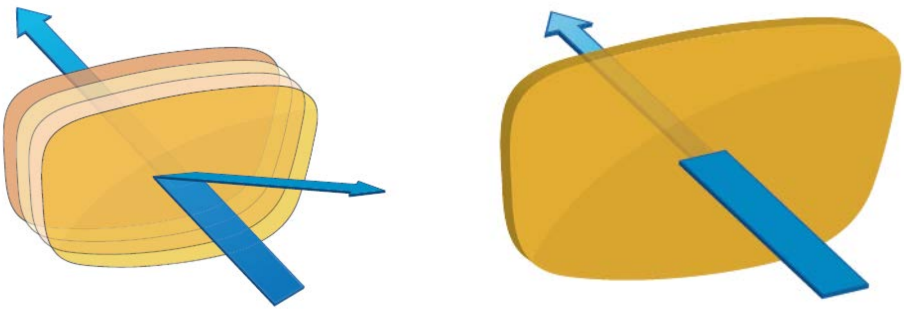
Technical solutions in the field of medical optics for protection against blue light

Corresponding to those described in various articles, wearing appropriate glasses can be useful for preventing the cumulative effects of light exposure, both outdoors and indoors. With the potential risks associated with outdoor conditions, but also with enclosed spaces described above and with the natural protections of the eyeball, however, it is important to pay special attention to technical solutions available in the field of glasses lenses sold in specialized medical optics centres with in order to prevent the long-term effects of blue-violet light. It is well known that most quality correction lenses today offer complete protection against UV radiation with wavelengths of up to 380 - 400 nm.
Therefore, taking into account the basic phenomena (reflection and refraction) of the propagation of light radiation through optically transparent media (lenses) it is found that there is loss of light radiation, by reflection on the convex surface of the lens of 4% and another 3.8% at light output through the concave surface. Practically, from the luminous flux, only 92.2% will reach the eyeball in the case of a spectacle lens with an ophthalmic refractive index of 1.5.
But the transmission of light radiation is also affected by secondary reflections inside the lens. In addition, they can create disturbing parasitic images and lead to a lack of visual comfort. The lack of comfort is also due to the reflections caused by the light coming from behind the subject, from the side or from above, the effects being even more important.
Another important aspect must also be taken into account: the higher the refractive index of the lens material, the stronger the reflection process (example: for the refractive index of 1.6 the reflection loss is approx. 10.4 %). That is why the lenses made of optical materials with high refractive indices are made only with high-performance and special AR (antireflex) treatments for computer work, thus avoiding the installation of visual dysfunctions or discomfort in activity.
These reflections can have various consequences for the wearer:

- visual discomfort
- loss of contrast
- parasitic images
- the lack of aesthetics of the glasses

These anti-glare treatments are interference layers that can be applied to spectacle lenses by evaporating transparent dielectric metal oxides on the anti-scratch layer on both lens surfaces, convex and concave, thus determining the construction of specific lenses for computer use.
Coatings essentially involve layers created by successive deposits of special materials and thicknesses smaller than the wavelengths emitted by the computer screen. This anti-glare technology is increasingly used to reflect certain wavelengths in the visible

range that are harmful to visual health and are found in the emission of radiation inside (display, LED sources).



a) b)

Figure no. 3.Ways of protection against UV radiation (a) reflection and (b) absorption
Source: [www.essilor.ro]

This type of protection, "reflection protection" is most often used for computer lenses. From a practical point of view, it is possible to design anti-reflection layers that provide increased protection in the blue-violet light region by adding a specific reflection element to the wavelength to be rejected, in this case 415-455 nm. The reflective properties of harmful light can be effective up to 20% -25%, while maintaining superior anti-glare properties active throughout the remaining visible range and providing the user with very good visual comfort.

Photochromic lenses are lenses used in eyeglasses, which are almost colorless indoors and color quickly in the open air in the presence of UV radiation. Photochromic lenses are extremely effective in protecting against very intense sunlight, because the degree of coloration automatically adjusts to the amount of UV radiation and thus to external light.

The advantage of photochromic lenses is that they are strongly colored in open spaces, in bright sunlight, and therefore provide a high level of light filtration (including harmful blue light) and also can be worn at all times providing good protection against light. artificial blue and indoors providing protection by absorbing harmful light in percentages of 20-25%.

Results and discussions

Among all the variants of protection procedures studied, it is found that those that use multiple and quality protection layers represent the most frequently adopted solution by the lens manufacturers. But besides these mechanisms, optometry specialists can indicate other protection manoeuvres specific to each human subject depending on the main activity (especially the computer), age, and level of visual function.

The manoeuvres or protective lenses used in the computer activity are indicated in a personalized way depending on the work area, the duration and intensity of the activity as well as the age or the type of computer used.

Therefore, from the observations made on this activity of adapting a comfortable pair of glasses, the option of using a device for checking and measuring the degree of protection of the spectacle lenses, possible to apply in specialized medical optics centres, thus becoming the solution more practical in finding the optimal and personalized variant for each human subject.

Conclusion

Therefore, the light in the visible field that reaches the retina is essential for the quality of visual perception. Despite several mechanisms of self-protection or external protection, the retina can be exposed to high energy light levels, which cause long-term irreversible damage. That is why it is essential to protect with corrective and sunglasses lenses made (and verified) at high quality and to ensure the elimination by reflection or absorption of harmful blue light..

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