UNIVERSITY OF LATVIA
FACULTY OF PHYSICS AND MATHEMATICS
DEPARTMENT OF OPTOMETRY AND VISION SCIENCE

INFLUENCE OF GREY TINTED LENSES ON VISUAL FUNCTIONS

BACHELOR THESIS

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ANOTĀCIJA

Darbs ir uzrakstīts andļu valodā uz 27 lapaspusēm, tajā ir 12 attēli, 2 tabulas un 36 litteratūras avoti.

Darba mērķis bija novērtēt, kā samazināta apgaismojuma apstākļi ietekmē redzes funkcijas gados jaunākiem un vecākiem dalībniekiem.

Gados jauniem (21 – 35 gadi) un vecākiem (60 – 75 gadi) dalībniekiem tika mērīts augsta un zema kontrasta redzes asums. Mērījumi tika veikti ar un bez pelēki tonētām lēcām, kuru gaismas caurlaidība bija 50 %.

Rezultāti parādīja, ka lielāks redzes asuma samazinājums, samazinoties optotipu kontrastam, bija novērojams gados vecākiem dalībniekiem. Skatoties caur tonētajām lēcām, standarta kontrasta redzes asums vairāk samazinājās gados vecākiem nekā jaunākiem dalībniekiem. Zema kontrasta redzes asumu tonētās lēcas abām grupām samazināja līdzīgā apjomā.

Atslēgas vārdi. Redzes asums, kontrastjutība, tonētas lēcas, novecošana

ABSTRACT

Bachelor Thesis is written in English on 27 pages. It contains 12 figures, 2 tables and 36 references.

The aim of this work is to evaluate the influence of decreased illuminance on visual functions of different age groups.

High (98%) and low contrast (20%) visual acuity was measured for younger (21 – 35 years) and older (60 – 75 years) participants. Measurements were done with and without grey tinted lenses. Light transmittance of filter was 50%.

Results showed that reduced contrast of optotypes affect visual acuity more for older than younger participants. Grey tinted lenses reduce standard contrast visual acuity more for older than younger participants. Grey tinted lenses reduce low contrast visual acuity in similar amount for younger and older participants.

Key words. Visual acuity, contrast sensitivity, colored filter, aging

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INTRODUCTION

The eye is a complex organ that provides information on the form, light intensity, and color reflected from objects. It is well know that eye is far from being optically perfect: aberrations (chromatic and monochromatic), diffraction and scattering cause major imperfections in the resulting retinal image. Visual defect due to refractive error is often compensated for by a kind of ophthalmic devices but often with spectacle lenses. Therefore, it is importance to be informed of how any ophthalmic device may condition visual performance. Tinted spectacle lenses are the most common type of ophthalmic. The goal of tinted spectacle lenses is to decrease the transmission of light but without interfering on person’s visual efficiency. Tinted lenses can improve contrast, reduce glare, and enhanced colour perception in colour deficient individuals, decrease light scatter in conditions such as cataract. In this study, only the grey tint was evaluated. The variables of visual performance like visual acuity should preferably not be affected negatively. This component of visual performance will be evaluated in this research study. Furthermore, it is well know that the peripheral visual system decreases with age. The degree to which age-related differences in neural markers of visual processing are affect by changes in visual acuity has not been systematically evaluated. Studies often report that their subjects had normal or corrected-to-normal vision, but the valuation of visual acuity appear to most habitually be based alone on self-report. (Kirk R. Daffner et al., 2013). It is usually identify that older people have greater difficulty performing visual tasks at low light levels. The quantification of flicker sensitivity to evaluate retinal function is used clinically in different methods. Dissimilary to spatial contrast sensitivity, temporal contrast sensitivity is conditioned less by scattered light or refractive error. This means that tests applying flickering stimuli can prove an accurate measure that describes the processing of temporal signals in the aging retina, relatively independent of age-related changes to the optics of the eye. Both visual acuity (VA) and contrast sensitivity (CS) are significant parameters for testing visual function. (Bi, W., Gillespie-Gallery et al 2016).

The aim of this work is to evaluate the influence of decreased illuminance on visual functions of different age groups.

Task:

1. To assess how changes visual acuity for older and younger subjects, if contrast of optotypes is reduced.
2. To evaluate influence of grey tinted lenses on standard contrast visual acuity for older and younger subjects.
3. To evaluate influence of grey tinted lenses on low contrast visual acuity for older and younger

subjects.

Method: Best Correct Visual Acuity (BCVA) will be test for two different age group.

The test made in the consulting room through a free computer program named Freiburg Vision Test (FrACT). Two kind of test were achived: the first on standard contrast (98%), the second on low contrast (20%). The test, with regular refractive correction wearing traditional spectacless or Lac, with and without the grey filter was performed. Five measurements for each participant was made, from which the average was obtained and annotated.

1. REVIEW OF LITERATURE

1.1. Contrast sensitivity

Contrast sensitivity (CS) is largely used as a measure of visual function in both basic research and clinical evaluation. Contrast sensitivity defines the threshold between the visible and invisible, which has evident importance for basic and clinical vision science. CS is an important parameter to indentify visual dysfunction. There are two pathways from the retina to cortex: the parvocellular and the magnocellular pathways (Nassi, J. J., et al 2009). Both of them could transform and distribute information to the visual cortex (V1) (Sincich, L. C. & Horton, J. C 2005). Parvocellular system is selectively sensitive to middle to high spatial frequencies (low temporal frequencies); however, the magnocellular system is sensitive to a very broad temporal frequency range (low spatial frequencies). Contrast-sensitivity function (CSF) is controlled by the spatiotemporal charac- teristics of the visual pathway; magnocellular system forms the basis of the achromatic CSF and dominates close-to-threshold detection. When the magnocellular system saturates, the parvocellular system dominates the higher contrast detection (Al-Hashmi, A. M., Kramer, D. J. & Mullen, K.T 2011). The contrast sensitivity function (CSF) relates the visibility of a spatial pattern to both its size and contrast, and is therefore a more comprehensive assessment of visual function than acuity, which only determines the smallest resolvable pattern size. Because of the additional dimension of contrast, estimating the CSF can be more time-consuming (Thurman et al. 2016). Contrast sensitivity is defined as the capacity to identify the lowest lumination difference between an object and the background. Standard visual acuity measurement is done with high contrast conditions. The contrast of the target quantifies its relative difference in luminance from the background, and may be specified as Weber contrast (C = (Lmax - Lmin)/Lmin). This does not present any information about visual performance in many of the several activities we perform in our daily lives, such as driving at night or reading in low light, and a patient’s vision cannot be fully considered by evaluating visual acuity alone (Karatepe et al., 2017). The clinical significance of contrast sensitivity (CS) is supported by research exhibiting that many conditions, including amblyopia, macular degeneration, diabetic retinopathy and cataracts. Damage of CS is also linked with functional disabilities and is often more predictive of performance impairment than are standard acuity measurements (Thurman et al., 2017). There are two types of contrast sensitivity: spatial contrast sensitivity and temporal contrast sensitivity. Spatial contrast sensitivity, detection of striped pattern at variuos levels of contrast and spatial frequency. Temporal contrast sensitivity is measured with gratings that reverse counteract at variuos rate over times, here contrast sensitivity fuction is produced for the time related processing in the visual system by presenting a uniform target field modulated sinusoidal in time . Both the system provides more complete and systemic data on the status and visual performance. Contrast is a measure of how different a luminance level at some point in space or time is, compared to some luminance reference. Spatial contrast compares some portion of the visual field with another portion, for example, the intensity difference between the light and dark bars (Anusha Y Sukhaand Al., 2013). Contrast sensitivity measurement is one of the primary methods at present used to assess visual function. The eye is able to sense an object by comparing differences in light level between the target and the background (Kerapete et al., 2017). Although several methodologies have been advanced over the decades to measure threshold CS, the standard overtures show single targets (e.g., sine-wave gratings or letter optotypes) and measures the smallest amount of luminance contrast needed to identify or discriminate the target using different tasks that include target detection, letter identification, and orientation discrimination (Pelli, D. G & Bex., 2013). A central question of practical importance presented in the literature on visual CS regards the extent to which unique and useful information might be gained from lengthy methods that evaluate the full range of the CSF, in comparison to time-efficient methods that produce a single CS estimate with letter optotypes (Woods & Wood., 1995).

1.1.2 Effect of aging on functional contrast sensitivity

The aging visual system undergoes many changes that disturb physiological functions, with consequent decline in visual performance as a result of either degraded retinal images or changes in the neural mechanisms in the retina and the visual pathways (Barbur, J. L. & Rodriguez-Carmona., 2015). During normal aging, the retinal image quality progressively decreases in average. This is due to increases in both aberrations and amount of scattered light (Weale RA., 1992). This deterioration of retinal image quality has an impact on vision and, therefore, in the design of ophthalmic optics for the aging people. Specifically, the contrast sensitivity function (CSF) declines throughout the life duration. Several reasons are responsible for this deterioration, ranging from purely optical degradation to retinal and neural losses (Owsley C & Sloane ME 1999). The visual function parameters (VA and CS) degraded with age, although relationship were stronger for parameters related to optical quality and intraocular scatter. As a result, the decrease in optical quality with age is greater for lower contrasts (figure 1). Martinez-Roda and colleagues evaluated the relationship between visual function and optical quality, partial correlations controlling for age (Martínez-Roda et al 2016).

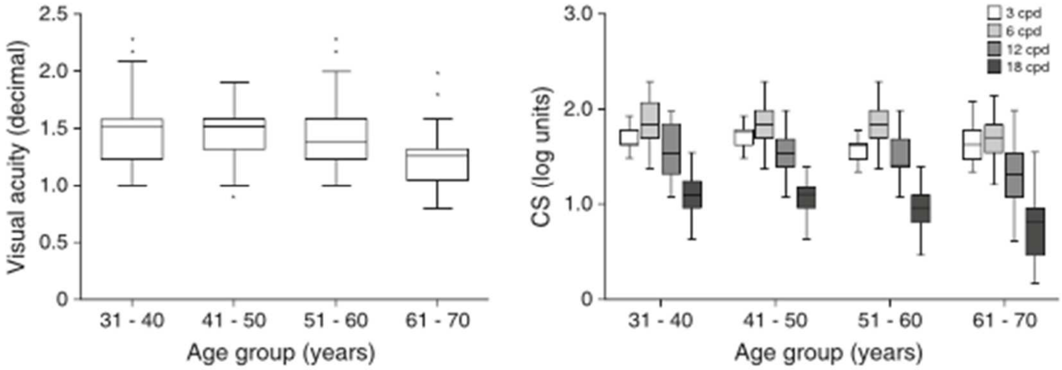

Fig.1. Decline of visual acuity (VA) and contrast sensitivity (log-CS) at spatial frequencies 3, 6, 12 and 18 cycles per degree in relation to age. Box is the interquartile range; dark line is the median; end of lines are minimum and maximum values (Martínez-Roda et al., 2016).

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Martinez-Roda and colleagues have conducted a prospective study with 198 healthy volunteers from 31 to 70 years of age. the visual acuity (VA) and contrast sensitivity (CS) at 3, 6, 12 and 18 cycles per degree (cpd) frequencies were assessed, together with values of optical quality and intraocular scatter- ing obtained with a double-pass system (Optical Quality Analysis System – OQAS), specifically the modulation transfer function cutoff frequency (MTFcutoff), the Strehl ratio, the OQAS values (OV) at contrasts of 100, 20 and nine per cent and the objective scatter index (OSI). Their studied the change of these variables with age and obtained standard values for optical quality and intraocular scattering parameters for four age groups: 31 to 40, 41 to 50, 51 to 60 and 61 to 70 years (figure 2).

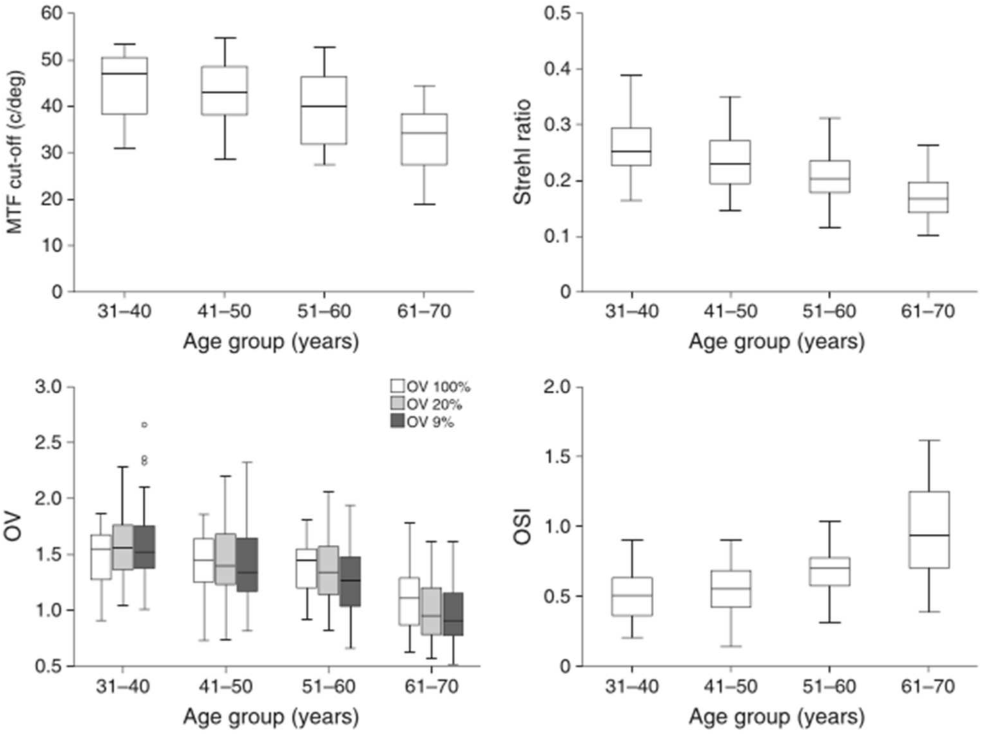

Fig.2. Change of the modulation transfer function cutoff (MTFcutoff) (cyclesperdegree), Strehlratio, Optical Quality Analysis System (OQAS) values (OV) at 100, 20 and nine per cent contrasts and objective scatter index (OSI) in relation to age group. Box is the interquar- tile range; dark line is the median; end of lines are minimum and maximum values (Martínez-Roda et al., 2016).

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Martinez-Roda et al. in their study showed that visual function, optical quality and intraocular scatter change with age, in particular, parameters related to low contrast stimuli and scattered light. These results suggest that optical deficits are compensated throughout the first decades of adult life by means of sensory or perceptual factors, as the changes in visual function were smaller than objective outputs, in particular until the age of 50. The relative contribution of optical and postoptical (retinal and neural) factors to the deterioration in spatial vision caused some contro-versy, although it is now accepted that optical factors play the major important role in normal eyes (Artal, 1993). Several factors contribute to this age-related increase in aberrations: changes in aberrations of the cornea, in the lens, or in their relative contributions. Campbell & Robson (1968) discovered the presence of several channels in vision, each discriminating to a different band of spatial frequencies. Ever since, it has been of interest to measure contrast sensitivity as a function of spatial frequency. This contrast sensitivity function

(CSF) normally consists of the measured contrast detection threshold at five or so spatial frequencies uniformly spaced on a log scale spanning the most sensitive part of the range (Yang Y et al., 2008). Contrast sensitivity decrease with age and is more susceptible to the effects of normal aging or disease than high contrast visual acuity (Derefeldt et al., 1979). Mesopic contrast sensitivity decreases in the 50s, ten years before photopic contrast sensitivity. This is due to the age-related reduction in the number of rods at the parafovea (Gao H & Hollyfield J., 1992). In accordance Gillespie-Gallery et al. dimostrated that the age dependence of contrast thresholds on adaptation luminance is more apparent at the parafovea (figure 3B) than the fovea (figure 3A)

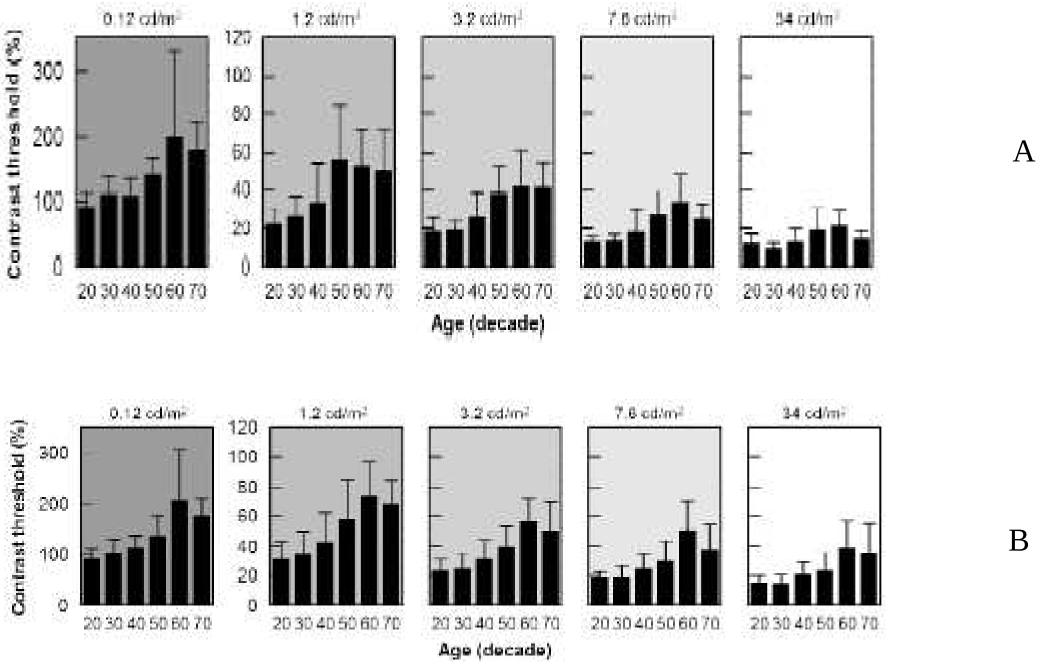

Fig.3. (A) foveal contrast threshold. (B) parafoveal contrast threshold (Gillespie-Galleryet al.,2013).

The analysis of age-related changes in binocular summation of contrast thresholds can provide useful information on the status of visual pathways (Gagnon RWC & Kline DW 2003). Binocular summation for contrast can be significantly reduced in older people, and some experience inhibition (performance in binocular viewing which is worse than monocular viewing). The deterioration in binocular summation with age has frequently been attribuited to large inter-ocular differences in sensitivity or image contrast however this correlation has not always been found. Binocular summation may decrease with eccentricity or light level, but results in the literature are mixed (Pardhan S., 1997). There are many vision attributes we can assess, but the eye is arguably most sensitive to color differences (Chaparro et al., 1993), and, unlike achromatic contrast sensitivity, color thresholds under optimum conditions remain relatively unchanged by small variations in refraction, pupil size, and scattered light (Barbur et al., 1997)

1.2 Colored Filters

Coloured lenses have been suggested for use with low vision patients, especially in those age-related. Howevere given the many subjective reports of low vision patients benefiting from the wearing of colured lenses, few studies have tried to correlate this developments using objective measures of visual performance. Tinted lenses are currently used by eye care specialists to assist people with low vision to maximize use of residual vision, improve visual function, control glare and improve orientation and mobility abilities. Spectacle wearers frequently choose tinted lenses to clear or non-tinted lenses for their protection against detrimental radiation, improved cosmesis, increase of visual performance and effects on colour vision. Between the available tinted lenses on the business blue, brown and grey tinted spectacle lenses are common with different degree ranging from A to D. Due to decreased transmission of light through such lenses, the optical system of the eyes and the ambient vision may be for a short time altered. Colour vision (CV) and contrast sensitivity (CS) are significant parameters of this altered visual world (M Shaik, PD Majola et al. 2013). Tinted lenses are often prescribed to people with various ocular diseases, including age-related macular degeneration (ARMD), retinitis pigmentosa (RP), cataract, diabetic retinopathy, cone dystrophy and oculo-cutaneous albinism (Frank Eperjesi 2002). Persons report a subjective increase in both the brightness and contrast of visual stimuli with coloured filters. A crucial benefit of tinted lenses is their caoacity to reduce glare from reflective surfaces. In decreasing glare, objects on a surface become more definitely considerable, thus bettering contrast. This was found to be the case with the study lenses at spatial frequencies of 1.5, 3 and 6 cpd. At high spatial frequencies, anyway the contrast sensitivity function decreases due to the optical defects of the human eye and the dimension of individual foveal cones. A modify in the illumination degree, but, tends to generate alteration in contrast sensitivity (De Fez et al., 2002) One of the features of tinted lenses is to reduce illumination and hereby decrease sensitivity to light. Darker tints have a tendency to decrease illumination over lighter tints. However, darker tints cause pupil dilation permiting for a greater degree of aberrations. High spatial frequencies are associated with more elaborate details these are maybe the motives why darker tints decreased contrast sensitivity function at high spatial frequencies. On the other hand, darker tints ameliorate contrast at low spatial frequencies probably due to the tints decreasing glare, thus having the highest contrast sensitivity function at low spatial frequencies (Ramkissoon P et al., 2002). Objective measurements show that filters improve contrast for stimuli of specific colours on certain backgrounds, contrast may be reduced for other colour combinations. For achromatic stimuli, there is some basis for the suggestion that colured lens filters improve contrast. For instance, light scatter (which is greater for short than for longer wavelengths) is reduced by filters, suggesting that filters should mitigate visual effects of scatter such as reduced contrast sensitivity (Luria SM 1972). Others have noted that filters decrease chromatic aberration. It has also been reported that pupil dilation in the presence of filter is superior than that with a matched neutral density filter, which might partly explain the perceived improvement in brightness that some individuals report (Luque et al., 2006). Different authors have reported that contrast sensitivity (and in some cases visual acuity) for achromatic stimuli is improved with colured filters for those with visual impairment resulting from cataract or other eye diseases, as well as for visually normal people (De Fez D et al., 2002). Past studies of tinted lenses and low vision have measured effects on visual acuity (VA), grating acuity, contrast sensitivity (CS), visual field, adaptation time, glare, photophobia and TV viewing (Kelley SA 1990). Therefore, the use of tinted lenses in low vision remains controversial and eye care practitioners will have to continue to trust on anecdotal evidence to assist them in their prescribing decisions (Wolffsohn JS et al., 2000). The purpose of this study consequently was to inquire the effect of tinted spectacle lenses and their levels on vision acuity in standard (98%) and low contrast (20%).

1.3 Visual acuity

Principal visual acuity refers to the ability of the visual system to discriminate fine distinctions in the surroundings as measured with printed or projected visual stimuli. In visual science, the term "visual acuity" refers to the ability of the visual system to resolve spatial detail. Visual acuity is a measure of the spatial resolving power of the visual system; it indicates the angular size of the smallest detail that can be resolved (Peter Lennie et al. 2002). There are several types of visual acuity (figure 4-):

- Detection acuity or visible minimum, to assess or to exclude the presence of an object. This ability is measured by increasing the size of a line or point on white background until it is perceived. This acuity is therefore related to luminance and not to the size of the object. It is determined by stimulation of a single receptor. For a normal person the thinnest line that can be perceived has a thickness of 0.5 sec of arc.
- Location acuity or minimum localizable, to evaluate the relative spatial location for two objects, hence the ability to determine the minimum spatial displacement perceptible between two figures. The minimum perceptible distance is 2 seconds of arc.
  - Resolution Acuity or minimum separable, to recognize details of an object, is the ability to identify two separated points. Because this is possible, they need to be stimulated two photoreceptors (cones) and that they are separated by a third cone with a lower level of stimulation indicating the lack of continuity. Usually it is measured with the presentation of square wave patterns. Thinner lines that may be distinct are in the order of 30-40 seconds of arc.
  - Letter acuity or morphoscopic or minimum recognizable; it is defined by the minimum angular dimensions necessary to allow recognition of the features or shape of an object. It also has neuropsychic functions because it involves recognition of a symbol mediated by the knowledge and experience of the subject.

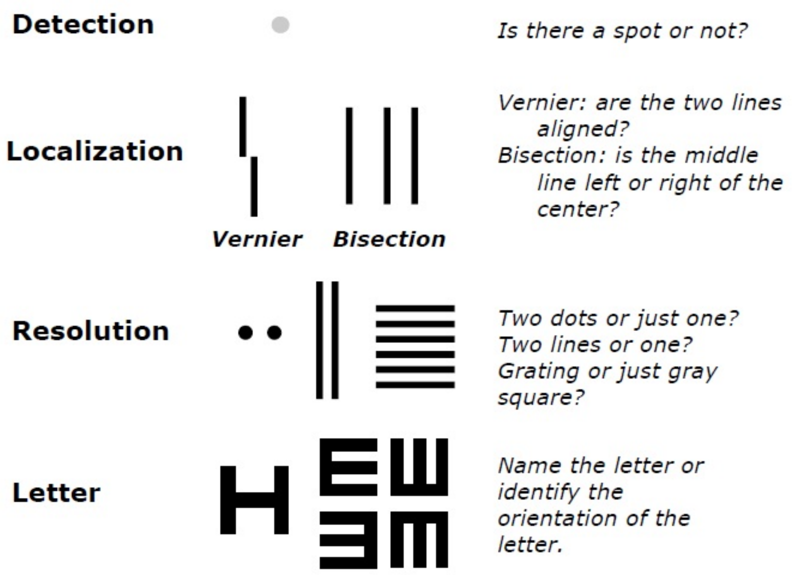

Fig.4. kinds of visual acuity[1]

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[1] (www.opt.uh.edu/onlinecoursematerials/stevenson-5320/L08Acuity.pdf)

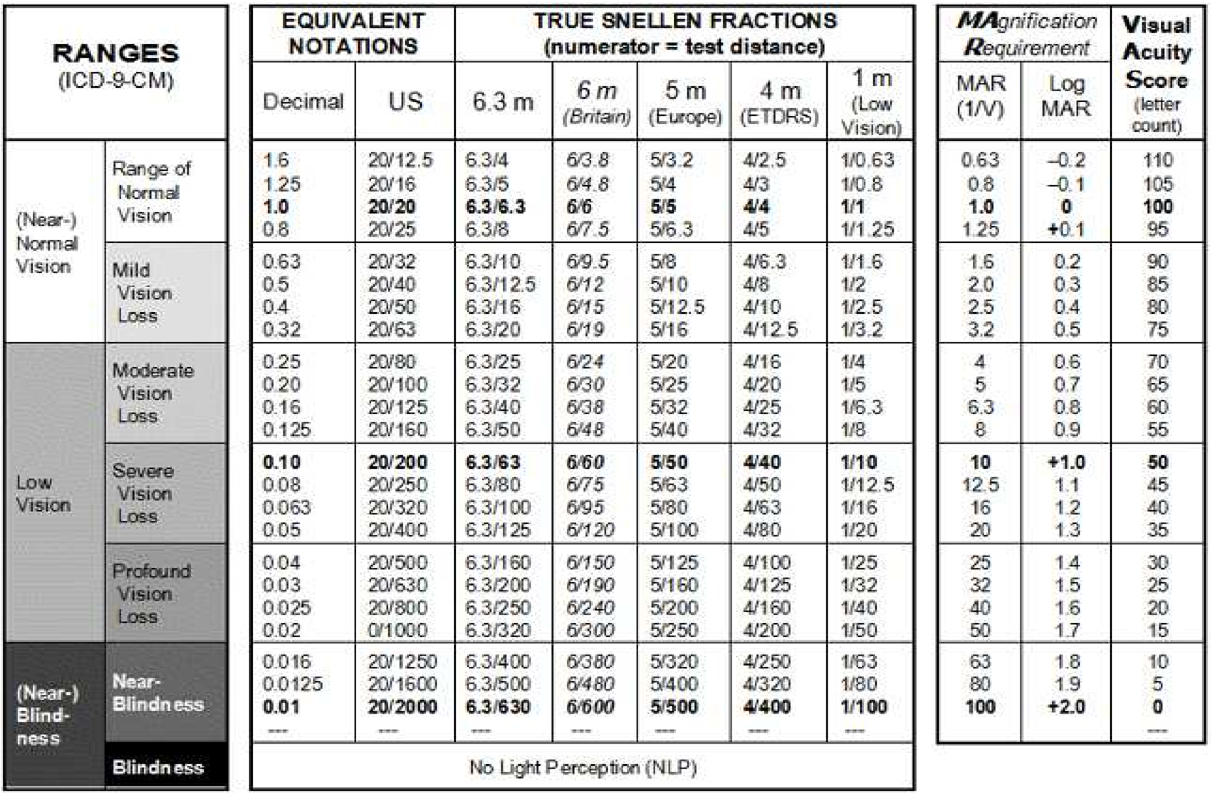
The examination of visual acuity is a measurement of that ability. The visual acuity score of an individual should demonstrate the reciprocal of the angular size of the critical detail within the smallest optotype that can be rightly recognized by that individual.

Clinical tests of visual acuity define a size threshold for a recognition task. The objects to be recognized are called “optotypes,” and usually they are letters, Landolt rings, or “tumbling E's” constructed so the stroke width and gap width are 1/5th of the height of the optotype character. The visual acuity is determined by measuring the angular size of the smallest optotypes whose identity (letters) or orientation (Landolt rings and tumbling E's) can be recognize.

The Landolt ring should be the standard optotype, and the gap in the Landolt ring shall be taken as the critical detail. "Clinical visual acuity," as measured in the usual office ophthalmic examination, is defined as a measurement of the ability to recognize black, high-contrast optotypes on a white background. (Visual Acuity measurement Standard – ICO 1984 Unanimously approved by the Visual Functions Committee, Ste. Margherita Ligure, Italy May 25, 1984 Presented to the Consilium Ophthalmologicum Universale, and approved for distribution Kos, Greece, October 5, 1984 Published in the Italian Journal of Ophthalmology II / I 1988, pp 1 / 15).

Visual acuity is typically measured under conditions of high contrast, using printed or projected charts with optotypes. The results of visual acuity testing are generally expressed in Snellen notation, which is the ratio of the test distance to the distance at which the critical detail of the smallest optotype resolved would subtend 1 minute of visual angle. So, a minimum angle of resolution (MAR) of 1 minute of visual angle (or arc, sometimes abbreviated as “min arc”) when tested at 20 feet (6 meters) is expressed as 20/20 (6/6), while an MAR of 10 minutes of arc if tested at 20 feet is expressed as 20/200 (6/60). Another means of expressing visual acuity are the decimal notation (the reciprocal of the MAR or the Snellen fraction), logMAR notation (the common logarithm of the MAR), the visual acuity rating, VAR, where VAR = 100 − 50 (logMAR), and the Snell-Sterling visual efficiency ($VE = 0.2^{(MAR-1)/9}$). Tabble 1 presents these alternative forms of measurement as a conversion table. The standard for normal acuity has traditionally been considered to be 20/20. However, individuals with normal, disease-free eyes often have acuity better than 20/20, provided that refractive error has been corrected (Elliott et al., 1995).

Table 1 – Visual Acuity Ranges and Visual Acuity Notations[2]



RANGES (ICD-9-CM)		EQUIVALENT NOTATIONS		TRUE SNELLEN FRACTIONS (numerator = test distance)					MAgnification Requirement		Visual Acuity Score (letter count)
		Decimal	US	6.3 m	*6 m (Britain)*	5 m (Europe)	4 m (ETDRS)	1 m (Low Vision)	MAR (1/V)	Log MAR	
(Near-) Normal Vision	Range of Normal Vision	1.6	20/12.5	6.3/4	*6/3.8*	5/3.2	4/2.5	1/0.63	0.63	–0.2	110
		1.25	20/16	6.3/5	*6/4.8*	5/4	4/3	1/0.8	0.8	–0.1	105
		1.0	**20/20**	**6.3/6.3**	***6/6***	**5/5**	**4/4**	**1/1**	**1.0**	**0**	**100**
		0.8	20/25	6.3/8	*6/7.5*	5/6.3	4/5	1/1.25	1.25	+0.1	95
	Mild Vision Loss	0.63	20/32	6.3/10	*6/9.5*	5/8	4/6.3	1/1.6	1.6	0.2	90
		0.5	20/40	6.3/12.5	*6/12*	5/10	4/8	1/2	2.0	0.3	85
		0.4	20/50	6.3/16	*6/15*	5/12.5	4/10	1/2.5	2.5	0.4	80
		0.32	20/63	6.3/20	*6/19*	5/16	4/12.5	1/3.2	3.2	0.5	75
Low Vision	Moderate Vision Loss	0.25	20/80	6.3/25	*6/24*	5/20	4/16	1/4	4	0.6	70
		0.20	20/100	6.3/32	*6/30*	5/25	4/20	1/5	5	0.7	65
		0.16	20/125	6.3/40	*6/38*	5/32	4/25	1/6.3	6.3	0.8	60
		0.125	20/160	6.3/50	*6/48*	5/40	4/32	1/8	8	0.9	55
	Severe Vision Loss	**0.10**	**20/200**	**6.3/63**	***6/60***	**5/50**	**4/40**	**1/10**	**10**	**+1.0**	**50**
		0.08	20/250	6.3/80	*6/75*	5/63	4/50	1/12.5	12.5	1.1	45
		0.063	20/320	6.3/100	*6/95*	5/80	4/63	1/16	16	1.2	40
		0.05	20/400	6.3/125	*6/120*	5/100	4/80	1/20	20	1.3	35
	Profound Vision Loss	0.04	20/500	6.3/160	*6/150*	5/125	4/100	1/25	25	1.4	30
		0.03	20/630	6.3/200	*6/190*	5/160	4/125	1/32	32	1.5	25
		0.025	20/800	6.3/250	*6/240*	5/200	4/160	1/40	40	1.6	20
		0.02	0/1000	6.3/320	*6/300*	5/250	4/200	1/50	50	1.7	15
(Near-) Blind-ness	**Near-Blindness**	0.016	20/1250	6.3/400	*6/380*	5/320	4/250	1/63	63	1.8	10
		0.0125	20/1600	6.3/500	*6/480*	5/400	4/320	1/80	80	1.9	5
		0.01	**20/2000**	**6.3/630**	***6/600***	**5/500**	**4/400**	**1/100**	**100**	**+2.0**	**0**
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	Blindness	No Light Perception (NLP)									

The presence of excellent visual acuity tells the examiner that the ocular media are clear, the image is clearly focused on the retina, the afferent visual pathway is functioning, and the visual cortex has appropriately interpreted signals received (Visual Acuity Jeffrey H. Levenson And Alan Kozarsky).

The pupil’s size is an important factor disturbing visual acuity. Large pupils consent more light to stimulate the retina and decreases diffraction, but resolution will be influenced by aberrations of the eye. On the other hand, a small pupil will decrease optical aberrations, but resolution will be diffraction imperfect. Therefore, a mid-size pupil of about 3 to 5 mm would be optimal, because this is a compromise between the diffraction and aberration limits (Smith G, Atchison DA. 1997, Atchison DA et al. 1979).

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[2] http://www.precision-vision.com/a-visual-acuity/

2. RESEARCH

2.1 Aim and tasks of research

The aim of this study is to evaluate the influence of decreased illuminance on visual functions of different age groups.

Tasks:

1. To assess how changes visual acuity for older and younger subjects, if contrast of optotypes is reduced.
2. To evaluate influence of grey tinted lenses on standard contrast visual acuity for older and younger subjects.
3. To evaluate influence of grey tinted lenses on low contrast visual acuity for older and younger subjects.

The aim of this study is to evaluate the influence of decreased illuminance on visual functions of different age groups.

2.2 Methods and procedure

Subjects: Thirty Caucasians aged between 18 and 75 years volunteered to take part in the study. None of the subjects had any preceding experience in contrast sensitivity measurement methods. The responses for two different age groups were studied. In the younger age group there were 15 subjects between the ages of 18 and 35. In the older group there were 15 subjects between the age of 60 and 75 years. The subjects included in the study were not affected by eye disorder on clinical examination.

There were no preceding history of eye disorder that might affect visual function, for example, amblyopia. There were no family history of glaucoma or diabetes. There were visual acuity of 6/9 (decimal 0-66) or better in each eye separately. Cataract was excluded on the basis of ophthalmoscopic examination. Any subject who had eye in which such an opacity was detected was excluded from the study. Glaucoma was excluded on the basis of a watchful family history and examination of the optic disc for subjects aged 70 or more. Subjects with Senile macular degeneration were excluded based on a morphological absence of macular degenerative change. The seeming pupil size for all eyes was larger than 2-5 mm.

Optical correction was between -5 dioptres and +4 dioptres inclusive (summation of sphere and cylinder).

Patients with normal visual acuity than their normal peers were selected between November 2016 and May 2017.

All patients who cooperated with me in this study had no strabismus, no keratopathy, and no cataracts or other eye diseases.

The measurements of visual acuity used the international standard vision acuity chart (E chart, Snellen chart), by Shin-Nippon chart projector CP-30 in photopic Brightness condition. Ambient illuminance remained constant throughout this procedure.

The chart was 4.2 meters away from the subject. All examinations were performed binocularly. All patients using their own refractive correction.

The order in which the examinations were completed was determined pseudorandomly for each subject with a random Landolt C generator.

The main data gathering instrument that was used in this study was “FrACT – Freiburg Visual Acuity and Contrast Test “ PC program and a set of tinted lenses.

The lenses used were made of CR39. The tint used was grey and light transmittance was 50%. The filters were cut by myself and fitted into lens holders for easy of use with a patient’s spectacles. Best Corrected Visual Acuity (BCVA) was tested using the “Acuity C” test of FrACT chart.

Participants were tested binocularly, under usual room brightness, with the chart placed 3 m away from the patient and 1 m above the ground.

The test based on two different optotype contrast, the first screen had 98% contrast while the second screen had 20% contrast (fig. 5).

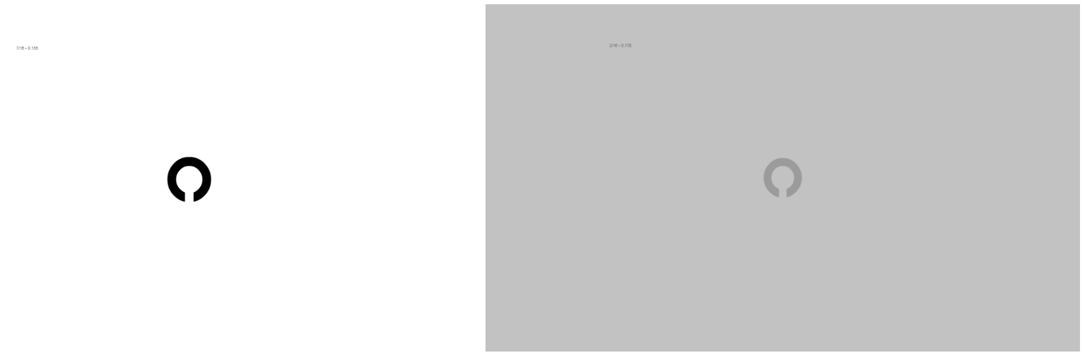

Fig.5. High (98%) (left) and low (20%) contrast Landolt rings.

Each subject was given the same instructions: “say in which direction is the gap of Landolt C out loud as accurately and as quickly as possible”

The Landolt rings directions were 4, and the test was form of 16 trials.

The black-on-white Landolt C appears randomly in one of four directions (up, down, left or right). The participant calls out the direction.

Based on the response, the size of the optotype presented is increased (for wrong answers) or decreased (for right answers).

Subjects were encouraged to guess or pass on Landolt rings they were unsure about.

This was repeated five times and average recorded. The BCVA values achieved in LogMAR were annotated and used to understand the findings.

After performing the test for both optotypes with usually refractive correction, the participant being tested by putting a template with neutral grey solar filter over the traditional spectacle.

The data considered are:

- Age of patients
- The best eye's refraction correction
- Spherical equivalent power
- BCVA 'best corrected visual acuity' in logMar (high and low contrast)
- BCVA 'best corrected visual acuity' with grey filter in logMar (high and low contrast)
- Pupil size in bright romm and dark room
- For statistical analysis t-test was used.

2.3. Results and analysis of data

2.3.1 Results of control group

The results from the experiments will be presented in this chapter. A total of 50 volunteers were responding to the call made. Of these subjects 26 people, because of eyes diseases or low vision, were excluded. Finally, 24 persons were examined about BCVA on standard and low contrast. The mean age was 30.53 years for young people group and 68.86 years for older group. All patients had a spherical equivalent average of -0.15 D. A total of 16 eyes had a cylindrical refractive error, 8 eyes of which showed astigmatism higher than 0.50 D.

The pupil diameter average was measured under photopic and mesopic conditions was 4.02 and 5.30 mm (range: 3 to 6.5 mm). Collected the data, the values regarding the BCVA of all partecipants were entered. The results showed that the vision decreases tendentially with age as shown in the figure 6. The older group had a lower BCVA average when compared with their younger counterparts.

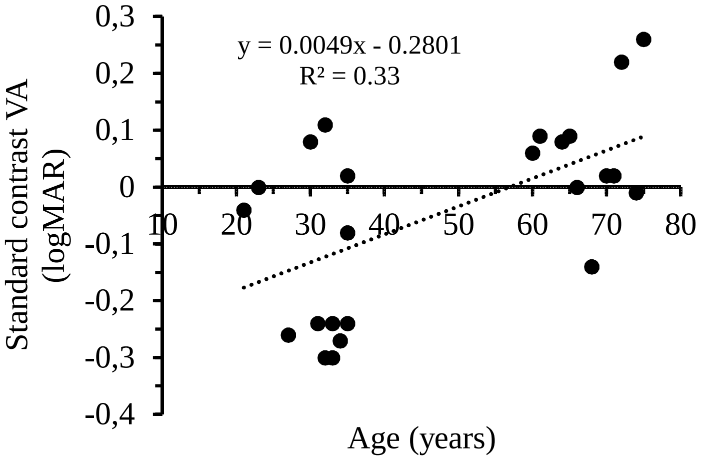

Fig.6. Standard contrast visual acuity of all participants depending on age.

Furthermore, the values regarding the standard contrast VA with grey filter of all partecipants were evalueted. You can notice a not significant change in visual acuity for young participants. Whereas, the data show that the average of BCVA decreases considerably for the older participants (figure 7).

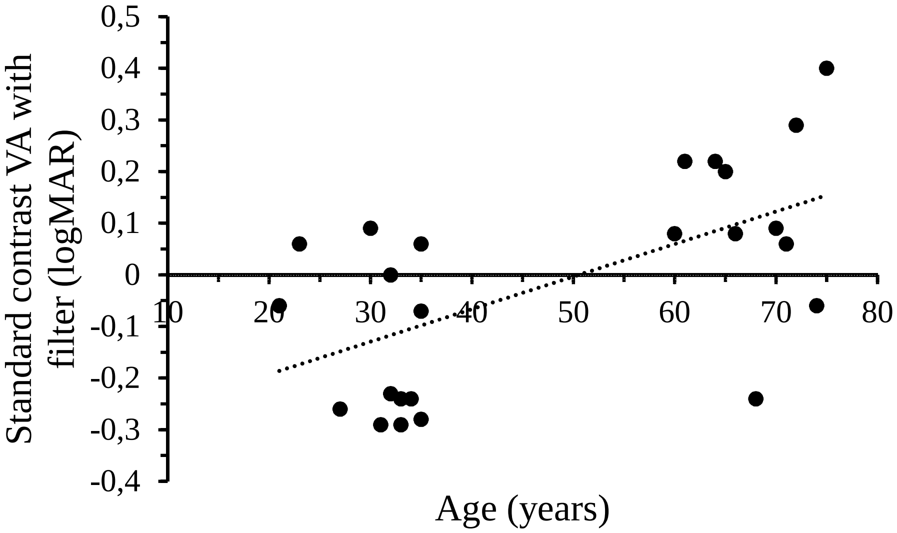

Fig.7. Standard contrast visual acuity of all participants depending on age with filter.

The BCVA tendency for younger partecipants in both contrast shows a non-signifying difference. The BCVA is almost the same (figure 8).

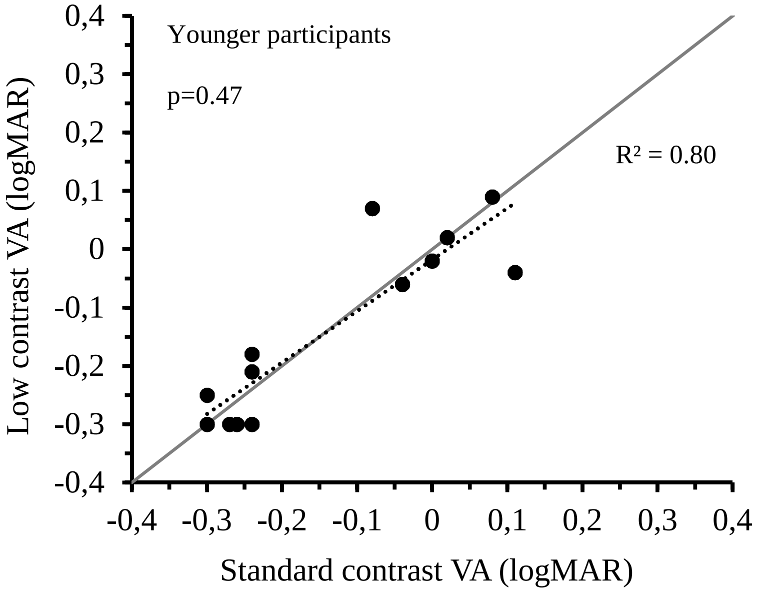

Fig.8. Standard and low contrast visual acuity for younger participants.

The older patients, instead, have a significant visual acuity worsening in low contrast than standard contrast. For analysis t-test was used. The P-value In standard contrast condition (98% brightness) the mean BCVA was 0.088 while the mean low cotrast BCVA was -0.11. (figure 9).

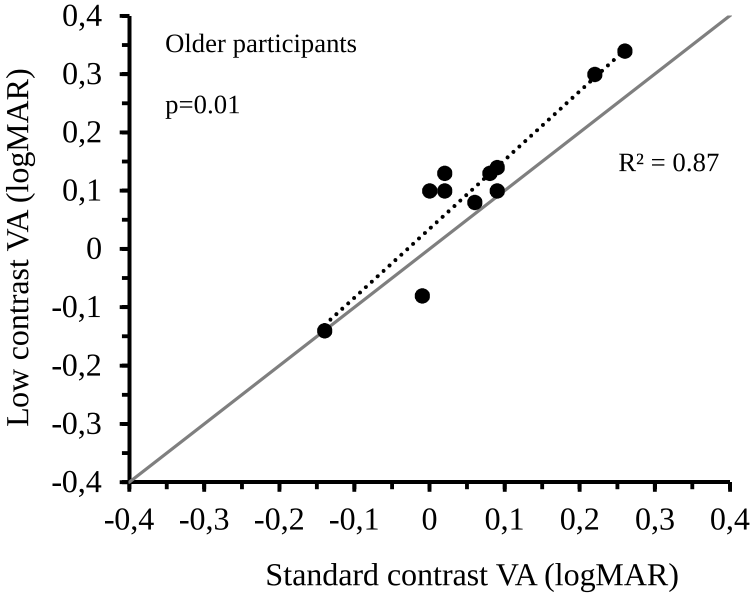

Fig.9. Standard and low contrast visual acuity for older participants.

The standard contrast BCVA average data with and without filter was analyzed. The results depicted in Figure 10 shows the effect of the tints grey on standard contrast visual acuity. The data was collected and categorised for both groups. The data shown that in vision with and without gray filter there are no significant changes in visual acuity for younger subjects. Instead, with regard to the older group, there was a worsening effect on the use of the grey filter (figure 10).

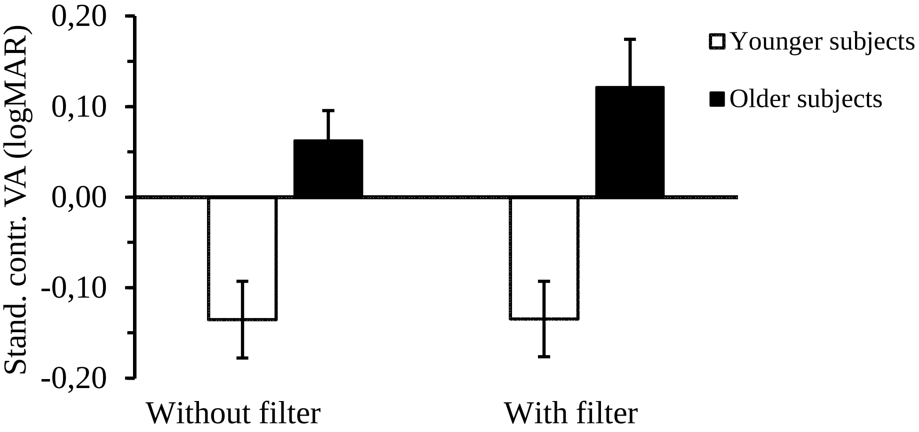

Fig.10. Average standard contrast visual acuity VA values for younger and older subjects with and without grey tinted lens (filter). Standard error for each column is shown.

In addition, the low contrast BCVA average data with and without filter were tested. An improvement in visual acuity for younger subjects can be observed . Instead, with regard to the older group, there was a minimum variation in worse with (figure 11).

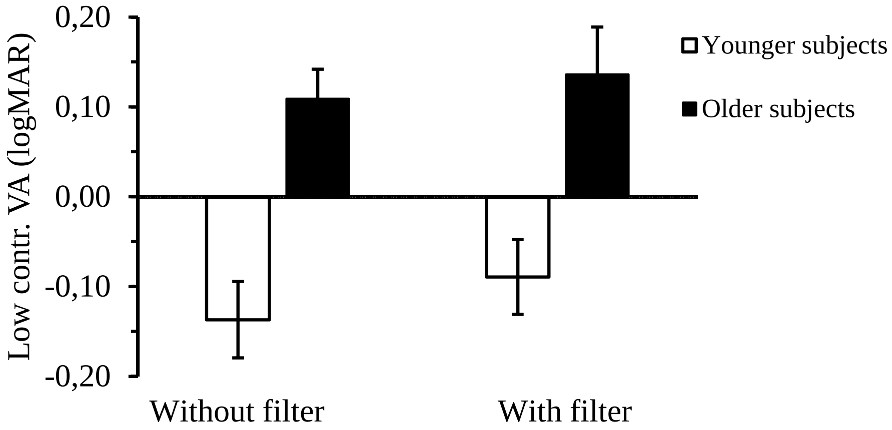

Fig.11. Average low contrast visual acuity VA values for younger and older subjects with and without grey tinted lens (filter). Standard error for each column is shown.

The variation with regard to low-contrast optotype is almost identical for both young people and elderly people wearing grey filter (figure12).

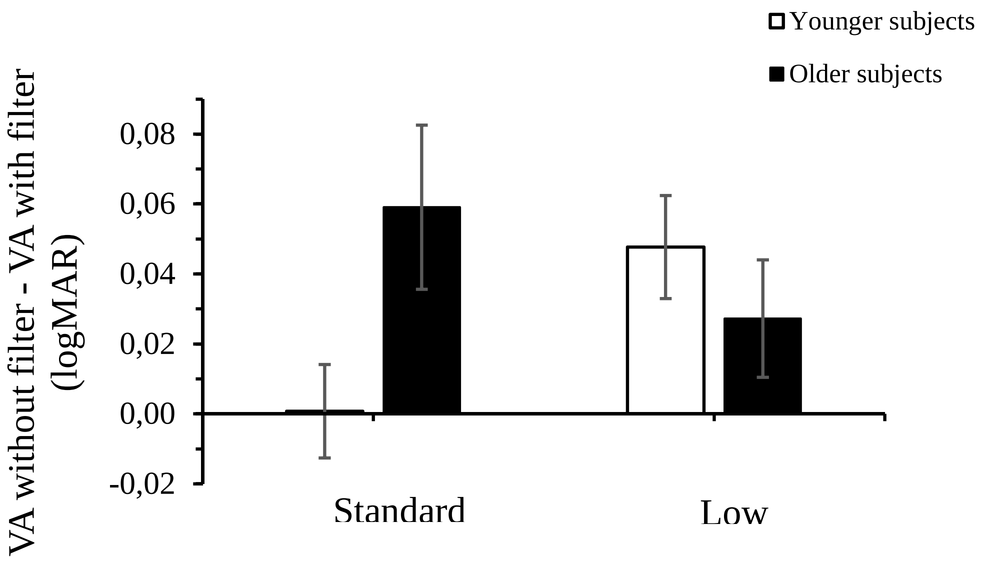

Fig.12. Differences in visual acuity VA with and without grey tinted lens (filter) for different age groups and for standard and low contrast optotypes are showed.

In standard contrast condition (98% brightness) the mean BCVA was -0.04 while the mean BCVA with fey filter was -0.014 for all partecipants. In low contrast condition (20% brightness) the mean BCVA was -0.015 while the mean BCVA with fey filter was 0.03 for all partecipant. The data demonstrate that grey filter had not influence significant in many cases or decrease minimum VA. This study focused to evaluate influence of grey solar filter on standard or low contrast visual acuity data within a heterogeneous group of subjects with minimal or absent visual impairment. In the present study the “FrACT” test was used to determine if grey solar filters can be used to improve VA. Related to previous studies, the focus was given more on situations where grey colored filters would increase the Visual acuity between targets and background compared to a no filter condition. The effects of wearing a grey filter on visual acuity for achromatic were determined. The expected result was that wearing a grey filter would not improve performance for most patients. VA has very important role in visual function. The visual acuity chart measures vision under ideal contrast conditions (98% contrast with black letters on a white background), a situation not often met outside the examination room. However, visual acuity is only one aspect or component of visual function. Other than visual acuity, visual function is really involved of many other components, including but not limited to: visual field, color perception, stereoacuity, glare recovery, dark adaptation, fixation and contrast sensitivity function (CSF). Shortly after the introduction of the first scientific tests of contrast sensitivity function (Bruce P. Rosenthal,Eleanor Faye M.D in 1981 at The Lighthouse Low Vision Service in New York) it developed apparent that CSF may essentially be a better indicator of how patients sees under non-ideal conditions, as well as how their eyes function in real-life conditions. In fact, CSF may be one of the most important components of visual function since it helps to estimate patients' ocular functions in the real life conditions. Some studies demonstrate a subjective enhancement of visual performance with filters, but objective data are ambiguous. Considerable amount of research has generated equivocal results, and has failed to demonstrate any consistent objective utility of tinted lenses or filters. Grey lenses were found to have a positive effect on more of the sample when compared to brown and blue. This could be related to the fact that such tints do not distort colour much since their transmission is roughly constant throughout the visible spectrum. (M Shaik, PD Majola et al. 2013). Wearing colored filters can increase contrast and improve visual acuity to some extent. However, this will only happen when the stimulus or scene being viewed hold the appropriate color components. In terms of operational utility, colored filters may improve detection of objects versus backgrounds. However, for optimal effect, filters need to be suitable to the situation.

CONCLUSIONS

1. Reduced contrast of optotypes affect visual acuity more for older than younger participants.

2. Grey tinted lenses reduce standard contrast visual acuity more for older than younger participants.

3. Grey tinted lenses reduce low contrast visual acuity in similar amount for younger and older participants.

FINAL WORDS

Thus, an important rationale for this study is to inform optometrists of the eventual influence tints could have on the abitual activities or occupations of their patients and thereby guide them in selecting the tint with the least adverse consequence and even make them informed of any eventual changes to the perception of their environment.

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