September 2020

White Paper

# Shamir Relax™

## Introduction

Today's lifestyles make new demands on our eyes. Use of digital devices requires prolonged and repeated accommodation, i.e., focusing on near and close objects and switching between these and distance viewing. The eyes' accommodative function peaks in childhood and declines with age. Prolific use of digital devices is causing many to experience eyestrain, headache and general end-of-day fatigue. Shamir has developed a lens that helps ease the eyes' accommodative effort, thereby easing today's visual demands and reducing eyestrain.

## Background

The human eye has the ability to clearly see objects at varying distances. However, it cannot focus simultaneously on both near and distant objects. For each distance, the eye must change its focus. The term 'accommodation' refers to the eye's ability to automatically change its focus from one distance to another, over a range of distances[1].

## Our Changing Environment

Today, in addition to reading books, we also read smartphones, tablets and computers, each at a different distance (some of them quite near) and in various postures.

On paper, characters have always been fixed in size and highly contrasted. On a digital screen, characters are smaller and pixelated. Our environment in terms of the light that surrounds us, has also changed.

Ten years ago, our eyes were most often exposed to natural light or the artificial light of incandescent lamps. Today, because of technological changes in our environment, our eyes are constantly exposed to the bright light of digital screens as well as such light sources as LED or CFL bulbs, whose light is strongly diffusing and includes potentially harmful blue light.

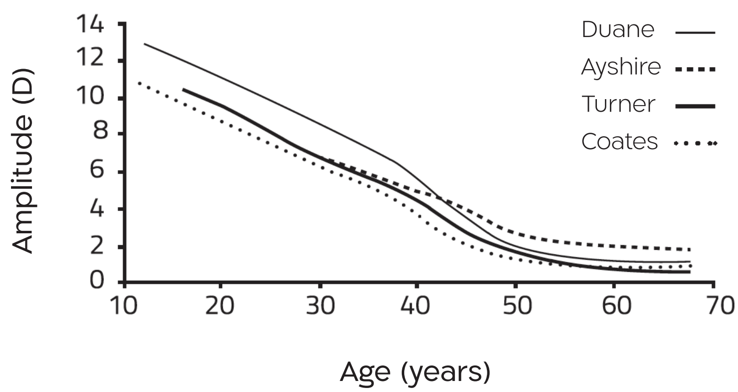
As a result, our eyes must focus more intensely on smaller and pixelated characters on screens, and must change focus more often in order to adjust to the variations of distances. These extra demands not only cause eyestrain, but also postural aches and pains.

## The Functioning Of The Eye

Our accommodative ability changes greatly with age-related changes of the eye. There is a continuous loss in the eye's ability to change its focus to objects at close distances. Presbyopia is an age-related loss of accommodation, a visual impairment that results from the gradual decrease in accommodation expected with age and may affect quality of vision and quality of life.

Accommodative amplitude is defined as the maximum potential increase in optical power that an eye can achieve in adjusting its focus. It refers to a certain range of object distances for which the retinal image is as sharply focused as possible. Accommodative amplitude falls progressively and almost linearly with age from at least the early teenage years, with presbyopic symptoms starting to occur at the age of 40 to 45 years[2,3]. As the amplitude of accommodation diminishes, the range of clear vision may become inadequate when performing near tasks[3,4].

Pre-presbyopia is an ongoing continual development. The loss of accommodation is gradual, beginning at an early age. In its early stages of development it affects young adults prior to the appearance of presbyopic symptoms (difficulties reading). The signs of presbyopia, the loss of amplitude of accommodation, develops during the early decades of life, and continues through early adulthood. About 0.2D of accommodation is lost per year. Thus the curve in the graph below shows a constant slope until the age of 40 or 50, demonstrating that the decrease in amplitude of accommodation is quite linear until this age[5].




Results of transverse studies of the mean monocular subjective amplitude as a function of age.
* Based on Duane, Coates, Turner, Ayshire Study Circle.

Repeated close and intermediate viewing are challenging demands for the eyes. Our eyes focus on close and intermediate vision tasks for long periods of time either at work, during studies, or at leisure opposite various digital screens, which have become an integral part of everyday life. In addition, we are required to make frequent transitions between different distances within the near/intermediate viewing zones as the eyes move from reading material to the desktop computer, to a tablet, to a mobile phone and so on.

Today's lifestyle poses special challenges for our visual capabilities, particularly as we approach the age of presbyopia, and also among younger age groups.

The effect on our eyes is far beyond tiredness.

## The Problem - Research Findings

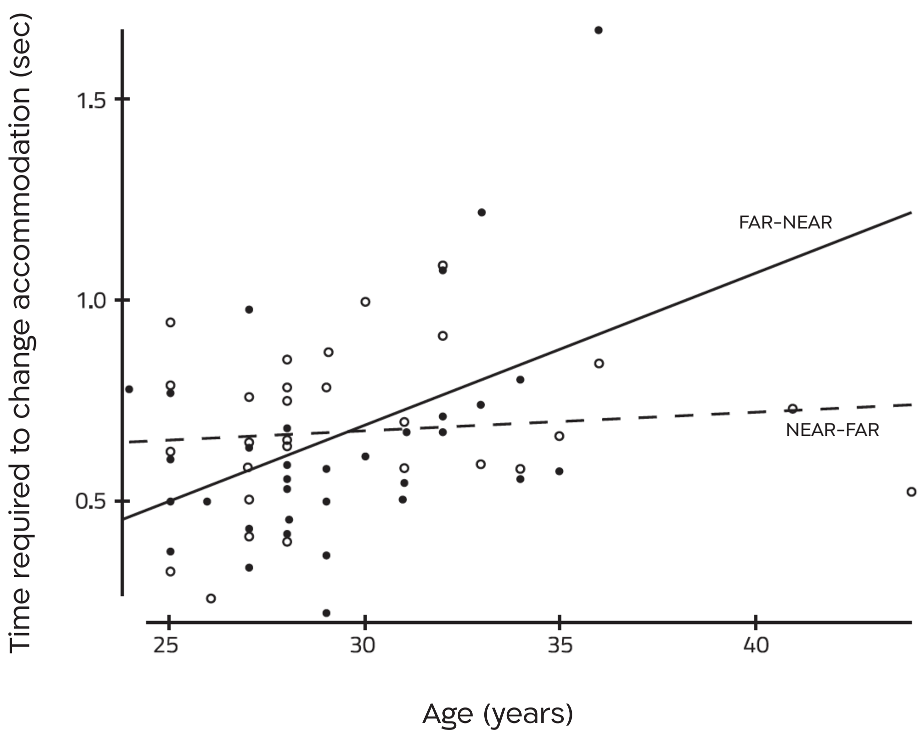
For nearly 300 years, scientists have investigated and presented various theories on the mechanism of accommodation. There are still disagreements today and it is not fully understood. But one thing everyone agrees upon, is that the amplitude of accommodation decreases and is age dependent[1].

Prior to the onset of presbyopia, vision is generally sharp in the close and intermediate viewing range, despite the gradual deterioration of amplitude of accommodation. Improvement of vision is not generally an issue at these ages. However, with advancing age, and considering today's visual challenges requiring increasingly intense effort in order for vision to function properly and comfortably in these viewing zones, visual acuity becomes particularly problematic. Changes in amplitude of accommodation with age is the most familiar and readily understood result. But other aspects of accommodation also change with age, and these too have been studied.

## Speed Of Accommodation

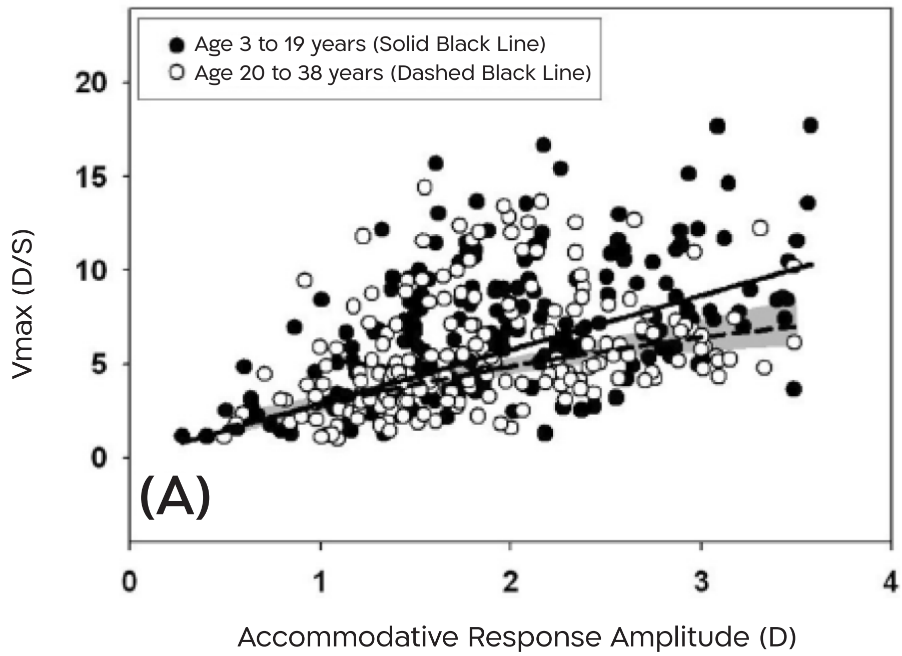
The eyes' accommodative response is slower among older adults, and the response becomes increasingly slow with age. Younger people have a comparatively faster accommodative response.

When talking about speed of accommodation, we refer to both the time of reaction (from the moment of the need for close viewing until the accommodative response is initiated) and peak velocity (the amount of time it takes from initiation of accommodation until the required power is reached[2,3,5–8]). Research has shown a statistically significant slowing of the speed of accommodation with age. In a study based on 65 subjects, age 24-44, accommodative speed slowed at a rate of about 39 ms/year[8].

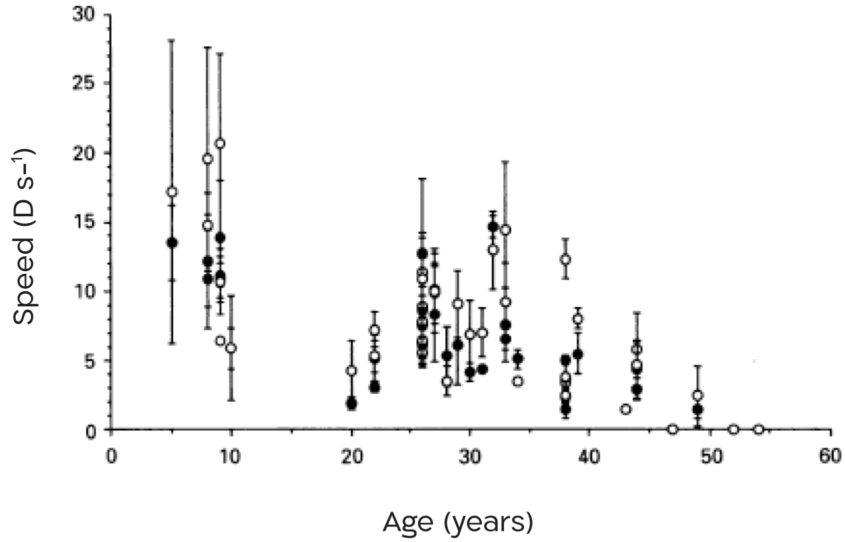



Mean Accommodative times as a function of subject age for FN (•) or NF (○).
*Optometry and Vision Science Vol 66

Another study found that particularly in the age group 20 to 40 years, there are highly significant differences in the speed of accommodation between age groups, and speed declines continuously with age. Accommodation speed is roughly linearly correlated with accommodation amplitude and declines roughly linearly with age. Another study confirms these results, showing peak velocities for response amplitudes ranging from 0.5D to 3.5D at two age groups - 3-19 and 20-38. Peak velocities in the older group were significantly slower than those in the younger group[7,9].




* Visual Psychophysics and Physiological Optics, January 2010

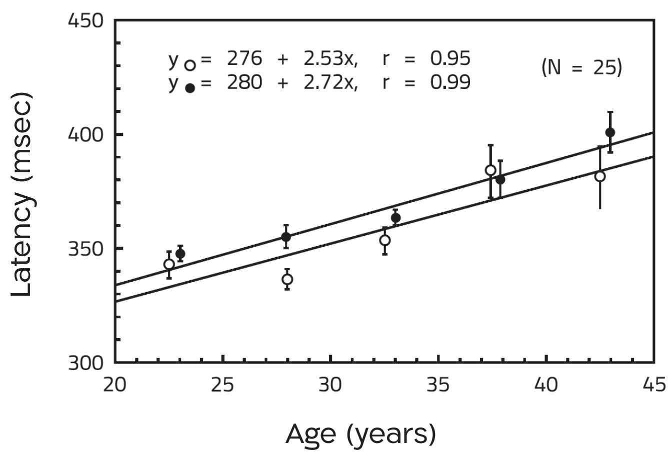



* Dynamics of Human Accommodation, K. Schaeffel. H. Wilhelm and E. Zrenner, Journal of Physiology (1993), 461.

Another study compared accommodative characteristics between three age groups: younger group (20-29), middle-aged group (40-49), and an older group (60-69). Findings indicated that those in the middle-aged group demonstrated a prolonged reaction time exhibiting a greater delay in start and finish (peak velocity) of the accommodative response as compared with the younger subjects[3].

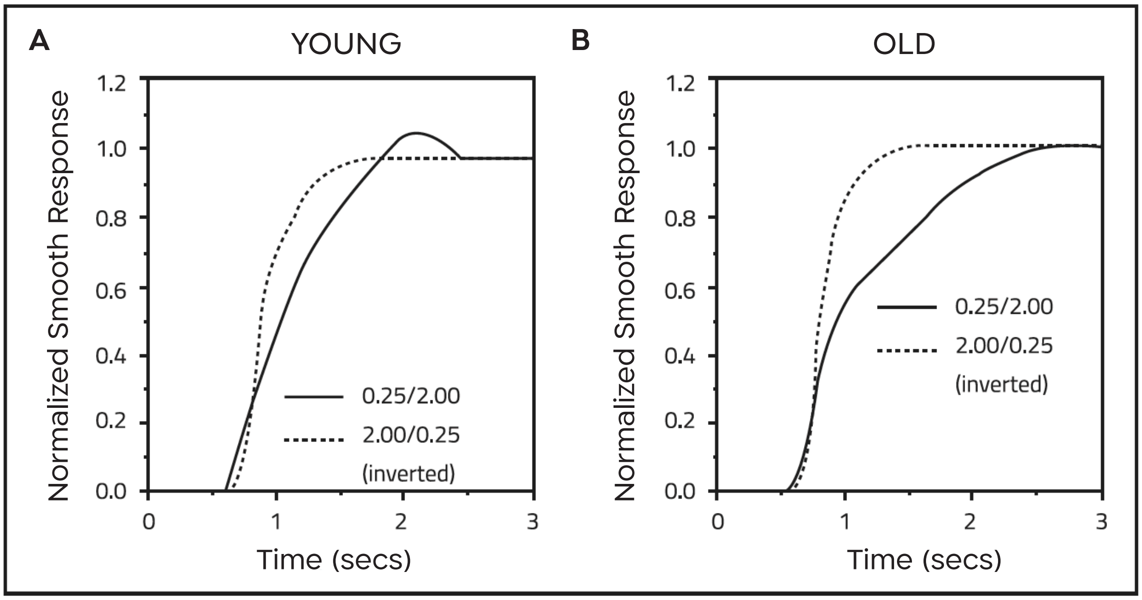
Dynamic measurements show the accommodative response of subjects over 30 to be significantly slower than that of younger subjects, while response time to target change from 1D to 4D was two times slower in the mid-40s group than in the younger groups[5].

Some researches focus on the latency of the accommodative response, what we referred to above as speed of accommodation. That is, in addition to the much slower accommodative response (peak velocity, or time to reach required power), they look at the latency of the accommodative response, the reaction time or waiting period after the stimulus, before accommodation starts to change. They demonstrate that latency progressively increases with age. An increase of latency of accommodation was found at a rate of approximately 2.5 ms/year for subjects between the ages of 20 and 50[10].




Latency of accommodation for increasing (○) and decreasing (●) step responses as a function of age for each subgroup. Plotted is the mean ± 1 SEM. Regression equations and correlation coefficients are provided.

* Vision Research, Volume 44, Issue 6 March 2004.



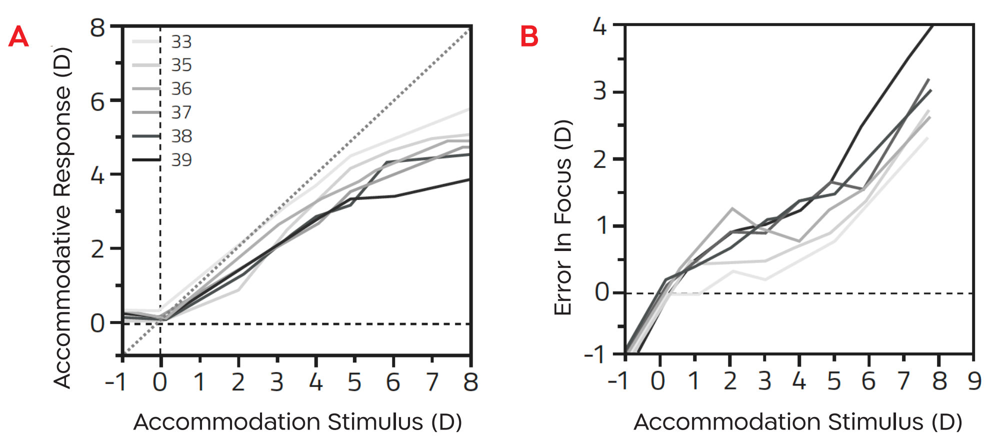

Responses of young (A) and old (B) patients to both directions (accommodation, far to near [FN], vs relaxation, near to far [NF]) of stimulus change between 0.25 and 2.00 D. The NF responses are shown inverted to allow direct comparison of their temporal profile with the FN responses (from Heron and Charman[22]).
* The above 2 graphs are reproduced from the article: The Physiologic Mechanism of Accommodation

In today's world where repeated close viewing is an essential part of everyday life, the slowing of the accommodative response significantly impacts one's general efficiency, resulting from the eyes' reduced functional abilities.

### Accuracy of accommodation

Due to the eyes' declining functioning with age, errors in performance and inaccurate accommodation also increase with age. The eyes' ability to focus becomes more frequently inaccurate making vision less sharp when focusing on the close or intermediate viewing zone. The greater the required accommodation, the greater the margin of error. That is, the closer the item in the near viewing zone, the greater will be the loss of visual sharpness.

The graphs below demonstrate that errors in focus increase with age[2].




Age related changes in accommodative response (A) and errors in focus (B) as a function of stimulus vergence under photopic conditions for a single patient.
* The Physiologic Mechanism of Accommodation, April 2014

### Unnatural Posture

Older adults try to adapt to accommodative problems and eye strain, by adopting unnatural, or less comfortable behaviors such as holding reading material at arm's length so that the paper or smartphone is farther away than it would be at a natural reading distance.

Although physically uncomfortable, this helps lessen the accommodative effort and increases acuity of focus.

### Asthenopia And Close Work

Visually demanding close work can cause eye discomfort, fatigue, blurred vision, eyestrain, pain in or around the eyes, and headaches[11–14]. Asthenopia is the term used to describe the sensation of extreme effort and weakness, or eye fatigue, resulting from prolonged visual effort[14]. Symptoms often occur after lengthy reading, computer work, or other close activities and are due in part to extreme accommodative effort[13]. The main cause of asthenopia is thought to be fatigue of the ciliary and extraocular muscles due to prolonged accommodation and vergence required by the near and close vision work. In subjects with poor accommodation, prolonged reading may lead to headache[12].

Accommodation, providing clear focus, is an essential skill required for performance efficiency. Accommodative fatigue, with its reduction of speed and accuracy, sets in after prolonged or repetitive accommodative effort[14]. Those engaged in a considerable amount of close work are more prone to developing the signs and symptoms of accommodative dysfunction, which result either from inaccurate accommodative response during close work, or from a failure of the eye to fully relax the accommodation following the near vision tasks[12].

The widely accepted rule of thumb is that during near vision tasks, half of the eye's amplitude of accommodation should remain in reserve. In other words, in order for a person to be able to read comfortably, 50% of their accommodative capability should remain in reserve14. Similarly, another convention suggests that one-third to one-half of the accommodative amplitude should remain in reserve during comfortable prolonged near viewing[15].

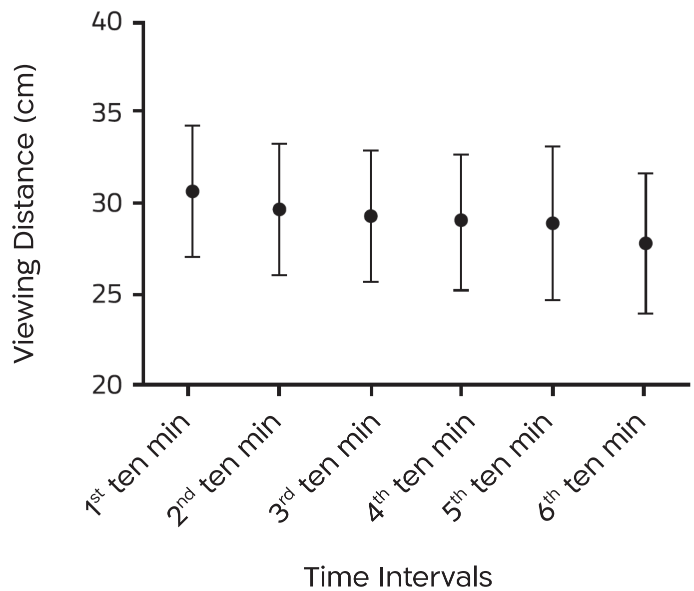
In a study comparing symptoms of asthenopia in patients between the ages of 15 and 40, examining different levels of hyperopia and correcting for different accommodative efforts, a significant reduction in asthenopia was found during the near-vision task when leaving 35% or more of the amplitude of accommodation in reserve. The symptoms of asthenopia are not associated with the severity of the hyperopic refractive error (unclear focus), that is, they are a result of the un-aided accommodative effort[14].

A study investigating the effects of reading for one hour, either from a hard copy or a video display terminal, found that reading ordinary text at close distance leads to significant changes in the resting postures of accommodation, and a remarkable accommodative effort. These may be related to separate symptoms of visual fatigue, such as blurred vision and asthenopia[13].

### Visual Challenges Of The Smartphone

Most people today use smartphones on a daily basis, engaging in many activities on the device, sometimes for long periods of time. The physical dimensions of a smartphone visual display are smaller than other computer devices or printed materials. The font size displayed is small, prompting users to hold the smartphone at a close viewing distance when reading it. Research indicates that the mean viewing distance for reading text messages on a smartphone is 36.2cm, and for Internet viewing 32.2cm, which is closer than that usually adopted for reading from paper or other digital devices. Close viewing distances increase accommodative demands. Visual discomfort from smartphone usage is likely to be greater if the phone is used for extended periods of time. Some people may use their phones for more than one hour in any one session. Playing games and accessing maps are common applications associated with extended use.

A study that evaluated asthenopic symptoms in young adults (18-40) after performing a 60-minute close-viewing reading task on a smartphone, found a statistically significant reduction in their viewing distance over the 60-minute period, reflecting the increasing accommodative demand.




Mean working distance for each 10-minute interval. Error bars indicate 95 per cent confidence intervals.
*Viewing distance and eyestrain with viewing of smartphones Long, Cheung, Duong, Paynter and Asper

They found a significant correlation between the change in total asthenopic symptoms score and the change in viewing distance. That is, subjects who reduced the viewing distance, thereby increasing the accommodative effort, were more likely to report higher asthenopic symptom scores. The scores showing the largest increase after the 60-minute reading task were for the symptoms tired eyes, eye discomfort and blurred vision.

People tend to adopt closer viewing distances when viewing small fonts, presumably to increase the angular size of the image on the retina. Alternatively, subjects may have held the smartphone closer at the end of the 60-minute period because of transient near work-induced myopia. Either way, by adopting closer viewing they bring themselves some relief, but at the same time they increase the accommodative effort[15].

A number of experiments have shown that the level of eye-lens accommodation affects muscular activity in the neck and shoulders.

One study investigated the direct effects of experimental near work on eye and neck/shoulder discomfort due to accommodative stress. The standardized visual task required sustained and fixed focus on a black-and-white Gabor grating of varying contrast displayed on a computer screen. Four viewing conditions were utilized to create different types of visual demands using four different trial lenses: 0 D trial lenses, binocular minus and monocular minus wearing -3.5 D trial lenses to facilitate increased accommodation, and monocular plus wearing +3.5 D trial lenses to facilitate decreased accommodation. The visually demanding experimental near work elevated both eye and neck/shoulder discomfort significantly. Participants with a greater mean increase in eye discomfort caused by accommodative or vergence stress also developed more neck/shoulder discomfort over time. Moreover, participants rating a greater increase in internal eye discomfort also experienced more neck/shoulder discomfort as the duration of the near work was prolonged.

It was suggested that symptoms such as ache or strain may be caused by accommodative or vergence stress. Furthermore, since moderate musculoskeletal symptoms are a risk factor for more severe symptoms, they recommend ensuring a good visual working environment to prevent musculoskeletal disorders in occupations involving visually demanding near work[11].

Another study examined the effects on asthenopia of accommodation and the relaxing of it by shifting the distance of the point of focus. They found that relaxation from accommodative response was effective in reducing asthenopic symptoms[16].

### Artificial Light In Our Environment – HEV Light

HEV (High Energy Visible) light, also known as blue light, is short-wavelength electromagnetic radiation (400-500 nm) in the visible spectrum that carries the highest amount of energy per photon.

Blue light presents a hazard to critical structures within the eye. This is a concern since we are far more exposed to blue light today than ever before, from increased viewing of digital screens that give off blue light. Exposure to blue light, even for a short period, increases the risk of retinal damage due to the light's high energy. This has been referred to as the 'blue light hazard'[17]. High energy blue light is far more hazardous than the low-energy part of the light spectrum (consisting of longer wavelengths from 500 to 700 nm)[18].

### Research Conclusions

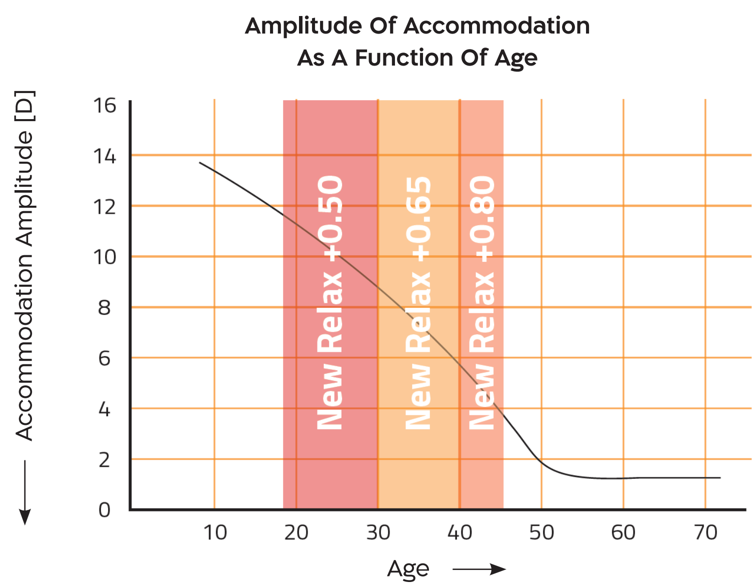
It has been amply demonstrated that the decline with age of the eyes' accommodative function, coupled with today's increased demand for that visual function, presents a problem expressed in the eyes being overworked, experiencing fatigue, and resulting in reduced performance efficiency, dry, tired eyes, headache and general fatigue, and physical discomfort due to attempts to compensate for accommodative disability by postural changes. A secondary problem to the eyes in today's digital environment is the potentially hazardous exposure to blue light.

### The Solution

In light of today's demands on our vision, and the above research findings, Shamir offers a solution that meets the needs of the current accommodative challenge.

Shamir's R&D team has developed a new range of **Relax**™ lenses designed to meet modern visual needs involving high use of digital devices with extended periods of intermediate to close viewing. The new range of lenses also addresses the concern over high exposure to HEV blue light emitted by digital screens.

The new Shamir **Relax**™ lens solves the problem of eye fatigue by providing extra support in the lower near-to-close vision viewing zone of the lens, easing the accommodative task for overworked eyes.




*Duane's standard curve
Duane A. Normal values of the accommodation at all ages. JAMA 1912;59:1010-3

Taking into account the age-related decline of the accommodative response, Shamir **Relax**™ is now available in 3 versions, each version carefully designed to meet the needs of specific age groups. SV lens wearers are thereby provided with just the additional help their eyes need to maintain the natural process of accommodation. The extra power in the lower lens area, making close and intermediate viewing tasks easier, allows every patient to improve their visual performance while avoiding eyestrain, headache, and general end-of-day fatigue. Decreasing the required accommodative effort, makes vision more comfortable.

At the same time that the eyes' accommodative challenge is made easier, Shamir **Relax**™ can also protect them from the hazards of blue light. The new Shamir **Relax**™ is available in an innovative lens material - **Blue Zero**™, providing built-in protection from blue light. Based on a unique polymer, **Blue Zero**™ absorbs HEV, or blue light, with proven effectiveness while maintaining lens clarity. Shamir **Relax**™ can also be ordered with **Glacier**™ **PLUS AR** coating.

**Shamir Relax™ – 3 Age-Customized Versions**

| Relax™ | Relax™ | Relax™ |
|---|---|---|
| +0.50 | +0.65 | +0.80 |
| Age 18-29 | Age 30-39 | Age 40-45 |

**Shamir Relax™ Is Recommended For**

Anyone between the ages of 18 to 45, who is a frequent user of digital devices, even if vision correction is not required.

It is particularly recommended for anyone who experiences eyestrain or end-of-day tired eyes.

When combined with Shamir's protection against blue light – **Blue Zero**™ lens material - and with the addition of **Glacier**™ **PLUS AR** coating the eyes are not only more relaxed, vision clearer and more comfortable, but visual health is protected as well.

**Conclusion**

Today's high use of digital devices makes extra demands on our eyes' accommodative function. This function declines with age requiring a greater effort from the eyes and causing visual and physical problems as people try to cope. Shamir's new **Relax**™ lenses aid the eyes by easing the effort required by accommodative tasks, providing an effective solution to this problem.

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