SINGLE VISION LENSES WITH ADDITIONAL NEAR-POWER: MEETING THE VISUAL CHALLENGE OF THE DIGITAL AGE

Life in modern societies is increasingly digitalized. The increase in near-point activities brought on by the widespread use of all kinds of digital devices is triggering a notable increase in the visual fatigue syndrome known as digital eye strain (DES), accommodative and vergence dysfunctions and dry eye. As practitioners, we must face this challenge – which represents nothing less than the digital Everest for our eyes – with concrete solutions for real life. Single vision lenses with additional near-power is an example of one such solution we are using to treat a number of clinical cases. In this review, we are going to share what we are busy doing to resolve this challenge.

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KEYWORDS

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This article is the result of two years working with and fitting **single vision lenses with additional near-power** in exactly **527 different clinical cases, plus a huge number of visual therapy cases**. It aims to show what has been working for us and some reasons we think underlie the success of this solution.

The digital and multi-screen society

In terms of images and vision, the 2010s have thus far been characterized by a huge increment in near-point tasks, both in children and the adult population. Whether it's at work, school or during leisure time, it is now not uncommon for people to go from one device to another in a world of smartphones, tablets, e-readers, laptops and desktops. This has led to an elevated risk for upper extremity disorders[1], principally the neck and shoulders[2,3,4], and an increase in the number of patients with ocular complaints[5], with a varied symptomatology and clinical signs, which are known as the Computer Vision Syndrome (CVS)[6] and also Techno-Stress Ophthalmology.[7] We, however, feel DES[8] better captures all aspects of the condition.

Some statistics from the Spanish population exemplify this phenomenon[11] (Tab 1, 2, 3):

– Spanish population aged between 10 and 74: 34 389 822
– Number which used internet last year: 28 400 000 (82.7%)
– The number who used it on a daily basis: 22 969 301 (82.9%)

These statistics show the extent to which people use digital devices. As a result of this increase in the number of hours spent in front of digital screens[9], no one is safe from the risk of suffering from some form of visual impairment.

Working with screens in a digital world
The use of computers, video terminal displays (VDTs) and all sorts of digital devices have caused major changes in the professional and ergonomic habits of our society.[5] The scientific literature show a variety of health disorders[12] related with computer work.[13,14] Most of the symptoms patients refer to are related to vision, which can be grouped in to two main categories[15], although they are usually intermixed **visual symptoms** and **asthenopia (Tab 4)**. There are also **musculoskeletal problems** resulting from work with VDTs and computers[4]; these are indirectly related to visual problems.[2, 3]

There is a wide range of prevalence of eye problems associated with VDTs[16], which can be explained by the different methodology used in the research.[17] Varying from 88.5 %[12] to 31.9%[18], with a direct link to time spent and a threshold between four[19] and six hours[20, 5] for the prevalence of some of the complaints for the symptoms of the first and second categories.

This symptomatology not only appears as an occupational disorder in workers but also in kids and teenagers with a variable prevalence of at least 55.6%[21]. In addition to the symptoms listed above, they report reduced attention, poor school behavior and **irritability.**

If this symptomatology is compared to Accommodative and Non-Strabismic Binocular Disfunctions (ANSBDs) – mainly Convergence Excess and Deficit, Accommodation Insufficiency and Excess – and those that cause uncorrected refractive errors, it is evident there are many similarities (Table 5).[22]

The Binocular vision sysmtem may be unable to properly sustain in continuous near-point tasks. Not only is an ANSDB indicative of this, but even patients with limited, normal or appropriate binocular capacities face this problem. This can get in the way of learning and cognitive tasks for both children and adults, interfering with school and work.[23, 24] (Figure 1)

FIG. 1| Visual daily tastks: jumping from screen to screen.

Age group	% of internet users
16-24	96.8%
24-34	93.8%
35-44	89.2%

Table 1. Percentage of users who consult or use the internet weekly and daily, by age group[11]

Profil	% of internet users
Students	98.8%
Employees	89.6%
Self-employed workers	85.6%
Unemployed	74.03%
Pensioners	40.2%
40.5%	Householders

Table 2. Weekly and daily internet users[11]

Age group	% of children who use a smartphone daily	% of children who use a laptop daily
11-12	46%	29%
13-14	75%	34%
15-16	90%	48%

Table 3. Daily use of smartphones and laptops among children aged 11 to 16[11]

Visual Symptoms first category	Asthenopia second category
Blur at near	Pain in and around eyes
Blurred distant vision after work	Headaches
Difficulty in focusing	Dry eyes
Occasional diplopia	Eye fatigue
Changes in visualizing colors	Excessive tearing
Loss in contrast	Sore eyes
Glare	High glare sensitivity

Table 4. Symptomatology associated with digital eye strain, from more to less prevalence

The particularity of the digital medium

Even continuous print reading is one of the most challenging visual tasks.[15] It involves diverse types of eye movements controlled at a high neural level. These are mainly fixations and progressive and regressive saccades[26] and, of course, the accommodation and vergences of the ocular motor system. Nevertheless, the fact is people can usually read regardless of the medium for a long time without any problem. However, there are some differences between reading print and digital. There are a huge number of comprehensive studies and research touching on the issue.[27, 28, 29, 30] In terms of cognitive performance, it appears print is still superior for learning and understanding elaborate texts.[30] There are obvious ergonomic and postural issues related to digital devices[31], plus visual elements. They are all inter-related, and may have led to possible visual disorders (Tab 6).

It is worth highlighting the hazard linked to **blue-violet light chronic exposure** in LED backlit devices has been an identified issue in recent years. Not only has possible cell damage induced by blue-violet light been verified in in-vitro studies[72, 73], but also the specific role of blue-violet light in degenerative ocular processes like age-related macular degeneration[74] has been demonstrated. It seems clear blue-violet light is closely linked with **visual fatigue**, as reading or working with an LED backlit screen leads to tensional and ocular symptoms.[75, 76, 77] It also causes **dry eye**, with symptoms worsening when carrying out close-up activities with any type of digital screen equipped with blue-violet-light-emitting LED lighting.[78, 79, 80, 81] **Discomfort glare** is also an issue, as the LED lights present in backlight devices produce a greater sensation of nuisance[82] than other types of lamps, with increasing discomfort as the blue-violet light intensifies.[83] Consquently, any possible solution to digital eye strain may incorporate some specific blue-violet light filtering.

Types of patients consulting for problems related to vision

As mentioned above, we have been experimenting more through consultations than ever. Figure 2 below shows several groups based of our patients and how their disorders and symptoms are interrelated.

There has been an increased number of consultations for both school age children and pre-presbyopic groups that are emmetropes or corrected ammetropes, with normal accommodative skills (according to the Duke-Elder criteria via A.O.A. Accommodative and Vergence Dysfunction Guideline).

In all of these groups there is a common need: the requirement of visual support for continuous near-work tasks, i.e. more refraction for near to far. Of course, patients with visual requirements need to be separated from those with none. For pre-presbyopic patients, the most significant fact is an early appreciation of the symptomatology typically associated with presbyopia, with as a major trigger factor being the difficulty in using their smartphones. Regardless of the patient's refractive status, it is easy to develop early presbyopia if there is continuous or partial deprivation of accommodation[37] as may be the case for individuals who are continually using digital devices.

From our own experience and clinical evidence, it seems there are some possible causes behind this: 1) age-related changes in accommodation that prior to the digital era did not need to be corrected as they didn´t present any associated symptomatology; 2) in the absence of highly demanding visual near tasks individuals can get by with ANSBDs, but as the near visual needs increase they begin to pose a problem; 3) undiagnosed typical ANSBDs; 4) uncorrected ametropia – especially low hyperiopia and mixed astigmatism; 5) and finally, more time doing near tasks leads visual fatigue.

For children and students, the eye strain, visual fatigue and blurred vision both near and far after near tasks are the most common complaints. These are consistent with the symptomatology listed in Table 5 and with the possible causes, which are similar to the pre-presbyopic group.
It seems clear that Accommodative Amplitude (AA) decreases in curvilinear manner from ages 3 to 40, with the biggest decrease occurring between 20 and 50[38] and completely going away after the 50s.[39] Several studies have found that contrary to what was expected according to the Hofstetter[40] studies on amplitude of accommodation measured subjectively, average amplitudes are only slightly greater than 7D, measured objectively from ages 3 to the teen years.[38] This then decreases with age, especially after 30.

Common symptoms (*)	Convergence insufficiency	Convergence excess	Accommodative insuffiency	Accommodative excess
Headache	Headache	Headache	Blurred vision	Headache
Blurred vision	Jumping or moving letters	Blurred vision	Headache	Visual fatigue
Visual fatigue	Lack of concentration	Asthenopia	Visual discomfort	Blurred vision
Jumping or moving letters	Visual fatigue	Diplopia	Visual fatigue	Difficulty focusing from one distance to another
Reading problems	Loss of place when reading	Avoidance of near tasks	Reading problems	Excessive light sensitivity
Lack of concentration	Blurred vision	Visual fatigue	Diplopia	Difficulty performing schoolwork
Loss of place when reading	Sore Eyes	Tearing	Lack of concentration	Diplopia
Sore eyes	Difficulty performing schoolwork	Closing one eye	Jumping or moving letters	Ocular pain
Difficulty performing schoolwork	Feeling sleepy	Loss of place when reading	Asthenopia	Change in reading distance
Visual discomfort	Visual discomfort		Avoidance of near tasks	Jumping or moving letters

Table 5. Symptoms related to some non-strabismic binocular disorders, from more prevalence to less.[22, 25] (*) Common symptoms for patients with uncorrected refractive problems and/or ANSBD, without differentiating the cause or etiology.

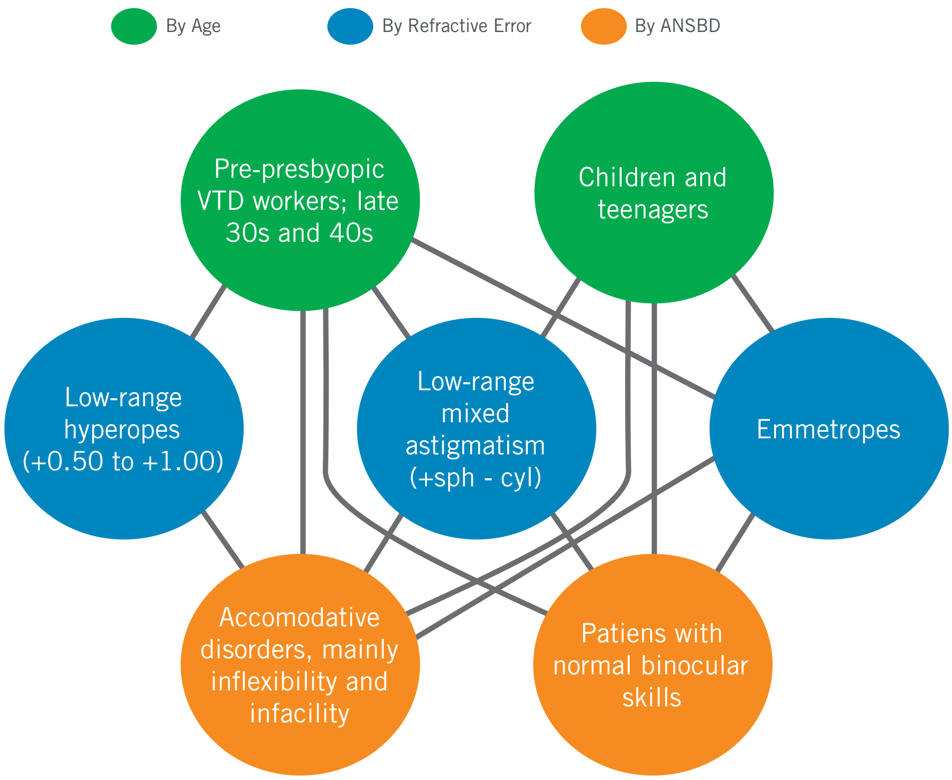

FIG. 2| Population groups with increased clinic visits

Fact	Erognomic effect	Possible visual effect
Shorter distances	The smaller the screen the closer we hold the device	More accommodative and vergence effort
Different and variable, near focusing distance	Variable near-point distances from 30 to 70cm	Continuous accommodative readjustment
Smaller text fonts	Constant use of instant messaging services	Most demanding accommodative and vergence effort
Focusing on screens	Poor text font edge resolution; continual change between focusing on device's screen and images or text	Difficulty focusing; readjustment and continuous micro accommodative fluctuations
Device size	The smaller the screen the more rigid the posture	Influence on eye moments and signals to blink. Lower blinking rate, more incomplete blinking
Reflected glare on screens	Discomfort glare	Loss of contrast; poor ergonomic performance; reduction of viewing distance
Backlights with LED lighting	Blue-violet exposure hazards	More prevalence of dry-eye, visual fatigue and discomforting glare
Rigid postures	Highly static postures; more head and neck declination	Musculoskeletal-related problems Establish relationship between trapezoid and accommodation

Table 6. Some specific ergonomic, postural and visual behaviors related to handheld digital devices and computer work[5, 31, 32, 33, 34, 35, 36].

In today's highly demanding near-visual environment, this decrease may lead to digital eye strain, as we require twice the required AA to perform near tasks comfortably.[41] This is more evident in the case of pre-presbyopic hyperopic patients or in myopic contact lens wears.

On the other hand we know that continuous near focusing it is a highly demanding visual task that triggers accommodative micro-fluctuations (AMFs)[7] or cilliary muscle tremors. When one eye focuses on an immobile stimulus, the accommodation that comes into play is not in a steady state but varies around a mean value.[44] AMFs can be measured and interpreted in Fk Maps (fluctuation of kinetic [refraction] maps) and have been closely linked with CVS or digital eye strain.[42, 43] This is due to the sustained or continued effort to maintain this accommodative state and could explain certain digital eye strain cases in which there is no present ammetropy – or it is corrected – nor binocular disorder.

Points 2) and 3) seem more obvious. ANSBDs induce their own symptomatology, similar to DES, as we have seen. We have found that a number of people in the labor market working in digital environments begin to suffer symptomtology at different rates.

Similar to this is point 4) regarding uncorrected ammetropies: the increase in visual tasks leads to a related symptomalogy and the need for a prescription.

The prescription for pre-presbyopic patients

Not so long ago this was not an age group used to consultations. This is no longer the case. And as a specific market and niche[45] with its own visual needs, we must offer them specific solutions. Irrespective of their refractive status, near refraction is a little bit more positive than far, typically between +0.50 to +1.00 for working at 40cm (it would be more positive if the work distance were closer, for example, when using an smartphone). Unlike the previous generation, they are used to both far and near

Accommodative insufficiency, illsustained accommodation	Accommodative excess	Accommodative infacility	Convergence insufficiency	Convergence excess	Fusional vergence dysfunction	Test (*)
Lag	Lead	Normal	-	-	-	Near JCC / MEM
Low	Normal	Normal/Low	-	-	-	AA
Fail (-) similar result Mono/Bino	Fail (+). Similar result Mono/ Bino	Fail (+/-) worst with repetition	Fail (+). Difference between Mono/Bino	Fail (-). Difference between Mono/Bino	Fail (+/-). Difference between Mono/Bino	Flipper +200/- 200
PRA <=-1.50	NRA <=+1.50	Both reduced <=+1.50/-1.50	NRA <=+1.50	PRA<=-1.50	Both reduced <=+1.50/- 1.50	P/NRA
			Low. Usually lower with repetition	HLN. Normal. Sustained with repetiton	Normal/ reduced. Lower with repetition	NPC
			Low 1:1; 2:1	High; >5/1	Variable	AC/A
			X'>X. High VP exophoria. At least 5X'	E'>E. Usually endo in VP.	Normal. Variable.	Phoria
			Convergence reduced	Near diver-gence reduced	Both ver-gences altered	Vergence ampli-tudes

Table 7. Summary of Accommodative and Non-Strabismic Binocular Disfunctions.[48,49,54]
Green: High possibility of plus lenses prescription
Orange: Average possibility of plus lenses prescription depending on case
Red: Low possibility

(*) JCC: Jackson Cross Cylinder
MEM: Monocular Estimated Method
P/NRA: Positive/Negative Relative Accommodation
NPC: Near Point of Convergence
AC/A: Accommodative Convergence/Accommodation

leisure and work tasks with a highly variable focusing distance. What this means is that the use of regular single vision lenses sentences them to a fixed focusing and working distances and forces them to adapt their postural and visual strategies (e.g. looking above or continuously removing their eyeglasses, approaching the object for some visual activities and moving back for others, etc.). On the other hand, the use of low-power progressive lenses has been shown to be more effective and, above all, comfortable[46, 47] when compared to regular single vision lenses in pre-presbyopic subjects. Similarly, the prescription of occupational lenses (for non-permanent wear) or single vision lenses with additional near-power (for permanent wear) providing three near-power values of +0.40 D, +0.60 D and +0.85 D, has a positive effect.

We have found that in a huge percentage of near vision-related, symptomatic pre-presbyopic patients, even with lowest near refraction their condition can be treated very quickly, both in the **visual and asthenopic symptoms categories** (Table 4). We have found these **single vision lenses with additional near-power** very useful in the treatment of accommodative NSBDs, both in pre-presbyopic patients and in students of all ages.

The presciption for patients with accommodative NSBD

Accommodative Insufficiency (AI) may be a defined as a condition in which a patient has an inhability to focus or sustain focus at a near distance.[50] This is shown clinically by an amplitude of accommodation lower than expected based on the patient´s age, and there is no sclerosis of the crystalline lens.[49] Individual accommodative response may be greater (lead), equal or less (lag) than the accommodative demand.[51] This a small lag is considered the norm. The underlying cause of AI is not well understood,[23] but everything suggests that reduced action in the fast-twitch accommodation phase (known as phasic) is a main factor, with abnormalities in the slow-twitch phase (known as tonic) as causes.[52]

The accommodation and vergences ocular motor system provides a focused and aligned retinal image,[53] thus accommodation and convergence are closely linked: accommodation to a near focus leads eyes to converge (measured by AC/A ratio), and when doing so the eyes accommodate (measured by the CA/A ratio).[54] Comprising infacility and ill-sustained accommodation, AI is one of the most frequent causes for asthenopia in children,[23,55] with the research showing a wide prevalence between 2% and 17% and even as high as 62%.[56] There are however differences between studies of students and the general population resulting from the way the research is carried out and methodological questions.

The classic approach when treating AI has comprised both Visual Therapy (VT) and plus lenses for near, **always after correcting for any possible ammetropia**,[50,67] as uncorrected ammetropia may lead to accommodative stress[57] and influence the accommodative response.[58] VT has been used with success – especially in-office environments – for more than 70 years[59] in the treatment of ANSBD,[60,71] reducing asthenopia after accommodative and vergence training and therapy.[61] It has also been shown to improve the academic performance of school-age kids.[62] Prescribing plus lenses is also part of treating accommodative disorders. Its success rate is as high as 90%[63] and 98% for schoolchildren with reduced accommodation.[64] Typically the addition power prescribed has not been higher than +1.00.[65,66]

Prescribing single vision lenses with additional near-power

We have found the following tests to be useful in reliably evaluating far and near refraction in the largest possible number of patients in the shortest possible time (Tab 7):
- far and near refraction, made with normal routine,
- near JCC (Jackson Cross Cylinder) or MEM retinoscopy (Monocular Estimated Method),
- phoria and associated phoria (with possible values of near prescription), cover test,
- AA (Accommodative Amplitude),
- NRA (Negative Relative Accommodation) and PRA (Positive Relative Accommodation),
- Flipper +2.00/-2.00,
- NPC (Near Point of Convergence),
- Vergences amplitude (mainly in near)

Following testing we calculate as the first starting value the additional near-power to be prescribed. This is for near JCC (or MEN retinoscopy) value or difference between NRA and PRA, e.g. +2.25/-1.75 for near support of 0.4 and +2.50-1.50 for near support of+0.85.

Following testing we calculate as the first starting value the additional near-power to be prescribed. This is for near JCC (or MEN retinoscopy), the value or difference between RNA and RNP, e.g. +2.25/-1.75, with near support of 0.44 and +2.50-1.50, with near support of+0.85.

We can then vary this value by taking into account these tips:
• The JCC or MEN should be calculated not only at the

typical 40cm distance, especially in pre-presbyopic patients. Near work is today multi-distance and entails multi-focus tasks, so what is useful for 40cm is not for 60 or 30cm. A complete anamnesis and a good knowledge of our patient´s environment are absolutely necessary.

• It is better if associated phoria is between the comfort zones of vergences. This point is important if we have an associated convergence insufficiency or near convergence is reduced.

• Near support should be varied depending on phoria status. In case of doubt and in the presence of EXO, it should be the lowest support, and in the presence of ESO, it should be the highest. There are a few reasons behind this. Average lag is typically highest in esophoria and lowest in exophoria,[68] and the accommodative response from monocular to binocular decreases inversely to the increase in esophoria.[69] Basic esophoria and convergence excess are often related to higher lags.[51] Plus lenses decrease the demand of accommodation and reduce the amount of esodeviation.[49] It may be highly effective in reducing asthenopia related to AMF in patients with DES or ill-sustained accommodation by relaxing accommodative effort as AMF fluctuates over a range of about ±0.5 D.[70] This is despite the fact its possible importance to accommodation remains ill defined.[70]

• In ill-sustained accommodation cases and in cases with by-the-rule binocular skills, we will choose the lowest near support according to age or the minimum positive value that induces a perceptible change.

Ill-sustained accommodation and by-the-rule binocular skills have their own characteristics: normal P/NRA, usually fails flipper +2.00/-2.00 at the end of testing or with repetition, normal AA but individuals have to stop very often to focus during the test; their symptomatology progresses within days, and they quickly recover their visual capacities.

Conclusions

This article is by no means the review of a clinical trial. Rather, **it is the result of daily work and practice over several years, with real patients and real complaints**. By detailing our experience and findings in Points de Vue, International Review of Ophthalmic Optic, we hope to start an exchange and debate with optometrists all around the world. We have found that the prescription of **single vision lenses with additional near-power (such as Eyezen™)**, with their blue-violet light filtering, is useful in addressing specific visual complaints in a wide number of patients. It can be combined with visual therapy and advice on ergonomics when doing near tasks (e.g. proper lighting, adequate working distances, adequate corporal postures, neck and eye declination and gaze and screen position respective to eyes). It can be used for patients with DES and functional and accommodative vergence non-strabismic disorders, such as ill-sustained accommodation, accommodative insufficiency, convergence excess and accommodative infacility. It can be for school-age children, students and the general pre-presbyiopic population. Together with visual therapy, single vision lenses with additional near-power provide rapid relief of associated symptomatology – something not to be neglected in today's digital era. What's more, they are highly comfortable when compared to single vision lenses in a near-point task environment, whether it's digital or not. •

KEY TAKEAWAYS

• There are key visual and ergonomic differences between carrying out visual tasks in print in a static environment and using digital devices and multiples screens.

• Continuous use of any kind of digital device and the resulting postural and visual behavior is triggering more consultations for vision problems than ever before.

• The most significant rise in consultations has been among young individuals, school-age children, students and young adults but also in pre-presbiopic population.

• Even people with normal visual skills have been experiencing symptoms similar to accommodative non-strabismic binocular disorders and DES (Digital Eye Strain).

• **Single vision lenses with additional near-power (such as Eyezen™)** are a very useful tool to be used to relieve symptomatology associated with DES and accommodative disorders in a variable near-point environment.

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