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Staying Smart While Using Smart Devices

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Digital eye strain is widespread, though symptoms differ among individuals. Accurate diagnosis of related issues like dry eyes or binocular vision disorders can ease discomfort. Good digital habits—maintaining distance, taking breaks, and avoiding screens before sleep—help manage this condition.

This article was written on a digital device (a desktop) and has been refined on another digital device (a laptop) during the author's after hours at home. The reader of this material will read it on a digital device, either during work hours or after.

Digital devices have long been suspected of harming our eyes, and there is some evidence that they may negatively impact our overall health—especially eye health. It is important to recognise this irony—digital devices are essential to our lives, but they might also be considered a necessary evil.

The negative effects of digital devices often arise from how we use—or misuse—them. This is an important point to keep in mind. In any case, once you finish reading this article, take a break and look at something far away (about 20 feet away) for at least 20 seconds. Will that reset the “damage”? We do not know for sure. But as eye care professionals we still advise patients to do so.

Digital Eye Strain

We are very visual animals and have designed our world in a visual way, placing sign boards and signals that are mostly processed through visual cues and clues. We seek knowledge visually, use the visual medium for entertainment, and stay in touch through written text. We see, we believe.

Just around the time of the Y2K problem, there was another problem that worried those in the know. It was dramatically called “computer vision syndrome”.

Thus, it is no surprise that gadgets that harness the visual medium will become an integral part of our life. With things moving into the virtual world—shopping, banking, entertainment, and education—our digital life span has increased. In most occupations most of our waking hours are spent on a digital device. This is not just in the information technology (IT) sector.

In the late 1990s, computers started to become mainstream across India. Institutions such as colleges, schools and other non-IT workplaces started to equip themselves with these machines. Kiosks and browsing centers were set up, where anyone could pay a fee for a stipulated duration of computer use.

Just around the time of the Y2K problem, there was another problem that worried those in the know. It was dramatically called “computer vision syndrome” (CVS). The word “syndrome” means a group of signs or symptoms that occur together due to a disease or disorder. It can typically involve more than one system in the body. With computer vision syndrome, it involved the visual system (for instance, dry eye, blurry vision) and the musculoskeletal system (for instance, neck pain, back ache). Headache can also be a common feature of computer vision syndrome.

Over the years the drama died, just like Y2K, and now the condition is simply called digital eye strain or DES. The eye symptoms remain the same, however. Today, about 50% of computer users have digital eye strain (Sheppard and Wolffsohn 2018)

To understand digital eye strain, we must first look at how the eye functions. It is also important to consider which mechanisms in the eye can be harmed by the use of digital devices.

Physiological Camera

Human eyeballs are slightly less than an inch long—about the size of your index finger's first joint. Despite being tiny, these small cameras capture the incredible beauty of nature through photons. The visual information is then chemically and neurally processed by our brain, which functions as a natural convolutional neural network. We see through the combined work of our eyes and brain.

Only at the centre of the retina (the fovea) will vision be super clear (compare it to a high-definition TV). In the rays that land away from the fovea, the resolution decreases (a standard definition TV).

The human brain is the most powerful computer ever known to humans. This is a cliché, yet, it needs to be said again. For, the amount of processing and computation by the human brain in complex tasks is still unmatched. While robotic vision and artificial intelligence (AI) are catching up, they are yet to reach the human eye (and brain) for detail and logic. At least at the time of writing this article, Magnus Carlsen is still better than ChatGPT at sizing up a chessboard!

The human eye acts as a specialised camera with some unique features. A ray of light bouncing off an object gets refracted—bent inwards—first through a tear film and then the cornea. It enters a watery (aqueous humor) chamber, and is further focused by the crystalline lens of the eye through a clear jelly (vitreous body) on to the retina. Only at the centre of the retina (the fovea) will vision be super clear (compare it to a high-definition TV). In the rays that land away from the fovea, the resolution decreases (a standard definition TV).

This is the reason we move our eyes to “look” at any object “carefully”. While holding the eye still, we have an awareness of the objects around, but to appreciate the details, we need to move our eyes. Some people describe the retina as the “film” of the camera where the image is focused. That description, however, is incorrect.

There are several specialised tissues and structures within the human eye to keep the camera running, pumping fluids in and out, changing the focal length of the lens, to appreciate objects clearly at different distances. All the received signals are sent efficiently and electrically through the optic nerve wiring into the brain. These signals are transported across many turns, ups and downs, and crossings through cables (nerve fibres) with different processing logic.

The wires then reach the main station at terminal V1 in the visual cortex. From there on the journey continues to other terminals like V2, V3, V4, V5, MT, and so on. Each of these stations takes different signals to be processed at different locations in the brain. For example, to identify a face, there is a dedicated fusiform face area in the brain, in the temporal lobe.

To locate a face in a crowd, the brain uses a specific area called the parietal lobe. When you search from one face to another or try to find a friend, the frontal eye fields in the frontal lobe control the required eye movements. As a matter of fact, more than half of the brain is dedicated to processing visual inputs. So, it is not just the retina that acts as the “film”. The entire brain is involved in processing visual information.

Two Eyes, One Vision

The eye works like a dynamic camera, capturing images at various viewing distances. Despite this, we rarely notice any focusing blur, no matter how far away an object is. This is because the crystalline lens in the human eye quickly adjusts focus with a very short delay—just a few milliseconds. As a result, any blur that might occur is not registered by our conscious mind.

Although we have two eyes, we perceive only a single image. The brain fuses the separate images from each eye using binocular summation mechanisms. At different viewing distances, both eyes must move together in a coordinated manner. This ensures that each eye focuses on the exact plane at the same time.

When viewing something up close, the eyes naturally converge (both eyes turn inward towards the nose) and accommodate (increase their “plus” power for focus).

Humans have several coordinated systems—such as reflexes, and those involved in movement or digestion. The eye also has its own coordinated systems, one of which is the “near triad”. This near triad enables us to experience clear, single, and comfortable binocular vision. It consists of three components—vergence, accommodation, and pupil constriction or dilation.

When you look at something far away, both eyes align in parallel, the lenses in each eye remain relaxed, and the pupils are slightly dilated (more “open”). However, when you shift your focus to a nearby object, both eyes converge, each lens “accommodates” by increasing its plus power to adjust focus, and both pupils constrict to boost depth of focus. These near triad movements work smoothly and automatically every time we shift our gaze from one spot to another.

But what happens if we do not shift our gaze between different distances and remain fixed at just one distance?

Human physiology is very clever, for it tries to optimise resources in the best way possible. Our visual system has “fast” and “slow” components. The fast reacts on demand, however, it cannot “sustain” the demand. If the demand requires prolonged time (that is, prolonged fixation to the same distance), it transfers the work to the slow system. This is a system that will adapt slow and discharge slow.

The primary components that achieve these fast and slow responses are ocular muscles, both inside the eye (ciliary muscle that controls the crystalline lens) and outside the eye (muscles that move our eyeball). These muscles must maintain degrees of tautness and relaxation to achieve the demands on the visual system. Their “tonicity” is maintained across different viewing distances. So, if eye muscle tonicity gets built for a particular viewing posture for a long time, coming out of that posture may mean overcoming some inertia.

During the COVID-19 pandemic, many people spent long hours binge-watching videos on their smartphones while lying in bed and holding their phones very close to their eyes. When viewing something up close, the eyes naturally converge (both eyes turn inward towards the nose) and accommodate (increase their “plus” power for focus).

If this close-up posture is maintained continuously for long periods, it can reset the eye’s focusing systems. Some people developed symptoms such as double vision, inward-turned eyes, and blurred vision. These issues often required strong minus-power spectacles to correct. In essence, they needed minus lenses to counteract the excess plus power their eyes had built up. Minus-power lenses are typically used by people who have trouble seeing distant objects clearly.

When the eyes turn inward and the pupils sometimes constrict, this condition is called “spasm of near reflex”. Prolonged close work is just one risk factor for developing this problem; there are several other possible causes as well. Importantly, not everyone who spends long hours working up close will experience this spasm.

Researchers have studied and modelled this condition (Bharadwaj et al. 2021), and have discovered ways to manage it (Roy et al, JAAPOS). However, the exact pathophysiology remains unclear, much like many other rare diseases. Still, when we understand what can trigger the problem, we can prevent it by following healthy digital hygiene habits.

Similarly, we must remember that the eye exam we get once in a while, with an eye chart, only measures the resolution capacity of the eye. It is not indicative of the rest of the visual functions (for instance, colour vision, 3D vision, eye coordination, and so on). Therefore, it is a misconception to think your eyes are normal or healthy, just because you can see clearly till the last line in the eye chart.

Dry Eyes

Another problem specific to digital device use is “dryness” of the eyes. Dry eye can have several causes. With regular digital device use, an evaporative dry eye type is more common. As the name suggests, the tears evaporate leaving dry spots on the sensitive corneal layer, irritating it. This reflexively triggers the eye to water, to wash away the dry spots. It is counterintuitive, but one of the symptoms of dry eye is watering!

The main cause of evaporative dry eye is a reduced blink rate. Whenever we focus or read intently, our blink rate tends to decrease—regardless of whether we are reading print or looking at a screen. However, symptoms are usually worse with screens than with printed materials. In addition, blinks are often more incomplete when using digital devices.

A systematic review and meta-analysis found a slight advantage in reading performance with print compared to digital screens (Clinton 2019). On average, the normal spontaneous blink rate is about 15 times per minute, with females tending to blink more often. This blink rate drops to roughly six times per minute during reading (Argiles et al. 2015).

If the blink rate remains chronically low, it can lead to increased evaporation of tears. Over time, this can disrupt tear dynamics and negatively impact the health of the ocular surface.

Fixing Digital Eye Strain

We saw some dysfunctions that can result from digital eye strain. To fix them requires a careful approach. First, make sure there are no refractive errors—blurry vision—that are under-corrected, over-corrected, or uncorrected. Eye strain and headache are common if refractive errors are not corrected optimally with a pair of spectacles, regardless of digital device use.

The second step is to evaluate the health of the ocular surface for a dry eye. This testing involves measuring the regularity of the ocular surface, checking for dry spots on the eye, checking the tear film quality, quantity, and the health of the glands that produce oil and tears to keep the ocular surface moist and healthy.

One way to fix dry eye, especially the evaporative type, is to blink more often, and make sure the blink is complete (upper eyelid should touch the lower lid).

One way to fix dry eye, especially the evaporative type, is to blink more often, and make sure the blink is complete (upper eyelid should touch the lower lid). In people with a partial blink, the lower region of the eye and cornea may show dry spots.

There are apps that can be installed on a digital device that gives reminders to blink or to take a break. BlinkBuddy from Microsoft is one example. Such reminders have been found useful to reduce symptoms of dry eye (Ashwini et al. 2021). An eye care practitioner may sometimes advise lubricating eye drops, which are usually artificial tears to decrease the symptoms of dry eye.

The next step is to evaluate binocular vision to check for any underlying issues with vergence or accommodation. It is difficult to determine whether digital device use causes this dysfunction, or if an existing dysfunction leads to digital eye strain. Not everyone who uses digital devices will develop binocular vision problems, and not all individuals with these dysfunctions experience symptoms while using digital devices.

While a correlation exists, no direct cause has been established. Amplitude, accuracy, and agility of binocular vision can vary from person to person. However, there are established normative data for these measurements. These norms allow us to compare the results from someone experiencing symptoms.

If the binocular vision parameters are abnormal, specific vision therapy exercises to regain normalcy are advised by the optometrist. If the parameters are normal, then general tips for blinking more, taking breaks, or instructions to follow the 20/20/20 rule are offered.

The 20/20/20 rule suggests that after every 20 minutes of digital work, you should take a break for about 20 seconds and look at something at least 20 feet away. This practice helps break the habit of rigid, close-up viewing and allows the eye's lens to relax its focus.

In an online survey about device use (Datta et al. 2023) involving more than 400 participants, more than 60% reported experiencing at least three symptoms, with tiredness being the most common issue. Only one-third of the participants were familiar with the 20/20/20 rule. Interestingly, those with more symptoms were the ones who actually practised it.

In general, health care practitioners advice people to cut out all electronic devices at least one hour before going to bed.

Other digital eye hygiene tips focus on maintaining appropriate viewing distances. In a study by Ramteke and Satgunam (2024) with more than 100 participants, researchers measured the distance, participants kept from their smartphone and desktop at work. Participants were also asked to complete a symptom survey afterwards.

It was found that those who were more symptomatic had a closer viewing distance. The study's results mean we now recommend that smartphones should be used at a distance of more than 35 cm from the nose, and a computer should be viewed at more than 62 cm. The lesson is simple—the larger the viewing distance, the lesser the strain on the binocular vision system. Larger font sizes or magnifying the screen can also facilitate working from a longer distance.

We also advise patients to avoid using smartphones lying down in a sleeping position. This posture makes the person bring the device much closer to their eyes than if they were using it in a sitting position. In general, health care practitioners advice people to cut out all electronic devices at least one hour before going to bed. Viewing artificial light before sleeping could hinder the regular sleep cycle as well (Pham et al. 2021).

There has been some buzz around blue blocking lenses for computer use to reduce eye strain. However, a randomised clinical trial study that came out of Australia (Singh et al. 2021) did not find any evidence for this claim. In general, UV blocking lenses are helpful as protective eye wear, particularly outdoors.

Epilogue

Digital eye strain is ubiquitous. Some people manage their work for long hours with digital devices, while some are more symptomatic. Getting a correct diagnosis of correlated conditions (dry eyes, binocular vision disorders, or both) can greatly alleviate the symptoms. Following good digital hygiene (viewing distance, frequent breaks, and avoiding use before sleep) can help with digital eye strain.

If your work requires the use of digital devices, it is helpful to choose more outdoor activities for entertainment to limit your screen time. While this article focuses on eye health, it is also important to consider posture, ergonomics, and your overall work environment. These are modifiable factors that can be addressed to help you remain productive and enable you to work smartly with your digital devices.

Blink!

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