Global vision

Part 7 – The spread of technology

In the final part of our series on the impact of global trends on eye health, **Professor Mark Rosenfield** reviews the ocular and visual implications of viewing digital electronic screens

While the explosion in the use of technology has provided a huge range of opportunities, it must also be noted that a large number of individuals report significant difficulties when working with these devices. Although the general term Computer Vision Syndrome (CVS) has been used to describe these symptoms, nowadays, computers include desktop, laptop and tablet devices, and the use of electronic reading devices and smartphones must also be considered.

It is difficult to estimate accurately the prevalence of ocular and visual symptoms associated with viewing electronic screens as both working conditions and the methods used to quantify symptoms vary widely. Nevertheless, Thomson suggested that between 64 and 90 per cent of computer users experience visual symptoms which may include eyestrain, headaches, ocular discomfort, dry eye, diplopia and blurred vision either at near or when looking into the distance after prolonged computer use.[1] A recent investigation of office workers in New York City noted that 40 per cent of subjects reported tired eyes 'at least half the time', while 32 per cent and 31 per cent reported dry eye and eye discomfort, respectively, with this same frequency. [2]

Eye care practitioners need to consider the visual demands of these devices, and how they differ from traditional printed materials. Factors that should be considered include the size and contrast of the text, viewing distance and gaze angle, duration of working time and surrounding environment (eg ambient illumination, glare and atmospheric conditions). A much wider variation in these parameters may be found in electronic displays, when compared with hard copy stimuli.

For example, research in our laboratory has shown that when viewing a webpage on a smartphone, the font size used may be as small as 0.3M (average newspaper print is typically assumed to be around 1M[3]) and the working distances adopted may be as close as 19cm.[4] Gaze angle also varies widely, and individuals may view a desktop computer screen close to primary gaze, a tablet computer or electronic reading device (such as a Kindle) with the eyes depressed while the smartphone is positioned somewhere between these primary and eyes depressed positions.


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The working distance when viewing a webpage on a smartphone may be as close as 19cm

Clearly, an eye examination that assesses vision only at 6m (in the primary position) and 40cm (with the eyes in a single position of gaze) is unlikely to produce enough information to satisfy the visual demands of the contemporary patient. Practitioners need to question patients about all their visual requirements, and then provide an optimum refractive correction (or corrections) to enable the patient to fulfil these needs. This can be particularly challenging for the presbyopic patient, for whom multiple corrections may be required. Further, the use of monovision or multifocal contact lenses for the correction of presbyopia may fail to provide the resolution required for some modern devices. New multifocal designs are needed to optimise vision in presbyopes.

Even for the pre-presbyopic patient, it is essential to remember that single-vision spectacles or contact lenses are not the only forms of refractive correction being provided. Patients having had refractive surgery or undergoing orthokeratology may present other issues such as loss of contrast sensitivity or varying vision which could interfere with their ability to view digital monitors comfortably.

With regard to the correction of astigmatism, the presence of 0.50 to 1.00D of uncorrected astigmatism produced a significant increase in symptoms while reading material from a computer screen.[5-7] This was demonstrated in subjects with up to 1D of residual astigmatism who were corrected with spherical soft contact lenses. Wiggins *et al*[6] suggested that symptoms could be reduced in these individuals either by fitting them with toric contact lenses, or alternatively by using a spectacle overcorrection during computer operation to correct the residual astigmatism. An additional group of patients having uncorrected astigmatism are those purchasing ready-made (spherical), over-the-counter reading glasses. Accordingly, when viewing electronic screens, it may be necessary to correct relatively small amounts of astigmatism (0.50-1.00D) which might be left uncorrected in other situations.

As noted earlier, dry eye symptoms are also relatively common during computer operation, with longer periods of computer work being associated with a higher prevalence of dry eye.[8] A review by Blehm *et al*[9] suggested that dry eye during computer use could either be caused by a reduced blink rate or by increased corneal exposure produced by the primary gaze position of the monitor (particularly in the case of desktop computers). In addition to a reduced blink rate during computer operation,[10-12] other investigations have noted differences in blink patterns such as alternating inter-blink periods of longer and shorter duration or an increased number of incomplete blinks.

Other factors which could

contribute to symptoms of dry eye during computer use include poor environmental conditions due to excessive heating or air conditioning and/or poor air quality due to physical, biological or chemical contaminants.[13,14] Interestingly, the application of topical elastoviscous solutions to the cornea does not modify the reduced blink rate associated with computer use.[15] However, it is unclear whether it alleviates the symptoms commonly associated with computer use.

Additionally, in recent years there has been a huge revival of interest in three-dimensional displays in movies, television and computers.[16] However, while observing these stimuli, some subjects may report visual symptoms including headaches, nausea and dizziness.[17,18] A review by Lambooij *et al*[19] noted that symptoms may arise from conflicts between accommodation and vergence, as well as excessive screen disparity (the separation of the monocular images viewed by each eye). An additional consideration is the rapid changes in apparent depth that may occur over time. Accordingly, practitioners need to be aware of these potentially abnormal cues, and provide appropriate clinical testing (such as assessment of the zone of clear and single binocular vision) to ensure that patients can meet the spatial and temporal requirements of these unusual stimuli.

When considering CVS specifically, Daum *et al*[20] estimated that provision of an appropriate refractive correction alone could produce at least a 2.5 per cent increase in productivity. This would result in a highly favourable cost-benefit ratio to an employer who provided computer-specific eyewear to their employees. Clinicians also need to consider the work environment, and may have to discuss issues such as appropriate working distances and postures, minimisation of glare and the need for frequent breaks with their patients.

Summary

When viewed through the lens of history, it may be that the technological revolution through which we are now living will be seen as equivalent to the industrial revolution of the early 19th century. While the latter saw the development of manufacturing capabilities due to improved iron production processes, the harnessing of steam power and the development of the railways, this expansion comes from almost instantaneous communication around the world and access to vast sources of information.

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Dry eye from computer use can also be the result of poor environmental conditions

It seems likely that health care in 50 years time may bear little relation to what we see at present. Human input may be restricted to pressing the start button and monitoring the machinery. Consider as an analogy the highly trained airline pilot whose tasks are limited to just a few minutes at the start and end of each flight, and who spends most of his or her time monitoring the instruments, just in case the computer control breaks down.

The eye care practitioner of the future may be restricted to a similarly limited role. But before we all get too depressed, consider also that many individuals encounter significant ocular and visual symptoms when working with this technology, and humans will be needed to listen to their symptoms, before they can be hooked up to another machine for a diagnosis!

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