11 –

17 –

33 –

34 –

35 –

* There is little evidence to support the proposal that the accommodative demands of the VDT differ from viewing printed materials at the same distance and gaze angle. However, the presence of any refractive or accommodative anomaly (e.g. accommodative infacility or insufficiency53) could impact upon the patient’s level of visual comfort during the task. In examining patients with CVS, the following clinical parameters should be assessed [with all near testing being performed at the distance(s) at which the electronic screen(s) are positioned]: (1) Best corrected visual acuity (2) Refractive error (including binocular balancing) (3) Accommodative error (lag) at the appropriate working distance (4) Monocular and binocular amplitude of accommodation (5) Monocular and binocular accommodative facility (6) Negative and positive relative accommodation Patients with accommodative anomalies may benefit from measures to improve the accuracy and dynamics of their accommodative response, including vision therapy and/or the provision of lenses to provide a clear image of the target at the required viewing distance and gaze angle. If adjustments can be made to optimize the design of the workstation, these should also be discussed with the patient.
* CVS symptoms is unproven. For example, Acosta et al.74 observed that topical instillation of an elastoviscous solution did not produce a significant change in the computer-induced reduction in blink rate. Mean blink rates for the computer condition with and without instillation of the elastoviscous solution were 6.4 and 6.1 blinks min)1 , respectively. Accordingly, it is uncertain whether the use of lubricating or rewetting drops will indeed reduced CVS symptoms. With regard to increasing the blink rate, Portello and Rosenfield80 compared post-task symptoms when subjects were either allowed to blink voluntarily or when the blink rate was consciously increased using a metronome during computer use. Although a significantly increased blink rate was recorded in the metronome condition (23.5 vs 11.3 blinks min)1 in the control session), no significant difference in posttask CVS symptoms was found either in the entire population tested (n = 23) or in those subjects reporting the highest symptom scores in the control condition. Furthermore, several subjects stated that increased conscious blinking interfered with their ability to perform the task satisfactorily, which may limit the practicality of this advice.
* Furthermore, Acosta et al.74 noted that blowing an air stream onto the face while subjects were playing a computer game did not produce a significant change in blink rate. Accordingly, to date there appears to be little experimental evidence to support many of the therapeutic interventions that have been proposed. Further work is required to determine what aspects of dry eye treatments will indeed reduce CVS symptoms.

36 –

39 –

40 –

41 –

10 –

* . A range of management approaches exist for DES including correction of refractive error and/or presbyopia, management of dry eye, incorporating regular screen breaks and consideration of vergence and accommodative problems
* Recently, several authors have explored the putative role of blue light-filtering spectacle lenses on treating DES, with mixed results. Given the high prevalence of DES and nearuniversal use of digital devices, it is essential that eye care practitioners are able to provide advice and management options based on quality research evidence.
* lue light Exposure to blue light (400–500nm) can be harmful to the retina, particularly suprathreshold, acute doses,87 88 with peak light damage occurring around 440nm. 89 Longer duration, less intense light exposure can also induce photochemical damage.90While some concern has been expressed regarding blue light emitted from digital screens, recent research indicated that the low levels of blue light from such devices do not represent a biohazard, even for long-term viewing.91 Newer forms of low energy lighting, including LEDs, emit less infrared radiation than their incandescent predecessors, but significantly more blue light leading to the suggestion that harmful cumulative exposures could occur.89 92 Theoretically, commercially available blue light-filtering spectacle lenses reduce phototoxicity by 10.6%–23.6%, without degrading visual performance, and have thus been suggested as a supplementary aid for protecting the eyes against the blue light hazard.93 Light exposure is also the main factor involved in setting circadian rhythms. Melatonin hormone is released in dim light conditions and is involved in the physiological control of sleep. Its release from the pineal gland is controlled by a pathway originating from the intrinsically photosensitive retinal ganglion cells containing melanopsin, which has a peak sensitivity of approximately 482nm, 94 that is, longer wavelength blue-turquoise light. Exposure to short wavelength light (including digital devices) before bedtime can disrupt sleep patterns,95 96while use of short wavelength blocking spectacles in the evening can improve sleep duration and quality97 98 and reduce subjective alertness.99 Blue light emitted by digital devices has also been implicated as a cause of DES. Isono and colleagues100 reported reduced subjective complaints and smaller reductions in CFF in young adults when reading from a sepia background (reduced blue light contribution) compared with the conventional white background of a modern tablet device. Although cited by Lin et al29 in their rationale for exploring the impact of blue-blocking spectacles on eye fatigue, the small sample size means that the results must be interpreted with caution. Given both the putative link between the blue light emitted from modern digital devices and ocular complaints and the commercial availability of blue-filtering lenses for treatment of DES, several authors have explored the impact of blue light-reducing spectacles on symptoms and objective measures of VF29 31 101 (see table 3). There is a lack of consensus in the findings of these studies, and a recent systematic review of the literature called for high-quality research, ideally in the form of randomised control trials, to address the health effects of blue blocking spectacle lenses.10
* Cheng et al101 showed no improvement in Schirmer test results when dry eye and non-dry eye participants used low-blocking, medium-blocking and high-blocking wraparound goggles but did report reduced symptoms with all levels of filter in patients with dry eye. Of note is the lack of a control lens in the study and potential placebo effect, while the wraparound style of goggles means that reduced tear film evaporation in addition to blue-light reduction may have impacted the results. Following a 2-hour computer task, Ide et al31 reported a significantly greater reduction in CFF in participants wearing control lenses, compared with those with high or low blue-blocking properties, although no differences in subjective questionnaires were observed between groups. More recently, Lin et al29 measured improved posttask CFF in subjects wearing high-blocking spectacles compared with low-block or no block lenses and reported that 3 of 15 symptoms (pain in/around the eyes, eyes feeling heavy and eyes feeling itchy) were lower in the high-blocking group, indicating that short-wavelength filtering spectacles may attenuate both some symptoms of DES and clinical CFF measurement. Notably, the high-blocking spectacles used had an obvious yellow colouration with the transmission spectrum indicating some filtering effect across a range visible wavelengths. Recent research in an animal model has demonstrated that exposure to violet visible light may suppress myopia progression103; if this finding translates to human eyes, there would be implications for use of short-wavelength blocking lenses in young people at risk of myopigenesis or progression.
* Further to improving subjective comfort, management of DES among computer workers may confer significant economic advantages. The experience of symptoms can reduce work accuracy,104 105 extend the time required to complete tasks4 and necessitate more frequent breaks.12 Following a double-blind study, it was estimated that provision of spectacles to correct small refractive errors in pre-presbyopic employees would increase productivity by at least 2.5%,4 indicating a favourable cost-to-benefit ratio of this intervention. Furthermore, the implementation of short, frequent breaks can enhance working efficiency, adequately compensating for time spent away from the screen.79

12 –

17 –

37 –

38 –

44 –

* DES is highly influenced by the visual demand and the duration of a given task.[8,9] For instance, Portello et al.[7] observed a positive correlation between the symptom score and the time spent working on a computer. Longer periods of screen visualization have been associated with greater tear film and ocular surface abnormalities, and accommo dative and vergence disturbances.[8–10] Accordingly, limiting the amount of time spent in front of a digital display is expected to have a positive impact on DES.[8,9,11] Based on this principle, frequent screen users are often advised to follow the 20-20-20 rule which instructs them to briefly look away from the screen for at least 20 s to a distant scene at least 20 feet (6 m) away after every 20 min of continuous work.[12,13] With the rise of display use, this general rule of visual ergonomics has become increasingly popular and is widely recommended by specialists in the field of vision, although only one study has examined this approach, reporting a benefit, but with no evidence of compliance.[14]. Accordingly, in the present study, a computer software was devel oped using the laptop webcam to assess user breaks, eye gaze and blinking and could emit personalized regular reminders of rest based on the 20-20-20 rule in order to evaluate, for the first time, the potential benefits of this rule on DES, dry eye and the accommodative and binocular vision systems in a sample of young, symptomatic, regular computer users.
* According to the results of the present study, enabling the 20-20-20 rule reminders had a significant impact on how participants used their computers.
* Participants took more breaks per day in total when the 20-20-20 rule reminders were on compared to when they were off (34 with reminders on vs 27 with reminders off), which was partially attributed to the breaks taken following the instructions of the reminders. Conversely, the average number of natural (spontaneous) breaks taken per day did not change significantly, although a slight increase of 5 breaks per day, on average, was observed when the rule reminders were activated. This may be due to an increased consciousness of computer usage which some participants reported during their visits.
* In the present study, following the 20-20-20 rule significantly improved binocular accommodative facility compared to before (i.e., visits 1 and 2). Iribarren et al.[42] found that the cumulative duration of near work over months showed a significant negative correlation with binocular accommodative facility. Accordingly, the 20-20-20 rule may improve accommodative facility in regular computer users by reducing screen time, thus preventing cumulative effects of prolonged near work, although more research is required to confirm these findings.
* According to the results of the present study, participants exhibited a noticeable reduction in the blink rate while using the computer (8 – 9 blinks/min when using the computer vs 16 – 22 blinks/min when looking in primary gaze). This is closely in line with previous research on contemporary digital device usage.[48] Most importantly, following the 20-20-20 rule had no effects on the blink rate and blink duration of participants while using the computer. Therefore, the 20-20-20 rule reminders are likely to have no beneficial effect on the blinking pattern during device use.
* Furthermore, there was a significant improvement in dry eye symptoms after the management period. Following the 20-20-20 rule led to a lower OSDI compared to previous visits, although this was not enough to prevent a positive symptom score (OSDI ≥ 13). Likewise, the severity of dry eye symptoms reported in SANDE I was lower after the management period compared to before, leading to a lower total SANDE I score, although no change in the frequency of dry eye symptoms was observed between visits. In parallel, the SANDE II scores after the management period were significantly smaller than 0, meaning that both the severity and frequency of symptoms reported by the partici pants were lower compared to the previous visit (visit 2). Symptoms of dryness (OSDI and SANDE I) reported one week after the discontinuation of the 20-20-20 rule (visit 4) were not different from those reported before the management strategy (visits 1 and 2), yet they were not greater than those observed at visit 3, thus some of the Table 4 Dry eye signs and symptoms obtained before (visits 1 and 2) and after two weeks of compliance with the 20-20-20 rule reminders (visit 3) and symptoms reported one week after the interruption of the management strategy (visit 4) and statistical results of the comparison. Data are presented as mean ± SD (min – max). Parameter Visit 1 (Baseline) (n = 29) Visit 2 (n = 29) Visit 3 (20-20-20 rule) (n = 29) Visit 4 (Online Follow-up) (n = 29) p-value Statistically significant posthoc differences (p-value) CVS-Q 10 ± 4 (6 – 20) 11 ± 4 (6 – 25) 8 ± 4 (3 – 22) 9 ± 4 (4 – 21) p = 0.001‡ Visit 1 – Visit 3 (0.008) Visit 2 – Visit 3 (0.008) OSDI 22.88 ± 12.49 (0.00 – 45.45) 24.64 ± 16.09 (0.00 – 62.50) 18.95 ± 13.58 (0.00 – 60.42) 19.96 ± 13.80 (0.00 – 50.00) p = 0.015‡ Visit 2 – Visit 3 (0.019) DEQ-5 10 ± 4 (3 – 17) / / / / SANDE I Frequency 40 ± 26 (4 – 90) 37 ± 23 (4 – 90) 31 ± 21 (0 – 85) 37 ± 24 (0 – 80) p = 0.124‡ — Severity 33 ± 22 (4 – 81) 32 ± 20 (4 – 90) 26 ± 19 (0 – 73) 33 ± 23 (0 – 90) p = 0.045\*‡ Visit 1 – Visit 3 (0.045) Total score 35 ± 21 (4 – 75) 34 ± 20 (4 – 90) 28 ± 19 (0 – 78) 34 ± 22 (0 – 80) p = 0.022\*† Visit 2 – Visit 3 (0.043) SANDE IIa Frequency / 1 ± 6 (-15 – 14); p = 0.358¥ − 11 ± 10 (-40 – 12); p < 0.005\*§ 8 ± 13 (-10 – 40); p = 0.005\*¥ / Severity / 0 ± 6 (-17 – 16); p = 0.904¥ − 12 ± 12 (-37 – 10); p < 0.005\*§ 4 ± 17 (-40 – 40); p = 0.222¥ / TMH (mm) 0.23 ± 0.13 (0.11 – 0.73) 0.23 ± 0.11 (0.09 – 0.64) 0.24 ± 0.10 (0.11 – 0.51) / p = 0.538† — Conjunctival redness Bulbar - Temporal 0.8 ± 0.4 (0.2 – 1.8) 0.8 ± 0.5 (0.2 – 1.9) 0.8 ± 0.4 (0.2 – 1.8) / p = 0.677† — Bulbar - Nasal 1.1 ± 0.6 (0.2 – 2.7) 1.1 ± 0.6 (0.1 – 2.9) 1.1 ± 0.7 (0.3 – 2.5) / p = 0.972† — Limbal - Temporal 0.4 ± 0.4 (0.0 – 1.6) 0.4 ± 0.4 (0.0 – 1.7) 0.4 ± 0.3 (0.1 – 1.3) / p = 0.810 ‡ — Limbal - Nasal 0.6 ± 0.5 (0.1 – 1.8) 0.6 ± 0.5 (0.0 – 1.7) 0.7 ± 0.5 (0.1 – 2.2) / p = 0.504 ‡ — Blink rate (blinks / min) 23 ± 14 (0 – 64) 22 ± 16 (4 – 64) 17 ± 12 (1 – 54) / p = 0.034\*‡ Visit 1 – Visit 3 (0.040) Incomplete blinking (%) 56 ± 31 (0 – 100) 53 ± 31 (0 – 100) 49 ± 31 (0 – 100) / p = 0.089‡ — Lipid layer thicknessb 3 ± 1 (1 – 5) 3 ± 1 (1 – 5) 3 ± 1 (1 – 5) / p = 0.180‡ — NIKBUT 10.98 ± 6.19 (4.25 – 24.16) 10.83 ± 5.85 (3.51 – 23.39) 10.79 ± 6.22 (3.70 – 23.55) / p = 0.991‡ — Corneal staining 1 ± 1 (0 – 3) 1 ± 1 (0 – 4) 1 ± 1 (0 – 3) / p = 0.924‡ — Conjunctival staining 1 ± 1 (0 – 4) 1 ± 1 (0 – 3) 1 ± 1 (0 – 4) / p = 0.685‡ — LWE Horizontal length 1 ± 1 (0 – 3) 1 ± 1 (0 – 3) 1 ± 1 (0 – 3) / p = 0.584‡ — Sagittal width 0 ± 1 (0 – 4) 0 ± 1 (0 – 3) 0 ± 1 (0 – 3) / p = 0.360‡ — MGD (%) Upper eyelid 23.8 ± 14.0 (2.7 – 69.0) / / / / Lower eyelid 41.2 ± 18.2 (10.3 – 69.9) / / / / CVS-Q = Computer vision syndrome questionnaire; OSDI = Ocular surface disease index; DEQ-5 = 5-item dry eye questionnaire; SANDE I = Symptom assessment in dry eye questionnaire, version 1; SANDE II = Symptom assessment in dry eye questionnaire, version 2; TMH = Tear meniscus height; NIKBUT = Non-invasive ker atograph break-up time; LWE = Lid wiper epitheliopathy; MGD = Meibomian gland dysfunction. a Statistical comparison with value of 0 (no change). b Graded as: 1 = open meshwork; 2 = closed meshwork; 3 = wave; 4 = amorphous; 5 = 1st order colours; 6 = 2nd order colours. Asterisks denote statistically significant values (p < 0.05). † Repeated-measures ANOVA. ‡ Friedman. § One-sample t-test. ¥ One-sample Wilcoxon signed rank test. C. Talens-Estarelles et al. Contact Lens and Anterior Eye 46 (2023) 101744 8 improvement was maintained one week after discontinuation. Similarly, the frequency score in SANDE II obtained one week after the discon tinuation of the rule reminders was significantly greater than zero, although the severity score revealed no difference. Consequently, the frequency of dry eye symptoms increased one week after the interrup tion of the strategy, yet the perceived severity of dry eye was maintained. Conversely, no differences in dry eye signs were observed between visits for any of the parameters, except for the blink rate which was significantly lower after the management period with the 20-20-20 rule compared to baseline (visit 1). One of the main factors responsible for normal spontaneous blinks is the imminent break-up of the tear film which is sensed by the cornea.[50] Consequently, excessive blinking has been associated with reduced tear stability and may occur as a wetting process.[51] The reduction in the spontaneous blink rate observed in the present study after the management period might reveal an improve ment in tear function, though this was not accompanied by an improvement in any tear film parameter.
* Finally, the CVS-Q score was significantly lower after the manage ment period compared to before, thus DES significantly decreased as a result of the 20-20-20 rule reminders. Particularly, the CVS-Q score of some participants fell below 6 (positive CVS-Q score) after two-weeks compliance with the 20-20-20 rule, thus excluding them from a posi tive DES diagnosis after the management period. Nevertheless, no dif ference with pre-management values was observed one week after the discontinuation of the reminders, although, as with dry eye symptoms, DES was not greater than at visit 3 and therefore some improvement was maintained at the follow-up visit. These results are in accordance with previous research.[14,52] Anggrainy et al.[52] found a significant dif ference in the incidence of DES between a treatment group taking breaks every 20 min during 5 working days and a control group. Similarly, Alghamdi et al.[14] found a reduction in DES in a group of symptomatic individuals 20 days after they were given a structured advice booklet with instructions on the 20-20-20 rule. Nevertheless, despite the improvement observed in the present study, the 20-20-20 rule did not prevent DES (CVS-Q ≥ 6).

26 –

* Comfortable working at near and intermediate tasks depend on the efficiency as well as coordination of the accommodation and vergence systems.[2]
* Eye fatigue is commonly associated with functional defects in EOMs resulting often from various near tasks.[5] Therefore, muscles relaxation practices may aid relieve eye fatigue symptoms.
* Yoga practices have shown to be associated with physical as well as mental health benefits through downregulation of the  hypothalamic‑pituitary‑adrenal axis and the sympathetic nervous system.[6] Further, studies have suggested that yoga eye exercises are believed to improve ocular motility and help to relieve symptoms of asthenopia and eye fatigue.[1,7] Various yogic websites, online yoga videos, and many yoga practitioners suggest simplified practices of yoga exercises and their benefits on eyes. There are claims of improvement of the visual system, coordination of two eyes, and refractive error. Definitive studies regarding this in literature are lacking. Hence, this study was designed to check if yoga ocular exercises could be an important tool to reduce eye fatigue and associated asthenopic symptoms.

16 –

* Although there is no consensus on how to manage CVS, a number of recommendations have been widely adopted. These include a combination of adjustment of the work station and lighting, antiglare filters, using a suitable distance for the computer monitor and regular work breaks, all of which may help in relieving the symptoms.14 In addition, the 20/20/20 rule usually is given as advice by eye care professionals to their patients experiencing near-point visual strain or prolonged exposure to near-point devices.15 The rule can be stated as follows: every 20 min, take a 20 s break and focus your eyes on something at least 20 feet away.16 Boulet reported that this 20/20/20 rule is commonly found on the websites of optometric associations, although it has very little evidentiary support, and its therapeutic benefits are unclear.15 However, all of these educational or environmental methods to reduce CVS are of unknown efficiency. Therefore, the aim of this study was to evaluate whether educational intervention with the 20/20/20 rule is effective to reduce CVS symptoms and the associated dry eye signs and symptoms.