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Digital visual training helps treat disorders associated with close work

Software platform provides home exercises to overcome asthenopia

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Computer vision syndrome (CVS) is a group of eye problems associated with computer and mobile phone use.[1] In this digital era, people spend much of their time looking at a screen.[2]

The number of people with exposure to digital media is growing exponentially—there are more than 4 billion Internet users in the world—and thereby the prevalence of CVS. One of the most common manifestations of CVS is asthenopia.[3]

The term is derived from the Greek words *asthen-opia*, meaning weak eye condition. It manifests as nonspecific symptoms such as fatigue, headache and pain in and around the eyes; burning of the eyes; and blurred or double vision. It is brought on by concentrated use of the eyes for tasks such as reading, computer work or close visual work, activities that cause tightening and spasm of the eye's ciliary muscles.[4-6]

Apart from refractive errors, binocular and accommodative vision anomalies are among the most common visual disorders in children.[7] Asthenopia is proving to be a major problem in school-age children, especially with the new norms of virtual classes and with constant and continuous near work. It is imperative that a complete binocular vision assessment is made in these children, with the prescription of a targeted therapy to ensure relief from symptoms.

People who do prolonged near work might have accommodation insufficiency or accommodation infacility, two conditions that cause blurred near vision, discomfort and strain; fatigue; as well as difficulty with attention and concentration whilst reading.[8]

Prolonged near work can also have a significant effect on binocular stability, with the potential development of convergence insufficiency,[9] characterised by exophoria at near, increased near point of convergence (>10 cm), low fusional convergence amplitude (<15–20 prism D) and significant symptomatology.[10] Various studies have proved convergence insufficiency and accommodation infacility to be leading causes of asthenopia.[11]

Despite the symptomatic evidence, there has been little research into how to improve the visual symptoms associated with prolonged near work and/or digital technology. Specifically, to date, no study has examined the effect of vision training on patients with vergence or accommodation issues. To help address this lack of research, our research group recently analysed the change in asthenopia score after vision training in subjects with CVS and associated accommodative or binocular disorders.

IN SHORT:

A new online platform for vision training reduces asthenopia score and significantly improves binocular and accommodative abilities in people suffering from computer vision syndrome.

Study design

A total of 76 subjects with symptoms of asthenopia, eyestrain and difficulty focusing after working on computers or following near work were recruited. The mean ± standard deviation age was 23.3 years ± 12.3 years; 58% of those recruited were women and 32% men.

Patients with any ocular pathology or who had undergone any previous vision training were excluded. Comprehensive examination of the enrollees included objective and subjective refraction followed by anterior and posterior segment evaluation.

Diagnostic tests were performed using a new validated software package, Bynocs, which allows the

measurement of different aspects of visual function (visual acuity, contrast sensitivity, phoria, fusional vergences or stereopsis) as well as providing specific types of visual exercises. This cloud-based software for assessment and management in binocular vision disorders requires the use of a computer or laptop with Internet connectivity, and a pair of anaglyph glasses and flippers to perform the tests.

The software has several advantages over conventional visual function tests and training, such as the use of engaging activities and real-time control of compliance, allowing successful home-based visual assessment and treatment. Tests include measurement of fusional divergence (break and recovery point), fusional convergence (break and recovery point) and accommodative facility (cycles per minute).

The presence of asthenopia was confirmed with the Asthenopia Symptoms Survey, with calculation of the asthenopia score. Each subject was given ten sessions of therapy using the software (Figure 1). Fusional divergence exercises were repeated five times in each of the first five sessions and three times in each of the next five sessions.

Fusional convergence exercises were repeated five times in each of the first three sessions, seven times in each of the next three sessions, then ten times in each of the last four sessions. Each of the ten sessions also included 4 minutes of accommodation exercises.

Subjects were reviewed in the clinic 10 days after finishing the therapy, and diagnostic tests of fusional divergence amplitudes (break and recovery point), fusional convergence amplitudes (break and recovery point) and accommodation facility were conducted.

Three groups were created after the initial visual assessment:

- Fusional vergence dysfunction (FVD) group (subjects with normal accommodation and vergence response impairment);
- Accommodative infacility (AI) group (subjects with normal vergence and a reduced level of accommodative facility); and
- Fusional vergence dysfunction with accommodative infacility (FVD+AI) group (subjects with impaired vergence and accommodation).

The Shapiro–Wilk normality test showed the data variables to be normally distributed. Parametric statistical tests were applied for data analysis.

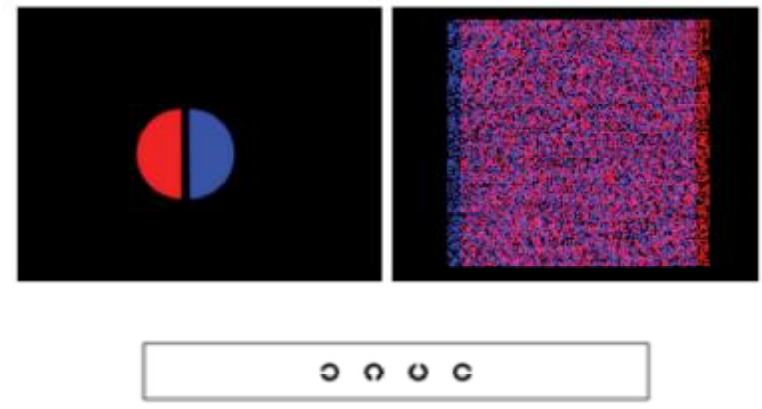

FIGURE 1. Bynocs screens. Top right, measurement of phoria; top left, fusional vergence measurement and training; bottom, optotypes for accommodative training.

Results

Overall mean asthenopia score significantly changed from 20.3 ± 3.1 before therapy to 11.7 ± 2.8 after therapy ($P < 0.001$). Specific findings in each of the three groups are described as follows.

FVD group (n = 31)

In this group, statistically significant improvements were observed after therapy in fusional divergence break point; fusional divergence recovery point; fusional convergence break point; fusional convergence recovery point; and mean accommodative facility. After finishing therapy, most subjects (84%) reported an improvement in symptomatology, although three subjects continued to report disturbances despite an improvement in the visual parameters evaluated.

These patients were carefully re-examined to see if another condition might be the cause for the residual disturbances. The remaining two patients experienced a mild improvement, and more sessions of training were prescribed (Figure 2).

AI group (n = 6)

In this group, no significant changes were found in the parameters characterising the vergence response, but accommodative

FIGURE 2. **CHANGES IN SYMPTOMATOLOGY**

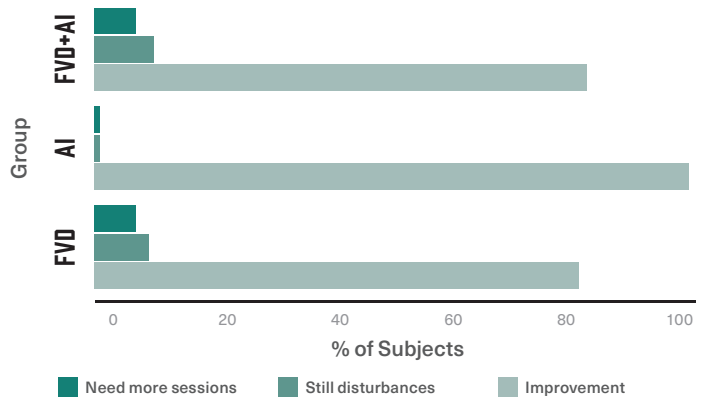

FIGURE 2. Changes in symptomatology in the three groups of subjects. *(All images courtesy of Ms Faiza Bhombal, Mr Md Oliullah Abdal, Dr Gul J Nankani and Dr David P. Piñero)*

facility improved significantly with training (4.1 ± 2.2 cycle/min vs 7.9 ± 1.5 cycle/min; $P = 0.008$). All subjects experienced a significant improvement in symptomatology (Figure 2).

FVD+AI group

The FVD+AI group demonstrated significant improvements in all the variables evaluated. Symptomatology improved after therapy in most subjects (85%), although four subjects continued to experience disturbances despite an improvement in the visual parameters evaluated. These patients underwent careful re-examination to see if another condition might be the cause for the residual disturbances. The two remaining patients experienced a mild improvement, and more sessions of training were prescribed (Figure 2).

Conclusions

In the presence of CVS, it is important to conduct a complete accommodative and binocular vision assessment because an anomaly in these aspects can contribute significantly to symptomatology compatible with CVS. If a binocular or accommodative disorder is detected, it can be managed successfully with visual training.

The new software platform described in this article can be helpful for this purpose, facilitating a significant reduction of asthenopia score and a significant improvement in the subject's binocular and accommodative abilities. More studies are needed to further investigate the efficacy of visual training therapy with this online platform.

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