Despite the fact that asthenopia has been discussed and related to various vision conditions for many years, its physiological basis is not well understood. Recently, a research group headed up by Jim Sheedy has been investigating mechanisms of asthenopic symptoms.\textsuperscript{1-5} These two papers report studies of the physiological effects of various asthenopia inducing conditions. In particular, these two studies were concerned with activity in the orbicularis oculi muscle. The orbicularis muscle consists of two parts, an outer or orbital portion and an inner or palpebral portion. The outer portion is used for eyelid squint, while the inner portion is used for eyelid blink.

In the Gowrisankaran et al. study, activity in the orbicularis muscle was measured by electromyography (EMG). Blink rates and palpebral aperture heights were determined from video recordings. Visual discomfort was assessed having subjects make a vertical line on an analogue scale representing symptom severity. Those measurements were taken after separate trials of reading under seven different asthenopia inducing conditions and compared to a non-stress control condition. The separate trials lasted fifteen minutes or until the subject could no longer read because the symptoms became intolerable. The task performed in each trial was reading material placed at 60 cm from the eyes. Twenty individuals between the ages of 18 and 36 years participated as subjects. The asthenopia inducing conditions were induced refractive error (+2.00 -4.00 X 180 OU in spectacles), glare, small font size (5 pt.), low contrast text (3.5%), accommodative stress (alternating between +1.50 D and -1.50 D lenses from one line of text to another), convergence stress (reading text at 16.7 cm through +6.00 D lenses), and up gaze (25 degrees above straight ahead gaze). Statistically significant increases in EMG activity were found with induced refractive error, glare, low contrast, small font, and up gaze, with the largest increases found with induced refractive error and the second largest increase with glare. The change in EMG with accommodative stress was almost statistically significant.

Palpebral aperture height increased with upward gaze, as would be expected. A trend toward increase in palpebral aperture height was almost statistically significant after accommodative stress. Palpebral aperture height decreased significantly with induced refractive error and glare, and almost significantly with small font and convergence stress. Blink rate increased significantly with induced refractive error, glare, and low contrast, and almost significantly with accommodative stress. Discomfort increased significantly in all conditions with the largest increase in induced refractive error.

Similar measurements were taken in the Nahar et al. study, with the asthenopia inducing conditions being generally less in magnitude and in duration. It was suggested by the authors that the levels of stress in this experiment were “low level,” such as might be withstood under work conditions for a long period of time. Once again electrical activity in the orbicularis muscle was measured with electromyography (EMG). Blink rate was also determined from the EMG...
recordings. Thirty-one subjects participated in the study. Four of the subjects were between the ages of 40 and 50 years, and the remainder were between the ages of 18 and 30 years. The visual stress inducing conditions were four levels of small font sizes (7, 8, 10, and 12 pt.), four different font types (Verdana and Times New Roman, each with and without ClearType rendering), four levels of low contrast text (5%, 10%, 20%, 40%), five levels of induced astigmatism (0.50, 1.00, 1.50, 2.00, and 2.50 D, with the minus cylinder axis at 45 degrees and the spherical equivalent equal to zero), and four levels of glare. There were also six control trials for a total of 27 trials, each of which lasted five minutes.

There was a significant increase in EMG activity with increased cylindrical defocus and with increased glare. The EMG activity showed an increasing magnitude as the amount of cylindrical defocus increased. There was no significant difference in EMG activity between the different font types, font sizes, or low contrast levels.

There was significant decrease in blink rate with decreased font size and with lower contrast. Blink rate increased with induced refractive error and glare. There was no statistically significant effect of different font types on blink rate.

Subjective discomfort was significantly affected by all testing conditions, with the effect of different font types being smallest. Subjective comfort was slightly better with ClearType than with Non-ClearType and slightly better with Verdana than with Times New Roman. The biggest decrease in subjective comfort occurred with increased cylindrical defocus.

In both studies, induced refractive error and glare resulted in increased EMG activity and increased blink rates. The authors noted that these are both conditions that derive the visual benefit of improved retinal imagery from eyelid squinting. The effects of low contrast were variable in the two studies, as were the results for small font size. The authors suggested that the mechanism by which refractive errors or glare on the one hand and low contrast and small font size on the other hand cause orbicularis contraction may be different. The authors also noted that the accommodative stress and convergence stress conditions they used in the first study did not cause any statistically significant changes in EMG activity, palpebral aperture height, or blink rate. As a consequence, they suggested that the mechanism for asthenopia in accommodative or convergence stress may occur by a mechanism that does not involve the orbicularis muscle.

These studies are significant in that they suggest different asthenopia mechanisms with different visual stress conditions. It appeared that the authors attempted to mimic the stresses of particular work conditions more than the stresses of clinical vision conditions in these studies. Although there is still a long way to go to understand the mechanisms of asthenopia, studies such as these are good initial steps.


In this paper from the Department of Ophthalmology at the Mayo Clinic College of Medicine in Rochester, Minnesota, the results of interviews of thirty adults with strabismus are reported. The patients ranged in age from 18 to 74 years, with a median age of 39.5 years. Twenty of the thirty patients were women.

Seventeen of the patients had diplopia and thirteen did not have diplopia. Various types of strabismus were represented, with the most common diagnoses being cranial nerve palsies (8), consecutive exotropia (5), and decompensating exodeviation (5). Nineteen of the thirty patients had childhood onset strabismus. Twenty-three of the thirty had strabismus surgery but still had symptomatic strabismus at the time of the interview. Eighteen of the 23 with surgery had the surgery 48 weeks or more prior to the interviews.

The patients were asked eleven open-ended quality of life questions. For example, the first question was “What bothers you most about your eyes?” and the fourth was “How does having double vision / misaligned eyes affect your work?” Other questions were open-ended questions dealing with aspects of social life, hobbies, self-esteem, relationships, activities, etc. Transcripts of the interviews were reviewed by three investigators and the answers were classified into 48 topics. The median number of topics mentioned by individual patients was 22.

For the 17 patients with diplopia, the most common responses were in the topic areas of nonspecific negative feelings (15), general disability (15), difficulty driving (14), self-esteem problems (13), reading problems (12), self-confidence problems (12), and self-consciousness (12).
For the 13 patients without diplopia, the topics areas most often of concern were concern about appearance to others (12), problems with eye contact (10), and problems with interpersonal relationships (10).

Twelve topical areas were mentioned by more than 50% of both patients with diplopia and patients without diplopia. These included nonspecific negative feeling, driving difficulties, work problems, self-confidence and self-esteem problems, general visual function problems, and self-consciousness. The authors noted that personality and occupation may be more important in the answers given than whether the strabismus was large or small angle. The authors intend to use the information from this study to compose a health-related quality of life assessment tool.

References