Accommodation, convergence, pupil and eye blinks at a CRT-display flickering near fusion limit

Wolfgang Jaschinski, Matthias Bonacker & Ewald Alshuth
Institut für Arbeitsphysiologie an der Universität Dortmund
Germany

Introduction

Visual display units (VDU) with cathode ray tubes (CRT) refresh the CRT phosphor periodically at the frame frequency of the VDU. This can give rise to the perception of flicker and, consequently, visual discomfort and asthenopic com-plaints. Flicker disappears if the refresh rate exceeds a limit, called critical flicker frequency (CFF), which typically lies in the range of 50 - 100 Hz, depending primarily on the sensitivity of the subject, the particular viewing conditions, and the CRT phosphor decay time. The average critical flicker frequency for a bright-background CRT screen is around 70 Hz. Perception of flicker can be avoided by using refresh rates above the CFF.

However, absence of visible flicker does not necessarily mean that all visual functions have reached a state corresponding to steady light. Several studies have uncovered evidence that visual functions may respond to intermittency of light even if the refresh rate exceeds the critical flicker frequency. The electroretinogram (ERG) responds to frequencies above CFF. Berman et al. (1991) described synchronous ERG-responses to a special text arrangement on a CRT screen with a refresh rate as high as 76 Hz (which was above CFF for these stimulus conditions) and ERG-responses up to 145 Hz elicted by directly viewed fluorescent lamps. On the other hand, visually evoked cortical potentials have a cut-off frequency near CFF (Sternheim and Cavonius, 1972).

Other studies have investigated the focusing mechanism of the eye and measured the static accommodative responses to flickering monocular stimuli as a function of the viewing distance. For near targets, the accommodative response (in diopters) is typically less than the value expected theoretically from the inverse of the observation distance (also in diopters). This lag of accommodation is most evident at low refresh rates: the accommodative response increases with flicker frequency up to 40 Hz (Owens and Wolfe, 1985). Chauhan et al. (1992) found a further increase up to a frequency of 100 Hz. Neary (1989) reported an increased accommodation response at certain rates of intermittency, both above (50 Hz) and below (25 Hz) flicker fusion.

Kennedy and Murray (1991, 1993) and Wilkins (1986) investigated the possibility that natural saccadic eye movements (during steady illumination or at very high modulation frequencies) may be adversely affected by intermediate frequencies around 50 - 100 Hz, which are common refresh rates on CRT screens.