The effect of visual fatigue on clinical evaluation of vergence

Aiga Švede, Aiga Batare, and Gunta Krūmiņa

Department of Optometry and Vision Science, University of Latvia, Riga, Latvia

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Introduction

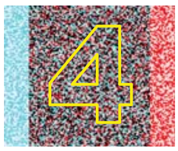
The increased number of complaints and visual fatigue after a prolonged near work can be related to significant changes in coordinated work of accommodation and vergence system such as a decreased accommodation and vergence range[1-2], as well as an adaptation of accommodation and vergence system (changes in tonic accommodation and vergence)[3-5]. These changes are better observed if very close viewing distance (e.g., 20 cm) is used[3-5]. If larger viewing distances are used (e.g., 40 cm and 2 m)[6], the vergence system demonstrates a compensation mechanism; The dark vergence moves in the direction of the task's distance during the first working hour and shifts back to approximately pre-test level during the second hour. Most studies[2-6] were performed in experimental conditions which can not mimic the usual working environment of participants.

Therefore, we evaluated the effect of prolonged near work (computer and paper work at least 4 hours a day) on the clinical measurements of vergence response such as associated phoria (vergence state as a result of accommodation and vergence interaction), vergence facility (dynamics of vergence response), negative and positive fusional vergence (vergence amplitude) in usual working environment.

Method

Phoria (Figure 1), vergence facility (Figure 2), negative and positive fusional vergence (Figure 3) were tested in 15 students (20-22 y.) using specially designed computerized tests. Dichoptic images were presented to each eye using red-cyan filters (red filter in front of the right eye) at 50 cm viewing distance. The measurements were performed on five working days (from Monday to Friday) in the morning and at the evening. Participants were allowed to do their everyday work (at least 4 hours computer work or reading of printed or written text) at their usual working distance (but not closer than 40 cm).

Figure 1. Stimulus for the phoria measurement. Vertical lines (height 10 mm, width 2 mm, between lines 10 mm) were presented on a gray background. Participants had to place lower line under the upper line.



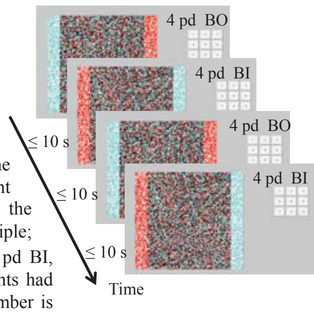
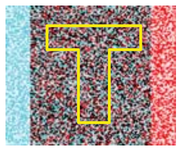


Figure 2. The stimulus for the vergence facility measurement and the sequence of the presentation (random dot principle; 4 pd BO crossed disparity; 4 pd BI, uncrossed disparity). Participants had to give the response (what number is presented from 1 to 9). After response (or after 10 s) the stimulus is switched to opposite disparity.



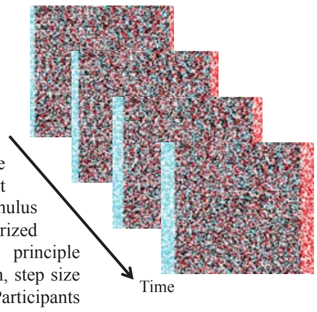


Figure 3. The stimulus for the fusional vergence measurement and the sequence of the stimulus presentation used in computerized tests based on random dot principle (stimulus velocity 200 mm/min, step size ~1 Δ; the maximum 51 Δ). Participants had to response when fusion breaks by pressing the left buttom of the mouse and telling which was the last letter seen (A, H, T, Z, X, I).

Results

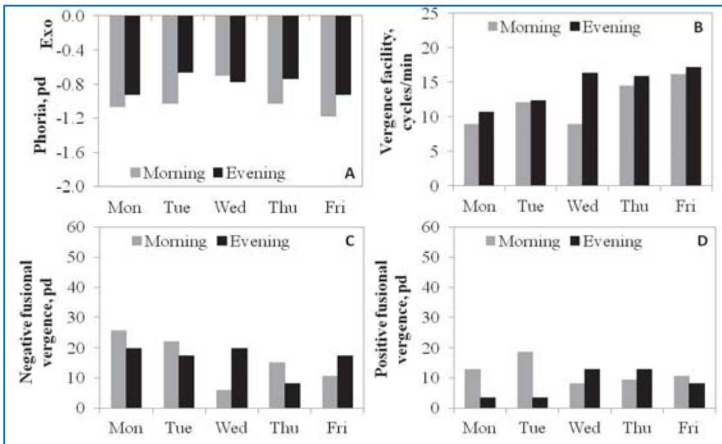


Figure 4. Phoria (A), vergence facility (B), negative and positive fusional vergence (C, D) for one participant demonstrating variations (not statistically significant) at different working days. We observed no correlation between subjectively evaluated fatigue and variations of vergence parameters.

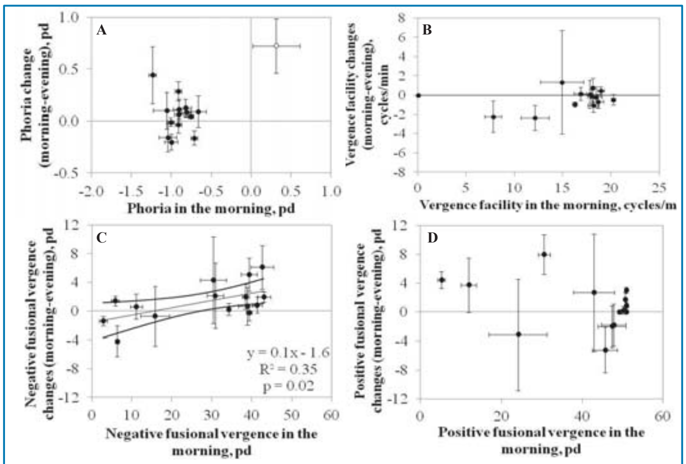


Figure 5. Excluding the outlier (A: open circle), phoria demonstrate no statistically significant changes. Negative fusional vergence (C) demonstrated statistically, but not clinically significant decrease of values at the evening (for larger morning values).

Conclusions

Values of vergence parameters vary among different working days and times, still this difference show no strict statistically and clinically significant tendency. Small deterioration of negative fusional vergence or improvement of vergence facility can be explained with the overall motivation of the participants (willing to finish the test faster) and less with their fatigue.

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Contact: aiga.svede@lu.lv

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