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Shutter glasses as a training tool in sports vision training

– Changes in visual perception according to frequency and duty ratio –

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Introduction

Shutter glasses seem to be a tool for training visual functions in the context of sports vision training to increase movement coordination. Several studies discussed effects and non-effects of training with shutter glasses e.g. within coincidence anticipation (Smith & Mittroff, 2012; Reichow et al., 2010)[6,7], motion cognition or short-time memory (Appelbaum et al., 2011 and 2012)[1,2] as well as the precision of eye-hand-(racket-)coordination and aiming accuracy e.g. in table tennis targeting precision (Bürger, 2011)[3].

No investigation justifies the training settings and strobe settings yet. Based on the necessity of an adequate load dosage to allow training effects, the present study intends to assess which strobe settings lead to a significant decrease of visual/perceptual performance.

Fig. 1: Shutter glasses used in the course of sports vision training in combination with P-Rotator® (left) and Eyeport™ (middle and right)

Methods

62 subjects (31 male, 31 female, median of age=25, median of visual acuity 1.6 (logMAR=-0.20)) took part in 13 test series to determine afferent motion perception (DTDS, Wist et al., 1998 und 2000)[8,9], reaction and anticipatory dynamic vision (Jendrusch & Ehrenstein, 2008)[5], dynamic depth perception (three-rod-test according to Helmholtz; with the test apparatus of Jendrusch, 1995 and 2000)[4] and peripheral awareness (Oculus Twinfield 2 Perimeter).

Shutter glasses (liquid-crystal visual occlusion spectacles) generate intermittent vision by opening and closing the lens shutters at different frequencies. The results with different randomized strobe rates (level I-VIII) of shutter glasses (Nike Vapor Strobe®) currently used in sports vision training have been compared.

Fig. 2: Shutter glasses (Nike Vapor Strobe®) with control and display panel

From level I to level VIII the frequency (periodic visual occlusion) declines and the duty ratio/cycle (or the proportion of time that the lenses are open) increases. While darkening, the glasses had a residual light transmission of 1-4 %.

Results

By increasing level (lower frequency and higher duty ratio) the afferent motion perception performance for stimulus motion duration of 280 ms (Fig. 3) and 420 ms decreases significantly (MANOVA, p≤0.001).

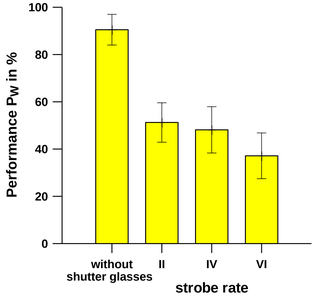

Fig. 3:
Change of afferent motion perception (DTDS; observation time=280 ms) at the strobe rates II, IV and VI in comparison without shutter glasses

The quality of depth perception declines significantly between level II and VIII (at a motion speed of the rods of 7 mm/s; 2p≤0.001) respectively between level II and VIII as well as V and VIII with a test velocity of 2 mm/s (each with 2p≤0.01; Fig. 4).

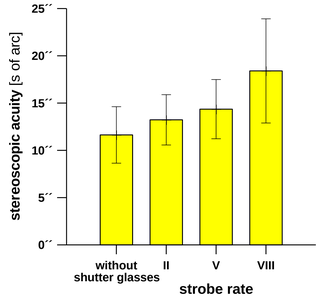

Fig. 4:
Change of depth perception (stereoscopic acuity in s of arc; motion speed of the rods = 2 mm/s) at the strobe rates II, V and VIII in comparison without shutter glasses

Maximum visual field decreases significantly (MANOVA, p≤0.001); for blue stimuli between level II and VIII and for red stimuli between level II and V. There is a larger decrease for red stimuli. These differences are statistically significant (each with 2p≤0.05; Fig. 5).

Reaction and anticipatory dynamic vision (timing) show no significant differences (MANOVA, p>0.05).

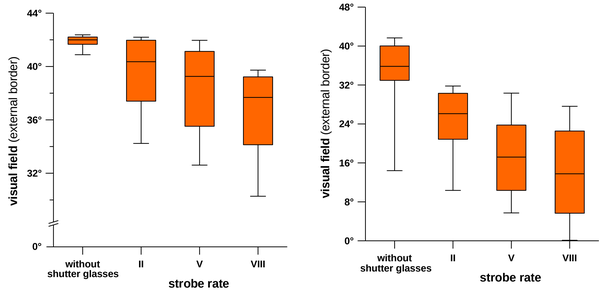

Fig. 5: Change of the (nasal) size of visual field (perimetric) for blue (left) or red (right) stimuli at the strobe rates II, V and VIII in comparison without shutter glasses

Conclusions

Users of shutter glasses during sports vision training are promised an increase in visual performance (related to sports). So far there is, however, no evidence for shutter glasses efficiency, which on the one hand is due to the lack of scientifically adequate studies, on the other hand in the lack of appropriate training settings and strobe settings.

The present study shows that for different visual performance skills lower frequency and higher duty ratio lead to increasing perceptual stress. No discrete levels for changes in performance were found.

The combination of different requirements in sports needs an adjustment of training settings and strobe settings for each skill/sport-specific demand.

However, generalized (nonspecific) training with the shutter glasses lacks effect-focused specificity.

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