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TECHNICAL NOTE

THE USE OF OCULOGRAPHY IN THE ASSESSMENT OF THE EFFICACY OF ANTI-G STRAINING MANEUVERS: PRELIMINARY EXPERIMENTS

Marcin STROJEK, Krzysztof KOWALCZUK, Michał JANEWICZ, Mariusz WALAS, Tadeusz GRZESZCZUK, Stefan GAŹDZIŃSKI, Mariusz WYLEŻOŁ
Military Institute of Aviation Medicine, Warsaw, Poland

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Author's address: M. Strojek, Military Institute of Aviation Medicine, Krasińskiego 54/56 Street, 01-755 Warsaw, Poland, e-mail:mstrojek@wiml.waw.pl

Abstract: Human centrifuge has numerous innovative uses as a training simulator. In recent years, the centrifuges have been used in oculographcic examinations so as to enable reconstruction of certain pilotage-related elements in simulated conditions. An evident loss of saccade movements was observed while subjecting pilots to hypergravity conditions although the extent of hypergravity was fully controlled and maintained at a constant level by pilots themselves. The preliminary results of the studies are promising and encourage taking up new research in the field.

Keywords: acceleration, human centrifuge, hypergravity, oculography, hypoxia, visual disturbances

INRTODUCTION

A continuous increase in the quality and efficacy of performance of combat aircraft pilots in hypergravity conditions while maintaining the optimum attention distribution remains an important element of flight training. Optimum solutions have become available thanks to the new generation of human centrifuge training simulators. Human centrifuge training simulators offer wide training, diagnostic and research possibilities. The device facilitates e.g. practical training of anti-G maneuvers, introduction to the effects of hypergravity loads with high increase gradients and push-pull effects (i.e. positive hypergravity loads occurring immediately after hypogravity episodes), as well as various simulator-based trainings carried out in conditions corresponding to actual flight conditions. The centrifuge facilitates training of flights over selected terrain types, air combat maneuvers, ground target attacks, or responses to ground-based counteractions. Human centrifuge training allows to increase and (or maintain) optimum tolerance of hypergravity loads when actual

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performance of airborne tasks is impossible or not recommended [7]. It provides a safe alternative to raising pilots' awareness of the adverse effects of hypergravity such as G-force-induced loss of consciousness (G-LOC) and spatial disorientation [2]. Oculographic analyses conducted upon systematic human centrifuge training facilitate comprehensive assessment of pilots' fitness under actual gravitational loads as well as their ability to make an optimum use of combat aircraft in the full range of capabilities and parameters. In addition, the centrifuge allows carrying out medical research studies, e.g. on methods of protecting pilots from high and rapidly increasing gravitational loads; it also has a large potential of being used in psychophysiological studies to determine and analyze pilots' behavior while performing airborne tasks.

METHOD

Gravitational loads occurring upon plane turns may be several times larger than the Earth's gravity force; this may be accompanied by various psychophysical reactions of the body. Centrifugal forces occurring in gravitational loads cause blood flowing out of the brain (leading to hypoxia) towards the lower limbs reducing proper blood supply of the central nervous system. Brain hypoxia is also accompanied by vision disturbances which may, in extreme cases, include loss of vision upon maintained consciousness or G-LOC [4,6]. The objective of the study was to make the pilots perform certain pilotage elements in simulated hypergravity conditions so as determine whether these changes might be observed by means of oculographic techniques. [1,3,5].

A series of test centrifuge runs was carried out for the purposes of the study. The study subject was a fully trained military pilot (TG) with high airborne mileage and professional experience. The effect of gravitational loads on the saccadic activity of the pilot's eyes was measured using two devices, namely the JAZZ G-Plus saccadometer (Ober-Consulting, Warsaw) and SMI Eyetracking Glasses (30Hz).

RESULTS

An evident loss of saccade movements was observed while subjecting pilots to hypergravity conditions although the extent of hypergravity was fully controlled and maintained at a constant level by the pilot himself (Figs. 3A and B):

A. normal saccades (green);
B. loss of saccadic movements due to hypergravity.

Of note are the changes in the vertical position of the baseline due to the gravitational load.

Fig. 1. Human centrifuge in motion.

Fig. 2. A pilot (TG) during the oculography test in the human centrifuge.

CONCLUSIONS

As the obtained results are promising, future tests are planned to be repeated in a larger sample of pilots with different levels of experience so as to assess the effect of gravitational loads on oculomotor activity, particularly in inexperienced pilots. Since the pilot study afforded very promising results, future tests are planned to be repeated in a larger sample of pilots with different levels of experience (including cadets). This will allow to verify the effect of gravitational loads on the oculomotor activity in pilots, particularly those with little professional experience.

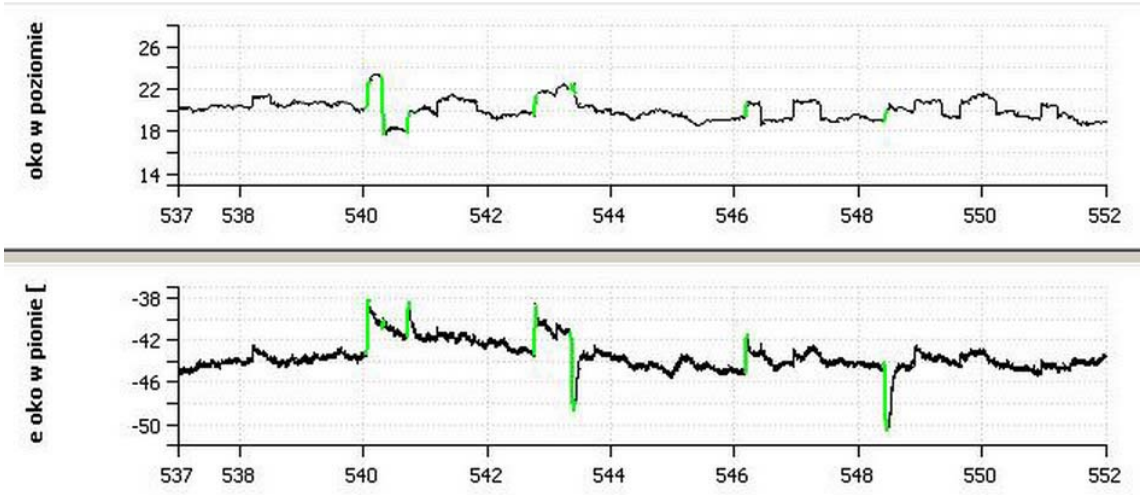

Fig. 3A. Normal saccades (green).

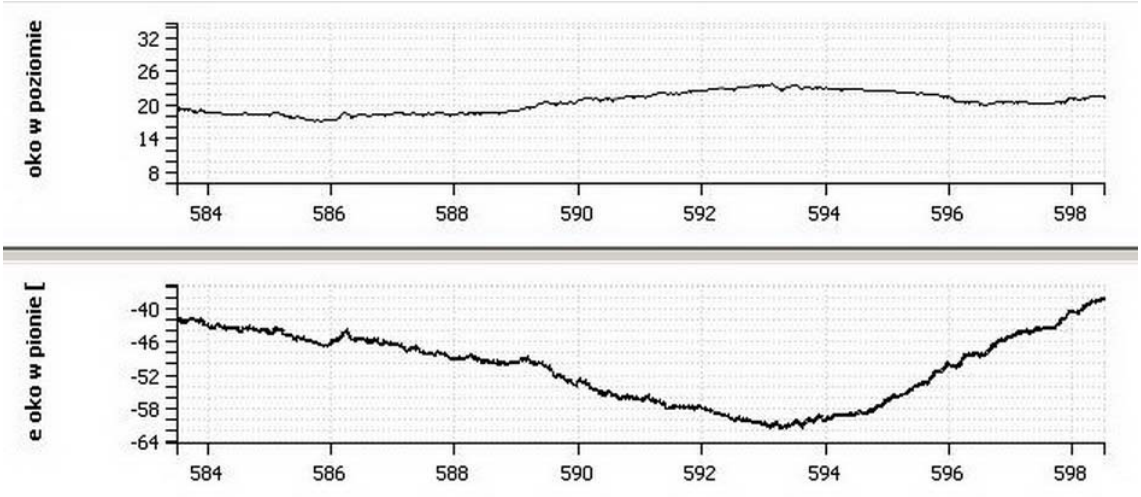

Fig. 3B. Loss of saccadic movements due to hypergravity.

AUTHORS' DECLARATION:

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