WG 8 (Aerospace Medicine)

Eye Movement Patterns Under Exposure to Spatial Disorientation Illusions During Simulated Flight

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Background:
SD is a significant contributor to aviation mishaps, often resulting from misinterpreted sensory cues, leading to an incorrect understanding of the aircraft's position, attitude, or motion. Understanding eye-scanning behaviors associated with SD can improve training and reduce incidents.
Purpose:
To analyze eye-tracking patterns contributing to or mitigating spatial disorientation (SD) during flight, providing insights to reduce its impact.
Methods:
Eye movements of 45 participants (30 aircrew members, 15 cadets) were recorded using Tobii Pro Glasses 2 during SD-inducing flight simulations in the Gyro-IPT SD simulator. Metrics such as fixations, saccades, and visits were compared between SD and non-SD groups, and statistical analyses were performed to identify differences.
Results:
Among 284 flight profiles, 136 SD events were recorded across 30 aircrew and 15 cadets. Some illusions targeted navigators, F-15 aircrew, or active aircrew instead of cadets. SD events during visual illusions were more likely with frequent instrument panel checks. In contrast, vestibular illusions showed the opposite effect and had a higher probability of causing an SD event among participants who examined the HUD in greater frequencies.
Conclusions/ possible implementations:
Efficient SD mitigation requires task-specific eye-scanning strategies: visual illusions demand greater instrument focus, while vestibular illusions benefit from HUD engagement. Implementing the knowledge and training based on the current results can improve performance in flight profiles with high SD risk. There is potential to develop a real-time alert system installed on aircraft during real flights, helping to mitigate or entirely eliminate the fatal results of SD events.

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The Effect of Monocular Deprivation on Visual Performance in Pilots

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Ocular dominance is a key factor in visual processing and performance, particularly in high-demand operational environments such as military aviation. While traditionally considered stable in adulthood, recent findings suggest that long-term exposure to asymmetric visual input—such as that experienced by helicopter pilots using Helmet-Mounted Displays (HMDs)—may influence the progression of visual acuity and potentially induce shifts in ocular dominance. This retrospective longitudinal study examines the relationship between ocular dominance and changes in visual acuity parameters over time in Israeli Air Force (IAF) helicopter pilots. The study analyzes a cohort of 300 pilots who underwent annual optometric assessments at the IAF Aeromedical Center, spanning multiple years of service. The primary objective is to determine whether ocular dominance is associated with differential changes in myopia, hyperopia, and astigmatism, and whether these changes vary based on pilot age, service duration, and flight platform. Data were analyzed using repeated-measures ANOVA and linear mixed-effects models to assess trends in visual acuity degradation and its correlation with ocular dominance over time.
Preliminary findings indicate that pilots with prolonged exposure to HMDs exhibit distinct patterns of visual acuity progression compared to non-HMD users, with notable differences in the dominant versus non-dominant eye. These results suggest that the operational demands of aviation may contribute to ocular dominance shifts and asymmetrical visual deterioration, warranting further investigation into adaptive visual training and early intervention strategies.
The implications of this research extend to pilot selection, training methodologies, and the ergonomic design of visual display systems in military aviation. By understanding the long-term effects of asymmetric visual exposure, this study provides valuable insights into optimizing flight safety, vision screening protocols, and personalized corrective measures for pilots operating under demanding visual conditions.