

SLEEP DEPRIVATION DECREASES EYE GAZE ENTROPY IN WOMEN BUT NOT IN MEN IN A MANUAL SPACECRAFT DOCKING TASK: INDICATIONS OF AN ADAPTATION OF SCANNING STRATEGY

N. Klett¹, S. Piechowski², S. Benderoth², D. Aeschbach², C. Mühl²

¹ Department of General Psychology and Methodology, Otto-Friedrich-University, Bamberg

² Institute of Aerospace Medicine, German Aerospace Center (DLR), Cologne

INTRODUCTION

Fatigue is a pressing problem in driving, aviation, and spaceflight and represents a root cause of 15-20% of accidents in transportation operations. Changes in visual scanning efficiency have been associated with sleep deprivation. This study investigates the effect of 24h of sleep deprivation on scanning efficiency and spatial distribution of fixations by means of gaze entropy in a spacecraft docking task, during which participants had to manually control a simulated spacecraft with 6 DoF.

METHODS

A counterbalanced crossover design with a sleep deprivation condition and a control condition was used. Linear mixed models were applied to analyze the data of 61 participants between the ages of 20 and 39 years ($M = 24.90$, $SD = 4.68$) with 28 female participants. Subjective sleepiness ratings were collected before each test session, wherein the participants conducted a sustained attention task as well as the 6df task. During the test session, eye-tracking data was continuously recorded.

RESULTS

An interaction between sleep deprivation and gender of the participants significantly affected both entropy measures. Female participants showed a significant decrease in gaze transition entropy ($p < .01$) and stationary gaze entropy ($p < .05$) during sleep deprivation compared to male participants. This suggests a reduction of scanning complexity and a more exploitative examination of the visual scene, respectively, in response to sleepiness. A significant association between gaze transition entropy and docking performance depending on trial difficulty was found ($p < .05$). Lower scanning complexity (GTE) was linked to better performance, but only in easier trials.

CONCLUSION

Sleep deprivation leads to alterations of gaze behavior in female participants, possibly as an adaptive reaction during a critical operational task. Women reduce their visual scanning complexity, a change that was associated with better performance in easy trials. Future research needs to identify optimal entropy ranges for specific docking maneuvers to guide docking training and inform strategies to mitigate the impact of fatigue.