SLEEP DEPRIVATION SYSTEMATICALLY CHANGES EYE MOVEMENT CHARACTERISTICS

Justine Winkler1 | Ricardo Ramos Gameiro1 | Daniel Aeschbach1 | Peter König2 | Christian Mühl3

1 Institute of Cognitive Science, University of Osnabrück, Germany | 2 Institute of Aerospace Medicine, German Aerospace Center, Germany | 3 Institute of Aerospace Medicine, German Aerospace Center, Germany

Presenting Author: Justine Winkler
Presenter’s E-Mail: juwinkler@uos.de

Deutsches Zentrum für Luft- und Raumfahrt

University of Osnabrück

MOTIVATION
During our day-to-day life, sleepiness endangers our safety as well as that of others. Specifically, it impairs operator performance in security-related working environments, for example in aviation. To reduce the number and impact of sleepiness-related accidents, easy to handle monitoring methods are needed. Here, we investigate the relationship between gaze as a measure of visual attention and sleepiness.

RESULTS

Visual Exploration

The effect of sleep deprivation on the spread of fixations, visualized by fixation density maps. The two upper FDMs represent 24 control or sleep allowed (SA) subjects without treatment in both the first (Session 1) and the second recording (Session 2). The two bottom FDMs represent 21 sleep deprived (SD) subjects in the recording session before sleep deprivation (Session 1) and in the session after treatment (Session 2).

Conclusion: Visual exploration behavior decreased in sleep deprived subjects.

Visual Exploitation

The effect of sleep deprivation on the fixation duration depending on the session. No significant effects were found. Blue bars represent 24 control subjects without treatment, whereas red bars represent 21 subjects who had been sleep-deprived in the second session.

Conclusion: The fixations made by sleep deprived subjects took less time.

Comparison of viewing patterns between single subjects

Similarity of viewing behavior between all pairs of observers in the first (left) and the second (right) recording session assessed by an AUC value matrix. The color indicates how well observers predicted the viewing behavior of each other. The higher the value, the better the prediction. A value of 0.5 (shown in dark red) denotes prediction at chance level, whereas yellow indicates a better prediction. Observers are sorted according to their groups: control or sleep allowed subjects (SA) and sleep deprivation (SD) subjects. The blue line in the matrix represents the border of the groups.

Dendrogram of agglomerative hierarchical clustering of the similarity of viewing behavior between observers in the first (left) and the second (right) recording session. The height of the edges indicates the difference in viewing behavior. Red labels represent control or sleep allowed (SA) subjects, whereas green labels represent sleep deprivation (SD) subjects.

Conclusion: For the change in viewing patterns after sleep deprivation, there is a high variance between subjects.

CONCLUSION
Sleep deprivation has a unique biometric fingerprint on our attention and eye movement behavior, leading to less exploration behavior when examining an image. The degree of this change in viewing pattern varies across individual subjects.