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Introduction: Oculomotor tracking performance changes according to time awake and circadian phase following a distinct pattern of impairment. A constant routine study demonstrated that increasing time awake 1) reduces the precision of visual motion processing as evidenced by increased direction and speed noise, 2) decreases the gain and proportion of tracking that is smooth during steady-state closed-loop pursuit and 3) decreases the slope and intercept of peak saccadic velocity versus amplitude curves. Although these metrics also show circadian modulation, it is unclear what proportion of the impairment is due to circadian phase relative to homeostatic mechanisms. We aimed to determine the contribution of homeostatic sleep pressure on these oculometric changes by administering low-dose caffeine over one night of sleep deprivation.
Methods: Study participants completed two weeks of a stable schedule including 8.5 hours in bed at home, followed by a ~24-hour laboratory constant routine (CR) in semi-recumbent posture under < 4 lux of light. Isocaloric snacks were provided hourly. The visual tracking task was performed every two hours after waking and hourly overnight. We computed fourteen largely independent metrics of tracking performance, included those listed above. Low-dose caffeine of 0.3 mg/kg was administered hourly during the biological night.
Results: Nine participants (5F) completed the study. Caffeine dosing: 1) prevented the impairment of visual motion processing (no significant slope for speed or direction noise), 2) reduced by approximately half the impairment of closed-loop pursuit performance (gain, -0.47%/hr, significance of slope change: $p < 0.006$; proportion smooth, -0.35%/hr, $p < 0.005$), and 3) had an insignificant ($p > 0.39$) effect on the impairment of saccadic peak velocity (slope, -1.13%/hr; intercept, -0.62%/hr).
Conclusion: These results suggest that visual motion processing and some proportion of closed-loop pursuit performance are impaired due to homeostatic mechanisms during sleep deprivation.
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0227

THE ROLE OF CAFFEINE IN MITIGATING COGNITIVE DEFICITS DUE TO SLEEP DEPRIVATION

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Introduction: In a prior study, we found that sleep deprivation impaired memory maintenance in a procedural task. Caffeine benefits sustained attention under conditions of sleep deprivation; however, the extent to which caffeine helps higher-order cognition, such as memory maintenance, is unclear. Here, we investigated the extent to which caffeine affected sustained attention and memory maintenance in sleep-deprived individuals. We further examined how the timing of caffeine administration affected cognition.
Methods: In the evening, participants completed UNRAVEL, a measure of memory maintenance, and the Psychomotor Vigilance Task (PVT), a measure of sustained attention, and were randomly assigned to stay awake in the laboratory overnight or sleep at home. Sleep-deprived participants were randomly assigned to one of three groups (Sustained, Acute, or Placebo). Based on group assignment, participants received caffeine or placebo at three timepoints (00:30, 04:30, 08:30). The Sustained group received 100mg of caffeine at each timepoint. The Acute group received placebo during the first two timepoints and 200mg of caffeine at 08:30. The Placebo group received placebo at each timepoint. Rested participants received 200mg of caffeine or placebo at 08:30 when they returned. All participants then completed UNRAVEL and the PVT.
Results: Using a large sample (N=352), we replicated findings that sleep deprivation increased errors in UNRAVEL, particularly following interruptions-reflecting memory maintenance deficits. Sleep-deprived participants who received caffeine were more likely to perform to a criterion accuracy threshold that participants were instructed to maintain. However, in participants who maintained this threshold, caffeine did not mitigate memory maintenance deficits. For the PVT, sleep-deprived participants exhibited more lapses in attention; caffeine reduced lapses in sleep-deprived and rested participants. The Sustained and Acute groups did not differ on any measure.
Conclusion: Although, the effect of caffeine on higher-order cognition has been disputed in the literature, the current study suggests that caffeine is beneficial for sustained attention and less beneficial for higher-order cognition, particularly the maintenance of task-relevant representations. Thus, caffeine appears to have domain specific effects on cognition.
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0228

SLEEPINESS AND FATIGUE IN CADETS AT THE U.S. MILITARY ACADEMY: PRELIMINARY RESULTS FROM A 10-YEAR FOLLOW-ON STUDY

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Introduction: In 2003, a four-year longitudinal study was launched to assess Cadet sleep patterns in the United States Military Academy (USMA) Class of 2007. Results confirmed that Cadets received significantly less sleep than recommended for their age group. The present study is a follow-on to the 2003 research, and included two components: (1) a cross-sectional survey, and (2) a longitudinal study tracking the sleep of a representative sample of Cadets. We present the findings from the survey.
Methods: Cadets (N=857, 19% response rate) from all four classes completed the cross-sectional online survey in winter 2018. Survey questions focused on sleep-related behaviors, daytime sleepiness (Epworth Sleepiness Scale-ESS), sleep quality (Pittsburgh Sleep Quality Index-PSQI), and fatigue (Fatigue Severity Scale-FSS). Data from 726 Cadets were analyzed (median=21 years of age, ~71% males).
Results: The average ESS score was 10.5±3.93 with 363 (50.0%) Cadets reporting elevated daytime sleepiness (ESS score>10). The average PSQI score was 6.66±2.57 with 442 (64.1%) Cadets classified as poor sleepers (PSQI score>5). The average FSS score was 4.37±1.22 with 384 (69.7%) Cadets having an FSS score denoting elevated fatigue level (score>3). Approximately 30% of the Cadets scored high on all three questionnaires and ~87% reported

not having enough time to sleep. Cadets reported light (57.3%) and noise (52.5%) in their sleeping quarters as factors disrupting their sleep. Approximately 65% of the Cadets indicated drinking caffeinated beverages (energy drinks: ~13%). Adjusted for age/gender, morningness tendency was associated with lower sleepiness ($p<0.001$), better sleep quality ($p<0.001$), and lower fatigue ($p=0.004$).

Conclusion: Given the demanding and rigid daily schedule of Cadets, elevated sleepiness, fatigue, and poor sleep quality are endemic at USMA. Cadets with morning preferences reported less severe sleep-related problems. Improving habitability in sleeping quarters may reduce the disruptive effects of light and noise on Cadet sleep. The views expressed are those of the authors and do not necessarily reflect the official policy or position of the DoN, DoD, or the U.S. Government.

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0229

EXAMINING CHANGES IN SUBJECTIVE SLEEP QUALITY AMONG U.S. ARMY TANKERS BEFORE AND DURING A MISSION READINESS TRAINING EXERCISE

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Introduction: Sustained sleep restriction associated with military operations results in a large sample of individuals who present with insomnia-like symptoms. While units deploy and train together, unit hierarchy can result in group differences. Studying active-duty Soldiers presents the unique opportunity to examine how this organization can influence sleep in the larger group. In this analysis, we examine the variance in subjective sleep quality between groups.

Methods: 246 tankers from battalions within a brigade participated in a study planned around a mission readiness training exercise. Crewmen completed a baseline (T1) and retrospective (T2) survey capturing subjective sleep quality. Insomnia Severity Index (ISI) scores and subjective sleep duration from the Pittsburgh Sleep Quality Index (PSQI) were analyzed. Battalion differences within the brigade were tested using t-tests and analysis of variance (ANOVA).

Results: For sleep duration, Soldiers reported sleeping significantly less hours per night ($M=4.98$, $SE=0.23$) at T2 compared to T1 ($M=5.59$, $SE=0.10$), $t(118) = 2.52$, $p= 0.013$. At the battalion level, there was a significant interaction for sleep duration, $F(3, 115) = 6.34$, $p=0.001$. Battalions W, Y, and Z reported sleeping significantly less at T2 compared to T1. Conversely, Battalion X reported sleeping significantly less at T1 than T2. ISI severity of all crews indicated subthreshold insomnia, in which Soldiers reported significantly more sleep problems at T2 ($M=13.25$, $SE=0.89$) than T1 ($M=10.25$, $SE=0.72$), $t(143) = -2.98$, $p= 0.005$. Additionally, there was a significant interaction for the ISI among battalions, $F(3, 40) = 3.34$, $p=0.03$. Battalions W, Y, and Z reported significantly more sleep problems at T2 than T1. Battalion X reported significantly more sleep problems at T1 than T2.

Conclusion: Across the unit, tank crews reported restricted sleep and subthreshold insomnia symptoms prior to as well as during training despite battalion group differences. It is possible that sleep quality may impact mental health, group dynamics, leadership, and unit culture.

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0230

PREIMMUNIZATION WITH A NON-PATHOGENIC BACTERIUM MYCOBACTERIUM VACCAE NCTC11659 PREVENTS THE DEVELOPMENT OF CORTICAL HYPERAROUSAL AND A PTSD-LIKE SLEEP PHENOTYPE FOLLOWING SLEEP DISRUPTION PLUS ACUTE STRESS IN MICE.

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Introduction: Because regular sleep disruption can increase vulnerability to stress-related psychiatric disorders, there is a need to explore novel countermeasures to increase stress resilience after inadequate sleep. Immunization with heat-killed Mycobacterium vaccae NCTC11659 (MV), an environmental bacterium and immunomodulator, can increase resilience to chronic stress in mice. We therefore tested the hypothesis that MV immunization would prevent the negative impacts of five days of sleep disruption on stress-induced changes in sleep in mice.

Methods: 120 male C57BL/6N mice were implanted with EEG/EMG recording devices and given 3 weekly injections of either MV or vehicle before entering the experimental protocol (day 0). On days 1-5, sleep was disrupted by a slowly rotating bar, with an ad libitum sleep opportunity from ZT2-ZT6. At ZT4 of day 5, mice were exposed to a 1-hour episode of social defeat stress. Sleep recording continued for seven days after social defeat (day 12). Groups received just sleep disruption, just social defeat, both ('double hit'), or neither.

Results: In vehicle-treated mice receiving just social defeat, an increase in NREM delta (0.5-4Hz) power compared to baseline was observed during the post-stress dark period ($p=0.005$, Wilcoxon signed rank test). However, this was absent in mice receiving the double hit, who instead had elevated power in the high frequency beta (15-30Hz) power band in both NREM ($p=0.002$) and REM ($p=0.001$). Mice receiving the double hit also had increased REM and sleep fragmentation compared to controls for at least 6 days post-stress ($p<0.05$, ANOVA). NREM beta power immediately post-stress correlated with REM sleep disturbances 6 days later. MV preimmunization prevented all double hit-induced sleep disturbances.

Conclusion: These results suggest repeated sleep disruption may increase vulnerability to an acute stressor in part by shifting the adaptive increase in delta power to a maladaptive increase in beta power during post-stress sleep. Importantly, these data provide further evidence supporting microbiota-based countermeasures to promote health.