Navy Unmanned Maritime Systems Platoon Leadership Fatigue Level Negatively Impacts Platoon Performance During Expeditionary Mine Countermeasures Missions

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EXECUTIVE SUMMARY

Background and Approach

Navy Unmanned Maritime Systems (UMS) operators conducting expeditionary mine countermeasures (ExMCM) play a critical role in ensuring safe passage of the fleet. ExMCM operations are mentally and physically demanding, requiring UMS operators to sustain attention over long periods of time, contend with operating under various sea state conditions, and make accurate decisions under risk.

This report summarizes findings from a field study of a UMS platoon completing its Final Evaluation Event (FEE) during Basic Phase Assessment training. The FEE assesses the platoon's competency in completing tasks required for ExMCM operations (i.e., open water operations; mission planning; launching, monitoring, and recovering unmanned underwater vehicles; force protection; and post-mission analysis). There were two main aims of this field study: (1) test the feasibility of collecting useful physiological, cognitive, and performance data before, during, and after the FEE with the goal of obtaining a better understanding of the factors that need to be considered for fatigue countermeasures, and (2) provide a descriptive analysis of how individual and platoon changes in fatigue levels and sleep quality throughout the FEE relate to performance errors.

Key Findings

- The platoon's Leading Chief Petty Officer was compromised due to extreme fatigue, which had an outsized negative impact on platoon performance despite lower ranking platoon members maintaining alertness scores well within the range of normal tolerances.
- The platoon's average alertness score was significantly lower during the FEE compared with the pre-FEE baseline.
- There was slight, yet clinically relevant, evidence of sleep loss during the FEE. Both pre-FEE and FEE total sleep times were <7 hours, which is the recommended amount of sleep per night to recover to the adequate levels of alertness necessary for carrying out tasks without errors. Sleep efficiency and quality actually improved during the FEE, largely driven by the lower ranked platoon members.

Conclusions

Platoon leadership plays a critical role in UMS mission performance and ExMCM. Our results suggest that platoon leaders should especially monitor and take measures to address their personal fatigue state to ensure that their fatigue levels do not have a negative impact on the platoon's overall performance. UMS operators were able to obtain adequate levels of sleep despite the presumed relatively high operational tempo of the FEE. However, alertness scores suffered, indicating that the acute mental and physical demands of the operations likely account for the observed decrements in alertness. These results suggest that platoon configuration and task management are important factors to consider to ensure mission success.

To the extent that it is possible, platoons should aim to distribute tasks and responsibilities, including appropriate delegation of minor leadership roles, as a measure to protect against mission performance errors. UMS training should incorporate explicit guidance on platoon configuration management, manning, and leadership delegation strategies to adequately prepare platoons to adapt when leadership decision making is likely to be compromised due to fatigue.

Introduction

The operational conditions experienced by Navy Unmanned Maritime Systems (UMS) operators performing expeditionary mine countermeasures (ExMCM) missions are fertile grounds for fatigue. Fatigue negatively impacts performance and is experienced as a feeling of exhaustion, low mood, lethargy, an unfocused mental state, and an unpleasant bodily state (Hockey, 2013). ExMCM missions can unfold over many hours, and platoon configurations can require the same individual to complete physically and mentally demanding tasks while underway and shoreside. Critically, the consequences of poor decision making at any stage of ExMCM operations can induce high levels of stress, which need to be properly mitigated. Given that errors, such as missing mine-like objects during post-mission analysis (PMA), could cause catastrophic damage and losses, interventions and insights that promote behavioral stability, flexibility, and teamwork in the face of fatigue are of great value to UMS operators.

Training, expertise, and group dynamics can guard against fatigue during demanding UMS operations. All UMS operators have standardized schooling before becoming members of platoons. However, there is a range in levels of expertise within the platoons, which is often influenced by time on the job, and in areas of expertise, which are influenced by variations in rates (e.g., Minemen, Electronics Technicians, Aerographer's Mates, Operations Specialists). Experts are often better at simplifying problems and organizing knowledge in ways that help retain specific elements required to solve the problem (Egan & Schwartz, 1979; Jacobson, 2001; Lesgold et al., 1988; Stylianou & Silver, 2004). Experts are particularly capable at (a) identifying key organizing principles and goals associated with problems (Chi et al., 1984; Hmelo-Silver & Pfeffer, 2004), (b) searching more extensively and more deeply than novices (Campitelli & Gobet, 2004), and (c) extracting meaningful patterns in complex environments (Bransford et al., 1989; Chase & Simon, 1973). Furthermore, experts exhibit less brain activity in carrying out tasks compared with novices, suggesting that experts require less cognitive resources than novices to solve the same tasks (Callan & Naito, 2014; Kim, 2015).

Teamwork is also integral to ExMCM operation success. UMS platoon members not only vary in their level of proficiency across ExMCM tasks, but also in their personalities and motivations. Platoon leadership must be able to dynamically balance, coordinate, and synchronize platoon member contributions to meet the ever-changing demands of the mission (e.g., Zaccaro et al., 2001; Kane et al., 2002). This includes scheduling when the platoon can rest in addition to more standard leadership responsibilities like operational planning, manning, and resource management. Platoon leadership's ability to employ strategies to manage these critical mission and group dynamic factors can go far in mitigating platoon member fatigue, which is commonly exacerbated by performance inefficiencies.

Statement of Problem

While we understand conceptually the factors that may impact UMS operations, to date, there is a lack of research that adequately characterizes the mental and physical demands placed on UMS operators during ExMCM operations. This study is a first step toward providing the ExMCM community with insights that can be used to identify fatigue decrements and countermeasures, training, and standard operating procedures that will ensure higher rates of operational success. The current field study serves as a proof of concept that cognitive and physiological data can be gathered in the context of the Final Evaluation Event (FEE) to afford greater insights into the specific demands experienced by operators. Given the relatively high operational tempo of the FEE, we hypothesized that operator alertness and sleep would decline during the FEE compared with the pre-FEE baseline period. Additionally, we explored how individual- and platoon-level changes in fatigue and sleep quality throughout the FEE relate to performance errors.

Conclusions and Recommendations

Platoon leadership (i.e., the Leading Chief Petty Officer [LCPO]) fatigue state had a large influence on the success of the platoon. Unmanned underwater vehicle (UUV) mission planning, operation, and PMA errors were most frequent between 48 and 60 hours into the FEE (Day 3; see Figure 2). During this time, the LCPO's alertness score, determined from the ReadiBand™ wristband (Fatigue Science, Vancouver, BC, Canada), fell below 40, indicating that the LCPO experienced very high levels of fatigue, which likely impacted their ability to effectively task and manage members of the platoon. At the same time, all other members of the platoon (E3–E6) maintained alertness scores at or above 70, which is the threshold between reduced and low alertness (see Analysis Strategy section for a description of alertness zones). Given the role of the LCPO in the platoon, it is likely that fatigue changed the way the LCPO led in this context, which, in turn, negatively impacted the platoon's ability to perform. Moreover, the steady decline of the LCPO's alertness score throughout the FEE, which plateaued at an extreme level without any periods of recovery, further suggests that the LCPO may have felt it necessary to take on a larger share of the tasks and responsibilities to ensure the success of the platoon. However, this approach was counterproductive and reflects a potential lack of confidence in the platoon members' abilities to perform. A critical takeaway from these results is that it is important for key platoon leadership to actively monitor and address their personal fatigue levels, in addition to their platoon members' fatigue levels, as their personal fatigue has an outsized impact on platoon performance.

This study also revealed that while alertness scores decreased steadily throughout the FEE (see Figure 2), many key indicators of sleep quality improved (see Table 1). This finding is surprising given the relatively high operational tempo of the FEE and sporadic times at which the platoon was tasked. However, it is not uncommon for sleep quality and efficiency to improve under conditions of slightly greater stress. That is, it is likely that once operators had the opportunity to sleep, their sleep was deeper and more efficient, as evidenced by fewer waking episodes once asleep (Cerasuolo et al., 2020; Kredlow et al., 2015). These findings suggest that UMS operators get the most out of their sleep when given the opportunity. However, it is important to note that the amount of sleep they are getting (<7 hours) does not result in recovering to adequate levels of alertness necessary for carrying out tasks without errors.

In summary, this study demonstrates that it is possible to gather physiological, cognitive, and performance data that can inform the development of fatigue mitigation strategies in the context of ExMCM operations. We further found that the LCPO's disproportionate impact on the platoon's alertness score is representative of the real impact key leadership has on platoon performance. The greatest frequency of errors occurred when the LCPO's alertness score was below 40 and the rest of the platoon's alertness was >70. Thus, it is possible that when key platoon leadership's performance was compromised due to extreme fatigue, the entire platoon suffered despite their individual alertness scores remaining well within the range of normal tolerances of fatigue. More observational data that include which individuals were assigned to perform what tasks and who was responsible for tasking assignments are required to further understand the relationship between leadership fatigue, platoon fatigue, and platoon performance. Still, without additional data, it is reasonable to draw the connection between the LCPO's fatigue state and the greater frequency of documented errors 48 and 60 hours into the FEE.

Methodology

Sample

Nine Navy UMS operators (three women, six men; mean age = 28 years *SD* = 6.12, rank range = E3–E7) from the same platoon volunteered to participate in this study. The platoon was composed of Electronics Technicians, Machinist Mates, and Minemen. Volunteers were not compensated for their participation in this study.

FEE Data Collection Methods

The study was conducted at Explosive Ordinance Disposal Training and Evaluation Unit One (EODTEU1) at Naval Base Point Loma in San Diego, California. All procedures were reviewed and approved by the Naval Health Research Center Institutional Review Board (protocol #NHRC.2019.0006).

The Basic Phase Assessment is a 15-week training program, the final week of which is dedicated to the FEE. Three days prior to the FEE, participants were briefed on the field study aims and procedures and provided informed consent. Participants then engaged in a battery of five computer-based tasks assessing baseline attention control. Performance across these tasks was used to generate an attention control composite score to compare this platoon's attention control abilities and those of a benchmark group of UMS operators. Participants were given a ReadiBand to wear for the duration of the study that gathered actigraphy to compute fatigue and sleep variables, such as alertness scores, total sleep time, sleep quality, sleep latency, wake episodes during sleep, and sleep efficiency. ReadiBand data for the 3 nights prior to the FEE were used to establish baseline fatigue and sleep metrics for each participant. Participants were told to always wear the wristband except for when charging the device or engaging in water or other activities hazardous to the ReadiBand.

The 5-day FEE consisted of seven missions, tasked by instructors, that varied in duration and scope. These missions consisted of planning ExMCM missions, going underway to deploy UUVs, conducting PMA of vehicle data, and maintaining and fixing mission-critical equipment. Throughout the FEE, instructors kept a timeline of all critical events and assessed mission performance and errors. At the end of the FEE, experimenters collected the participants' ReadiBands to obtain their fatigue and sleep data.

Tasks and Measures

Attention control is the ability to regulate information processing in the service of goal-directed behavior (Burgoyne & Engle, 2020). The attention control battery (von Bastian et al., 2020) administered to participants consisted of the Antisaccade, Psychomotor Vigilance, Go/No-Go, Flanker, and Stroop Switch tasks. These tasks were used together to establish a comprehensive measure of an individual's attention control abilities.

For the Antisaccade task, a distractor (a flashing asterisk) appeared either to the left or the right of a central fixation cross immediately by briefly presented target "Q" or an "O" on the *opposite* side of the screen from the asterisk. Participants were instructed to look away from the asterisk to the other side of the screen to identify the target letter. Participants were scored based on the proportion of trials in which they successfully identified the target letter.

For the Psychomotor Vigilance Task, participants were shown a constant stimulus (i.e., a row of zeros within a yellow box in the center of the screen) for a variable time. Participants were asked to respond as quickly as possible by pressing the space bar as soon as the stimulus display begins to count up. Participants were scored based on their ability to consistently respond quickly to the display counting up throughout the task.

For the Go/No-Go task, participants were instructed to press a key when a blue circle appeared and withhold a response when an orange circle appeared. The orange circles appeared less frequently during the task. Participants were scored on their accuracy on the No-Go trials.

For the Flanker task, participants saw a row of arrows and were asked to identify the central arrow while ignoring the flanking arrows. In an incongruent trial, the central arrow and the flanking stimuli afforded a different response (i.e., >><>> or <<><<). In a congruent trial, they afforded the same response (i.e., >>>>> or <<<<<). Participants were scored on their response times for correct responses.

Lastly, for the Stroop Switch task, participants were asked to alternate between two tasks: either naming the ink color of a color word or naming the color word itself. Participants were cued to which task to complete based on whether a square was presented around the stimulus. If a square appeared around the color word, then participants had to respond with naming the color word. If no square appeared around the word, then participants had to respond with the ink color of the color word. Furthermore, ink color/word pairing were either congruent ("red" presented in red ink) or incongruent ("red" presented in green ink). Participants either switched between tasks across consecutive trials (switch trials) or repeated the task (repetition trials). Participants were scored on their response times.

In addition to the ReadiBand and attention control battery data, time-stamped operational performance data from instructors, including mission tasking, technical errors, and operator errors that occurred throughout the FEE, were obtained. For the purposes of this study, only the time-stamped operator error data were used to identify important time periods during the FEE to compare with the ReadiBand fatigue and sleep data.

Analysis Strategy

Performance on each computer-based attention control task was normalized then summed to create an attention control battery composite score. Higher attention control battery composite scores indicate an individual has greater attention control abilities compared with other individuals. Two UMS operators were excluded from the attention control battery analysis because they did not complete all the attention control tasks. Baseline attention control battery composite scores were also calculated for a group of 27 Navy UMS operators who took part in a separate in-lab study that assessed performance on a PMA task over a 24-hour wakeful period. These data were used as a benchmark comparison to establish whether the platoon that took part in the FEE was representative of the larger UMS community on attention control.

ReadiBand variables included alertness scores, estimated time asleep, sleep efficiency, sleep quality, sleep latency, and wake episodes. Sample averages and standard deviations were calculated for each relevant fatigue and sleep metric. Alertness scores were determined by the Fatigue Science SAFTE™ (Sleep, Activity, Fatigue, and Task Effectiveness) Model, a validated fatigue scoring algorithm (Hursch et al., 2004). Alertness scores >90 are optimal. Alertness scores between 70 and 90 are considered reduced and indicate reaction times may be slowed by up to 34% relative to a well-rested baseline. Alertness scores <70 are considered low and indicate reaction times may be slowed up to 100% relative to a well-rested baseline. Estimated time in sleep (sleep duration) is determined by Fatigue Science's sleep scoring algorithm. It is recommended that adults over the age of 18 obtain 7 or more hours of sleep per 24 hours to maintain optimal health and performance. Sleep efficiency is the percentage of time in bed sleeping relative to the total time in bed, with higher percentages indicating more restful and less fragmented sleep. Sleep efficiency is considered the most useful and accurate indicator of sleep quality, and values >85% are considered good. Sleep quality is determined by combining awakenings per hour of sleep and the time lost to awakenings. These two metrics are combined to generate a sleep quality score on a 1–10 scale. A sleep quality score >8 is considered good. Sleep latency is the time it takes to transition from wake to sleep. A sleep latency <30 minutes is considered good. Wake episodes is the number of times the participant wakes after falling asleep that are >5 minutes in duration. Sleep and fatigue metrics gathered no more than 3 days prior to the FEE were used as a baseline to compare against data collected during the FEE. Alertness scores gathered throughout the FEE were also used to visualize the relationship between changes in operator fatigue state and documented errors.

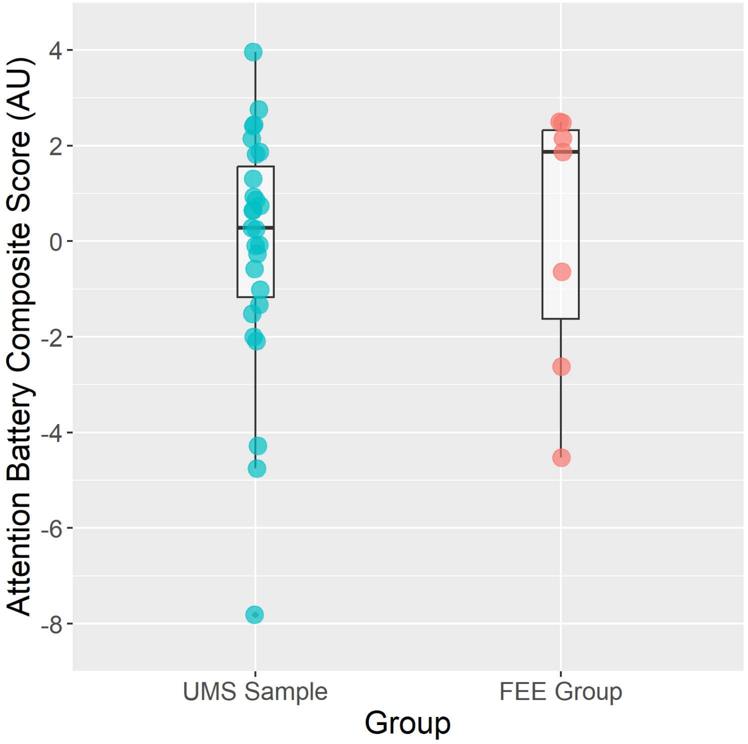
Results

Attention Control Performance Comparison to Benchmark Sample

A Welch two sample t test comparing attention control battery composite scores between the UMS platoon that participated in the FEE ($M = 0.17$, $SD = 2.83$) and the benchmark group ($M = -0.10$, $SD = 2.53$) revealed no significant differences, $t(8.66) = -0.23$, $p = 0.82$. Figure 1 depicts the distribution of attention control battery composite scores for the FEE and benchmark groups. Although there were only seven operators in the FEE group with attention control battery data, Figure 1 shows that these operators have similar attention control abilities to the benchmark group. Thus, while the sample size of this study is small, the sample is representative of the larger UMS operator community.

Figure 1

Comparison of Attention Control Battery Composite Scores Between Final Evaluation Event (FEE) and Benchmark UMS Operators



Note. FEE Group = FEE UMS operators, UMS Sample = Benchmark group. Box plots specify the median (thick bar), first and third quartiles (range of box), and range of non-outlier values (whiskers). Individual circles are individual participant's scores. Attention control battery composite scores are in arbitrary units (AU), and higher scores indicate greater attention control abilities (see Analysis Strategy section for description of unit calculation).

Alertness Declines While Sleep Improves During the FEE

Paired *t* tests comparing pre-FEE baseline and FEE average alertness, time asleep, sleep efficiency, sleep quality, sleep latency, and wake episodes were performed to identify specific sleep and fatigue factors that were impacted by engaging in the FEE (see Table 1 for means and standard deviations of all Fatigue Science metrics). This analysis revealed that alertness scores declined as a function of participating in the FEE compared with the pre-FEE baseline, $t(5) = 3.12$, $p = 0.02$, $d = 1.27$. Interestingly, there was no statistically significant difference in sleep loss between the pre-FEE baseline period and the FEE, $t(6) = 0.33$, $p = 0.70$. However, there was a difference of 28.8 minutes in average time asleep between pre-FEE and FEE, which is close to the amount of sleep loss considered clinically relevant (30 minutes) (Cepeda et al., 2016). Additionally, both pre-FEE and FEE average time asleep were less than the recommended 7 hours of sleep per night (Watson et al., 2015). Sleep efficiency and sleep quality improved during the FEE, $t(6) = -3.15$, $p = 0.01$, $d = 1.19$ and $t(6) = -2.61$, $p = 0.03$, $d = 0.98$, respectively. It did not take operators more time to fall asleep during the FEE, $t(6) = -1.25$, $p = 0.25$, although once asleep, there were fewer wake episodes, $t(6) = 2.66$, $p = 0.03$, $d = 1.01$.

Table 1

Final Evaluation Event (FEE) Platoon Actigraphy Sleep Measures

	Alertness		Time asleep		Sleep efficiency		Sleep quality		Sleep latency		Wake episodes	
Time period	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pre-FEE ($n = 7$)	92.7	6.15	6.52	1.57	83.34	5.24	5.78	2.37	15.14	3.52	4.57	2.79
FEE ($n = 9$)	70.96	16.39	6.04	0.92	87.25	3.94	7.31	1.39	18.44	7.33	2.37	1.34

Note. Averages and standard deviations of alertness and sleep variables were gathered by the ReadiBand prior to and during the FEE. Alertness was determined using the Fatigue Science SAFTE Model scoring algorithm (see Analysis Strategy section for interpretation of alertness score and sleep variables).

Increased Platoon and Leadership Fatigue Coincides With Greater Frequency of Errors

Figure 2 shows changes in individual UMS operator alertness scores throughout the FEE (individual lines colored by rank) in addition to the platoon's average changes in alertness (thick black line). Documented errors are marked by red vertical dashed lines labeled to correspond with the error details featured in Table 2. The red horizontal line at the alertness score of 70 is a visual aid to mark the threshold between reduced and low alertness as determined by the SAFTE Model. When individual and group lines dropped below this threshold, operators were in a fatigue state analogous to having a blood alcohol concentration (BAC) >0.08%. The four dark shaded regions spanning ~10 hours represent transitions to sunset and sunrise for each day of the FEE. The black solid vertical lines mark the official start and end of the FEE.

Throughout most of the FEE, the platoon (thick black curve) stayed above the alertness threshold of 70, and only dipped below this threshold at ~83 hours into the FEE. However, when the platoon's average alertness approached and then maintained a score of 75 (~48–60 hours into FEE; Day 3), there was a greater frequency of documented UUV mission planning, operation, and PMA errors (five total errors). It is noteworthy that during this time period, the LCPO's alertness score dropped below 40 and continued to decline. For reference, an alertness score <60 is equivalent to having a BAC >0.11% and a reaction time slowed by 100%. The LCPO's alertness score pulled the platoon average score toward 75 even though the rest of the platoon's alertness scores stayed above threshold between ~48–60 hours into the FEE.

Table 2

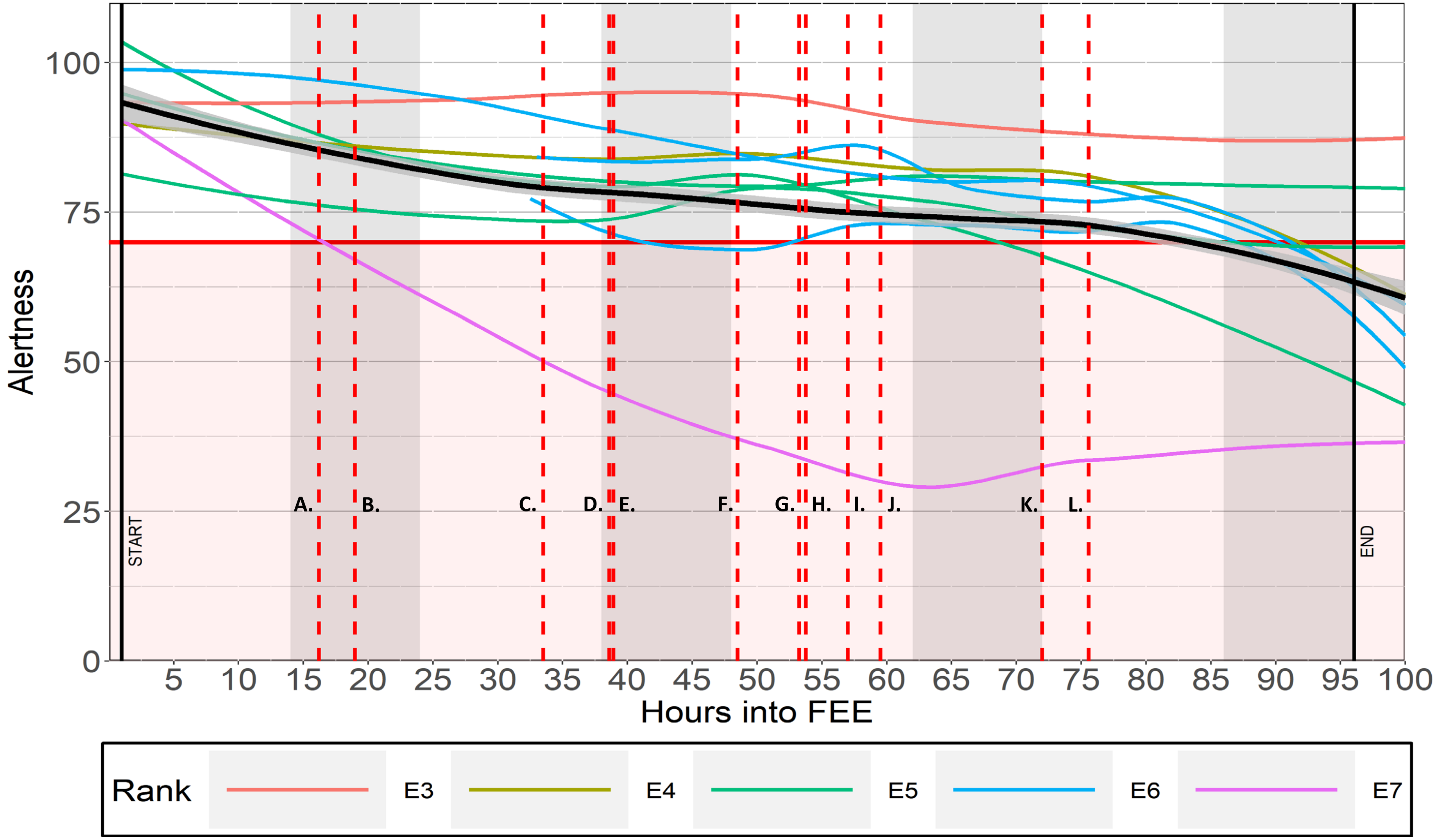
Final Evaluation Event (FEE) Documented Platoon Errors

Label	Error category	Day of FEE	Time	Hours into FEE	Summary of documented errors
A.	UUV mission	1	2225	16.4	Failure to accomplish UUV clearance for shore turnaround. No Chart Study. Reports lack detail even after prompting.
B.	PMA	2	0100	19	Incorrect labeling and confidence call of MILCOs.
C.	Planning	2	1530	33.5	Inaccurate SMEAC.
D.	UUV mission	2	2036	38.6	Missed timeline to recover UUV.
E.	UUV mission	2	2055	38.9	Missed timeline to recover UUV.
F.	Planning	3	0630	48.5	No India RI tasking in brief.
G.	PMA	3	1115	53.2	PMA operator confused MILCO target detection signatures in sonar data.
H.	Planning	3	1145	53.7	Operator confused about presented data during targeting brief.
I.	Planning and UUV mission	3	1500	57	Improper Q-route mission planning. Missing PIM. No GETAC shadow files on mission. Pre-mission sheets incomplete.
J.	Planning	3	1732	59.5	Delayed UUV launch.
K.	Planning	4	0600	72	PMD delayed awaiting completion of PMAs.
L.	UUV mission	4	0935	75	11m RHIB unmanned and floating in channel.

GETAC, laptop; MILCO, mine-like object; PIM, plan of intended movement; PMA, post-mission analysis; PMD, post-mission debrief; RHIB, rigid-hull inflatable boat; RI, request for information; SMEAC, Situation, Mission, Execution, Adminstration and Logistics, Command and Signal; UUV, unmanned underwater vehicle.

Figure 2

Alertness Scores as a Function of Time (in Hours) Into the Final Evaluation Event (FEE)



Note. Operator alertness scores are color coded by rank (E3–E7). The black vertical lines mark the start and end of the FEE. The black curve depicts the platoon's average alertness over time. Vertical dark shaded boxes spanning ~10 hours indicate sunset to sunrise transitions between days. The red vertical dashed lines mark time points of documented errors throughout the FEE. See Table 2 for specific details of documented errors.

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Acronyms and Abbreviations

BAC – blood alcohol concentration

EODTEU 1 – Explosive Ordinance Disposal Training and Evaluation Unit One

ExMCM – expeditionary mine countermeasures

FEE – Final Evaluation Event

LCPO – Leading Chief Petty Officer

PMA – post-mission analysis

UMS – Unmanned Maritime Systems

UUV – unmanned underwater vehicle

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14. ABSTRACT

Navy Unmanned Maritime Systems (UMS) operators conducting expeditionary mine countermeasures (ExMCM) play a critical role in ensuring safe passage of the fleet. ExMCM operations are mentally and physically demanding, requiring UMS operators to sustain attention over long periods of time, contend with operating under various sea state conditions, and make accurate decisions under risk. This report summarizes findings from a field study of a UMS platoon completing its Final Evaluation Event (FEE) during Basic Phase Assessment training. The FEE assesses the platoon’s competency in completing tasks required for ExMCM operations (i.e., open water operations; mission planning; launching, monitoring, and recovering unmanned underwater vehicles; force protection; and post-mission analysis). The platoon’s Leading Chief Petty Officer was compromised due to extreme fatigue, which had an outsized negative impact on platoon performance despite lower ranking platoon members maintaining alertness scores well within the range of normal tolerances. The platoon’s average alertness score was significantly lower during the FEE compared with the pre-FEE baseline. There was slight, yet clinically relevant, evidence of sleep loss during the FEE. Both pre-FEE and FEE total sleep times were <7 hours, which is the recommended amount of sleep per night to recover to the adequate levels of alertness necessary for carrying out tasks without errors. Sleep efficiency and quality actually improved during the FEE, largely driven by the lower ranked platoon members. Platoon leadership plays a critical role in UMS mission performance and ExMCM. Our results suggest that platoon leaders should especially monitor and take measures to address their personal fatigue state to ensure that their fatigue levels do not have a negative impact on the platoon’s overall performance. UMS operators were able to obtain adequate levels of sleep despite the presumed relatively high operational tempo of the FEE. However, alertness scores declined, indicating that the acute mental and physical demands of the operations likely account for the observed decrements in alertness. These results suggest that platoon configuration and task management are important factors to consider to ensure mission success. To the extent that it is possible, platoons should aim to distribute tasks and responsibilities, including appropriate delegation of minor leadership roles, as a measure to protect against mission performance errors. UMS training should incorporate explicit guidance on platoon configuration management, manning, and leadership delegation strategies to adequately prepare platoons to adapt when leadership decision making is likely to be compromised due to fatigue.

15. SUBJECT TERMS

Unmanned Maritime Systems, Expeditionary Mine Countermeasures, Fatigue, Training, Leadership

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