A PILOT STUDY OF TEAM COMMUNICATION IN SIMULATED NAVY WATCH SCHEDULES

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INTRODUCTION

Cooperation and effective communication are crucial for success in command, control, and communication (C3) settings such as military missions. In around-the-clock military operations, sleep opportunities tend to be limited, and sleep loss and circadian misalignment are common. This results in fatigue,[1] and C3 performance may suffer.

We assessed the team communication component of C3 performance in simulated Navy watch schedules using C3Fire, a computer-based team performance simulation in which team members must work together through effective communication in order to extinguish simulated forest fires.[2] C3Fire is a microworld, a low-fidelity simulation that allows for a high amount of control in the simulated environment and enables detailed monitoring of team interactions.[3]

In this pilot study, subjects were randomly divided into teams of four, which were assigned to one of two US Navy watch schedules. Each team completed the C3Fire task multiple times over four simulated watch days, for a total of 14 task sessions. We examined the evolution of communications across the watch days in the four teams.

METHODS

Three teams of four men and one team of three men (subjects' ages: 18–29) completed the study. All subjects were healthy civilians with no previous firefighting experience. Teams were in the laboratory continuously for 6 days (5 nights). The first day was considered an adaptation day. The next four days involved simulated watch standing ("watch days"), as described below. The last day provided an opportunity for recovery sleep.

Two Navy watch schedules were simulated in the laboratory. The 5/15 schedule rotates backward through watch periods with 5 hours on, 15 hours off watch. The 3/9 watch schedule cycles through watch periods with 3 hours on, 9 hours off watch, keeping the same alignment to the clock each day. In both the 5/15 and 3/9 watch schedules, four watch sections alternate to cover the 24 hours of the day. For each schedule, the two watch sections that were maximally out of alignment with each other were simulated. See Figure 1.

Each team was assigned to one of the four simulated Navy watch sections shown in Figure 1. During watches, which were 6 hours total on average during each watch day, subjects were engaged in a range of cognitive performance tasks. During other periods of scheduled wakefulness, they ate meals and were kept busy with other simulated duties. Sleep was restricted to 6.5 hours per day in all watch sections. In the two 5/15 watch sections, the sleep opportunity was split on watch day 4 (in the 5/15-A section) or watch d 2 (in the 5/15-B section). In the 3/9 watch sections, the sleep opportunity was either always split (in the

3/9-S section) or consolidated (in the 3/9-C section). The teams assigned to the 5/15-A and 5/15-B watch sections were in the laboratory at the same time. The teams assigned to the 3/9-S and 3/9-C watch sections were also in the laboratory at the same time.

Subjects were teamed up on the first day of the study, with no leaders assigned to any of the teams. The teams practiced the C3Fire task during the adaptation day (data not analyzed) and performed multiple sessions of the task during watches – one 2-hour block each day (see Figure 1). The C3Fire sessions required team members to work together to manage and deploy resources (fire trucks, water, etc.) to put out simulated forest fires. Each session lasted approximately 30 minutes, and sessions progressively increased in difficulty.

During C3Fire sessions, team members communicated by means of instant messages only. Messages sent between team members were coded for message tone (friendly, casual, abrupt), puerile speech, and leadership. Sessions with ambiguous messages were replayed and viewed for interpretation. All messages were coded by the same researcher, who was not directly involved in conducting the C3Fire sessions during the study.

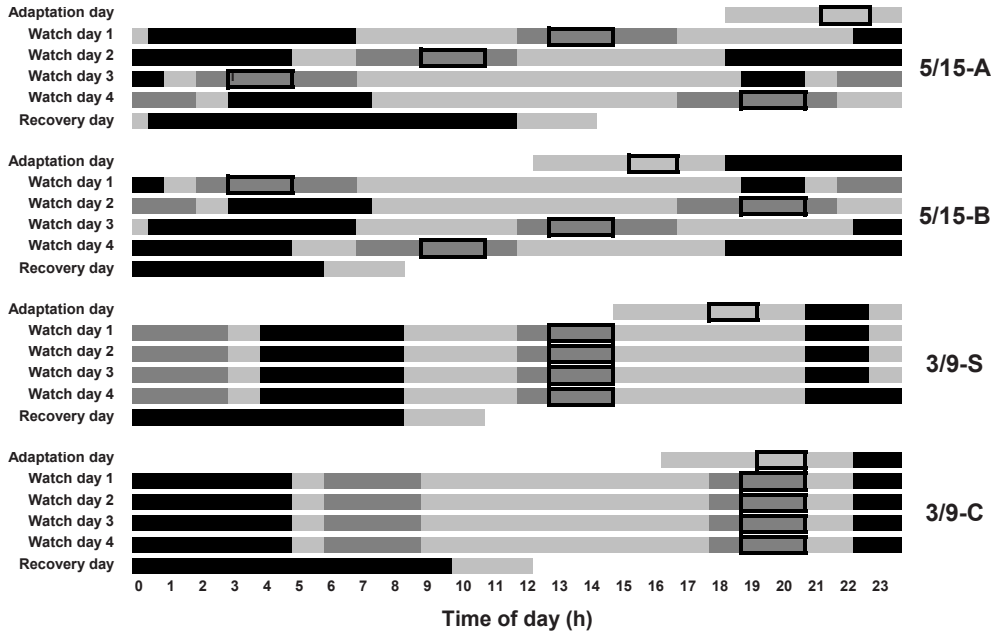

Figure 1. Schematic of the study design showing each of the four Navy watch sections simulated in the laboratory. Within each watch section, days progress from top to bottom and time of day progresses from left to right. Black bars represent scheduled sleep opportunities, dark gray bars indicate periods of watch standing, and light gray bars represent other periods of scheduled wakefulness. The C3Fire task was performed at the times indicated by the black outlined boxes.

RESULTS AND DISCUSSION

A total of 2,281 messages were exchanged. Teams on the 3/9 schedule exchanged significantly more messages than teams on the 5/15 schedule, especially during the first two watch days (χ^2_3=47.67, p<0.001), as shown in Figure 2. This substantial difference precludes

a head-to-head comparison of message tone and type between the teams on the two schedules. Instead, data were pooled across the two schedules and analyzed by watch day. There was a change in message tone across watch days (χ^2_6=92.6, p<0.001). As shown in Figure 3 (left), casual and abrupt messages decreased across watch days, whereas friendly messages increased considerably after the first day. Furthermore, as shown in Figure 3 (right), puerile messages increased (χ^2_3=134.6, p<0.001) and leadership messages decreased (χ^2_3=12.3, p=0.006) across watch days.

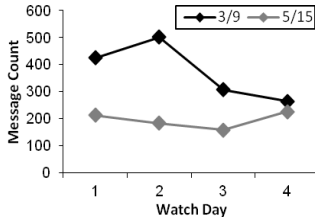

Figure 2. Total number of messages exchanged across watch days for teams on the 3/9 and 5/15 watch schedules.

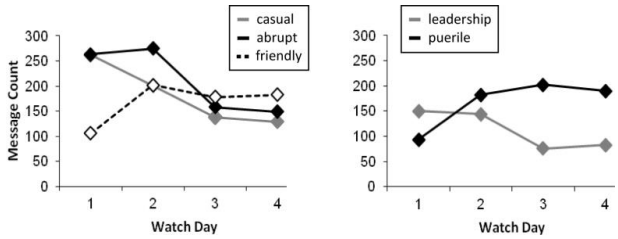

Figure 3. Evolution of casual, abrupt and friendly message tone (left) and evolution of leadership and puerile messages (right) across watch days.

Navy watch schedules that result in greater circadian misalignment are associated with poorer sleep quality, degraded psychomotor vigilance performance, greater subjective fatigue, and negative mood.[1] Data from the present pilot study suggest that fatigue from sleep loss and circadian misalignment in Navy watch schedules may also influence team communication. Whereas team cohesiveness may grow, as indicated by increases in friendly messages and decreases in casual and abrupt messages, team effectiveness might suffer, as suggested by a shift from leadership to more puerile communication. Although no leaders were specifically assigned to any of the teams, there was a pattern of leadership that initially emerged in each of the teams, which seemed to dissipate over time.

Fatigue has been associated with increased social loafing[4] – the phenomenon that individuals tend to put in less effort on a task when in a group.[5] Fatigue-induced social loafing may partially explain why message count overall, and leadership messages in particular, decreased over watch days in the present study. Previous research involving a command and control simulation documented an association between sleep loss and increased message processing time.[6] This effect may also have contributed to the general decline in message count in the present study.

Since subjects were first teamed up on the adaptation day, it is possible that the communication changes seen across watch days were partly due to subjects becoming more

familiar with each other. The majority of simulated duties performed during the study involved subjects operating independently. However, in addition to the C3Fire sessions, subjects also spent meal times together and played team-building games with each other every day. These activities may have promoted team cohesiveness and could account for the increase in puerile communication across watch days. The laboratory study simulated a typical Navy environment, in which this effect may be relevant as well.

This experiment was a pilot study of team communication with 15 subjects comprising 4 teams. Team composition and team member personalities determine team effectiveness and may have influenced team communication.[7] Such sources of variance were not controlled here. From these limited pilot data, it is not possible to attribute the observed difference in the number of messages exchanged between the 5/15 and 3/9 schedules to the watch schedules. Even so, this pilot study shows that evaluating team performance in laboratory simulated watch schedules is feasible.

CONCLUSIONS

This pilot study of C3 performance in simulated Navy watch schedules suggested that fatigue from sleep loss and circadian misalignment may affect team communication. While team cohesiveness may grow over time under these conditions, team effectiveness may suffer. Field research is needed to examine whether fatigue may degrade team effectiveness in real-world C3 operations.

ACKNOWLEDGMENTS

We thank the staff of the Sleep and Performance Research Center at Washington State University for their help with conducting the study. This research was supported by Naval Postgraduate School award N62271-13-M-1228.

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