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Fatigue proofing: The role of protective behaviours in mediating fatigue-related risk in a defence aviation environment

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ABSTRACT

In the military or emergency services, operational requirements and/or community expectations often preclude formal prescriptive working time arrangements as a practical means of reducing fatigue-related risk. In these environments, workers sometimes employ adaptive or protective behaviours informally to reduce the risk (i.e. likelihood or consequence) associated with a fatigue-related error. These informal behaviours enable employees to reduce risk while continuing to work while fatigued. In this study, we documented the use of informal protective behaviours in a group of defence aviation personnel including flight crews. Semi-structured interviews were conducted to determine whether and which protective behaviours were used to mitigate fatigue-related error. The 18 participants were from aviation-specific trades and included aircrew (pilots and air-crewman) and aviation maintenance personnel (aeronautical engineers and maintenance personnel). Participants identified 147 ways in which they and/or others act to reduce the likelihood or consequence of a fatigue-related error. These formed seven categories of fatigue-reduction strategies. The two most novel categories are discussed in this paper: task-related and behaviour-based strategies. Broadly speaking, these results indicate that fatigued military flight and maintenance crews use protective 'fatigue-proofing' behaviours to reduce the likelihood and/or consequence of fatigue-related error and were aware of the potential benefits. It is also important to note that these behaviours are not typically part of the formal safety management system. Rather, they have evolved spontaneously as part of the culture around protecting team performance under adverse operating conditions. When compared with previous similar studies, aviation personnel were more readily able to understand the idea of fatigue proofing than those from a fire-fighting background. These differences were thought to reflect different cultural attitudes toward error and formal training using principles of Crew Resource Management and Threat and Error Management.

1. Introduction

Fatigue is a significant threat to the safety of employees and organisational productivity (for a recent review of this issue see Gander et al., 2011). Defence is an obvious example of a work environment in which elevated levels of fatigue are often unavoidable especially in those undertaking active service (e.g. Murphy, 2002). Given the impracticality of working time regulation as the primary risk mitigation strategy, it would seem likely that defence force personnel have supplemented formal approaches (i.e. documented in the fatigue risk management policy) with informal methods (i.e. undocumented) for managing fatigue-related risk. Recent research has identified the existence of informal 'fatigue-proofing' strategies in a variety of industries (Dawson et al., 2012) where the restriction of working time arrangements is difficult or impractical. In this study, we have extended earlier work and interviewed army aviation personnel to identify self-reported examples of informal 'fatigue-proofing' strategies used to mitigate the fatigue-related risk associated with their operational environment.

2. Method

2.1. Participants

The 18 participants in this study had worked within a defence aviation unit for a period of at least six months during 2012–2013. Consequently, all participants had an appreciation of the unit's high workload and long hours. The participants were drawn from the Australian Army Aviation division. Prior to interview, participants read an information booklet describing the project and

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Table 1
Categorisation of the fatigue proofing strategies identified by participants.

Category number	Informal fatigue-proofing strategy	Count	%
1	Task-related strategies	49	33
2	Use of caffeine/energy drinks, food or water	30	20
3	Behaviour-based strategies e.g. communica-tions/interaction/supervisory mode	24	16
4	Alternative activities including opportunistic rest or exercise	21	14
5	Strategic napping	10	7
6	Preparatory fitness/training	9	6
7	Observing/discussing fatigue	4	3
Total		147	100

provided written, informed consent. Maintenance participants ($n = 7$) consisted of aeronautical engineers, aircraft technicians and avionics technicians, with ages ranging from 24 to 39 years and with a mean age of 34.2 years ($SD = 6.55$). The flight crew participants consisted of pilots ($n = 6$) and air crewman ($n = 5$) with ages ranging from 24 to 37 years, and with a mean age of 30.73 years ($SD = 3.25$). Participation in this study was voluntary with no incentives offered.

2.2. Materials and procedure

A semi-structured interview template was developed by the research team to allow the participants to describe their experiences, beliefs and perceptions around fatigue management in a defence aviation environment. Prior to data collection, the Institutional Human Ethics Research Committee approved the research protocol. Permission was also granted by the Brigade Commander. Subsequently, individual members of the unit were invited by their chain-of-command to participate in a study regarding fatigue risk management. 18 interviews were conducted. Consistent with Grounded Theory (Glasser and Strauss, 1967) sampling concluded when no new arguments or counter-arguments were identified. By the 14th interview no new themes had been identified and four subsequent interviews confirmed that 'thematic saturation' had been achieved (Rabinovich and Kacen, 2013). Interviews averaged 64 min and ranged in duration from 45 to 90 min. They were digitally recorded and transcribed (226 pages).

2.3. Informal fatigue-proofing strategies

Participants continually made systematic reference to fatigue-proofing (protective) strategies designed to mitigate the chances of making an error or prevent an error resulting in compromised safety. They identified 147 ways in which they and/or others act to reduce the likelihood or consequence of a fatigue-related error. Table 1 outlines the seven categories and the relative frequency of strategies in each of the categories. As Categories 2, and 4 through 7 are already well documented in the literature (Caldwell et al., 2009), we discuss the relatively novel Categories 1 and 3 in this paper; 'task-related strategies' and 'behaviour-based strategies' for reducing fatigue-related risk.

2.4. Task-related strategies for reducing fatigue-related risk (Category 1)

The most frequently reported category related to modification of the way a task was undertaken while fatigued. Participants identified the following five task-related strategies for reducing fatigue-related risk:

Task slowing: Participants reported taking more time to complete tasks, reducing work-flow or increasing and/or extending breaks to reduce time-on-task. As one participant observed "*. . . you take longer to do* it. It might take you longer to achieve it because you are mindful about what you're doing."

Task rotation: Participants reported reducing the time spent on a specific task, or having to undertake high demand tasks for extended periods, by rotating people in and out of a range of tasks.

Task buffering: Participants indicated that it was useful to build a buffer into tasks that allowed additional time to correct for mistakes or created space to accommodate to the slower cognitive functioning associated with fatigue. One participant captured this when discussing the relative benefits of declaring fatigue versus task modification. He reported "*. . .we can [risk] mitigate in the same sort of way [as signalling fatigue to a co-worker] by just giving ourselves a little extra buffer*". When asked to illustrate an example of 'buffering behaviours", he stated "*Let's not go down to X yet [lower altitude] but remain at Y [current altitude] for a little longer.*"

Load shedding/delegation: Participants indicated that they would frequently off-load work in order to manage the reduction in capacity associated with operating while fatigued. This could be done by either re-prioritizing work to another time. e.g. "*It was all the administrative stuff that I deferred.*" Alternatively, a similar outcome could be achieved by delegating to a colleague. e.g. "*I delegated all the tasks that I wasn't able to compete within my own capacity.*"

Double checking/cross checking: Many participants were clearly aware of the increased likelihood of errors when working while fatigued. Checking of one's own work was a common strategy reported by both pilots and maintenance engineers. It was also common for senior staff to understand the need to check the staff's work more closely when they or their staff members were fatigued. As one line supervisor noted, "*I want them [supervisors] to double check things and [when staff are fatigued] I also want the supervisors to do extra supervision.*"

Some participants also identified the need to seek additional voluntary checks of their work when fatigued.

2.5. Behaviour-based strategies for reducing fatigue-related risk (Category 3)

After task modifications and the use of caffeine and/or energy drinks, the next most reported category related to behavioural changes in the way staff managed the execution of a task. There were several strategies reported by participants. The four most commonly reported were:

Changes in communication style: Participants frequently indicated that they would change their communication style to address the declining motivation associated with increasing fatigue. Typically this involved the introduction of non-essential dialogue into the task in order to increase cognitive engagement.

Task verbalisation: Participants frequently reported talking out loud, either to themselves or others, in order to reduce the likelihood of a fatigue-related error. The strategy appeared to rely on the greater likelihood of one's self or a colleague detecting a procedural or logical error when the task is vocalised.

Increases in social interaction: Participants frequently reported increasing the level of social interaction in order to improve alertness through social facilitation (Allport, 1937).

Increases in supervisory oversight: Participants felt that fatigued workers were more likely to make errors and that increased levels of supervision would mitigate the risk.

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