The influence of circadian time and sleep dose on subjective fatigue ratings

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ABSTRACT

Subjective ratings of fatigue are increasingly being used as part of a suite of tools to assess fatigue-related risk on the road and in the workplace. There is some debate however, as to whether individuals can accurately gauge their own fatigue states, particularly under conditions of sleep restriction. It is also unclear which references are used by individuals to assess fatigue – for example prior sleep, time of day, workload, or previous ratings. The current study used a sophisticated laboratory protocol to examine the independent contributions of sleep, circadian phase and sleep debt to fatigue ratings. Importantly, participants had no knowledge of time of day, how much sleep they were getting, or how long they were awake. Twenty-eight healthy, young males participated in one of two conditions of a 28 h forced desynchrony protocol – severe sleep restriction (4.7 h sleep and 23.3 h wake) or moderate sleep restriction (7 h sleep and 21 h wake). Fatigue ratings were provided prior to and following each sleep period using the Samn–Perelli fatigue scale. Repeated measures ANOVAs were used to analyse the effects of circadian phase, sleep dose and study day. Results demonstrated an effect of circadian phase on both pre-sleep and post-sleep fatigue ratings. The significant effect of study day is interpreted as an effect of circadian time, as opposed to accumulating sleep debt. An effect of sleep dose was only seen in post-sleep fatigue ratings. The findings suggest that post-sleep fatigue ratings may be sensitive to prior sleep and may be useful as an indicator of fatigue-related risk, particularly when triangulated with information about recent total sleep time.

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1. Introduction

Sleep is important for cognitive performance, alertness and mood in a dose-dependent manner such that more sleep is generally associated with better cognitive performance, more positive mood states and increased alertness (Belenky et al., 2003; Van Dongen et al., 2003). As total sleep time declines, cognitive performance declines, with implications for error, judgment, decision-making and safety (Akerstedt, 2000; Folkard and Tucker, 2003). Circadian timing also impacts objective measures of performance and subjective ratings of sleepiness and performance (Dijk et al., 1992; Monk, 1987; Williamson and Friswell, 2011). Most of the studies referred to above examined performance and subjective measures under conditions in which participants are aware of certain details of the protocol such as time of day, and their own recent sleep history. Further, studies conducted in field settings provide time of day information and participants have an awareness of their recent sleep patterns when they are making subjective assessments of their individual fatigue levels (Ferguson et al., 2010; Jay et al., 2008; Powell et al., 2010). It is difficult to know then whether individuals make subjective ratings based on external cues or against some internal reference.

Extended wake, inadequate sleep and time of day all increase fatigue-related risk, waking function and one’s ability to perform a task safely (Dawson and McCulloch, 2005; Folkard and Tucker, 2003). There is good evidence that accidents on the road and in the workplace are increased at times of increased fatigue. Based on such evidence, individuals are asked to make judgments about their own performance on a regular basis. Road safety campaigns urge drivers to rest if sleepy due to the significant risk of fatigue-related accidents (Philip et al., 2003). Fitness for duty legislation requires workers to report to work in a fit state at their place of work and asks them to assess their own capacity to perform their job safely in relation to various factors such as alcohol and drug use and physical fitness. Increasingly, many jurisdictions now require that fitness for duty also encompass fatigue (Dawson and McCulloch, 2005; House of Representatives, 2000).

The management of fatigue-related risk in workplaces is a major priority for many high-risk industries. Fatigue risk management

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