

A controlled investigation into the psychological determinants of fatigue

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Abstract

Driver fatigue is associated with risks of road accidents that result in injury and death. Research has been limited by several issues such as confusion over definitions, how best to measure fatigue, and the contribution of psychological factors to fatigue. This study addressed these limitations by investigating the relationship between psychological factors and fatigue. Participants were assessed and were required to perform a monotonous task till they tired. Results found few psychological factors to be related to physiological and performance decrement fatigue outcome measures. However, psychological factors were found to correlate consistently with self-reported fatigue. The results suggest that fatigue is associated with a predisposition to be anxious, depressive, less self-assured, more conscientious (rule bound), less socially bold, less adaptable and low vigour. The results indicate that future research should employ a range of fatigue outcome measures in order to best understand what factors contribute to fatigue.

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1. Introduction

Experiencing drowsiness whilst driving is a major risk factor for automobile accidents, injury and deaths (Connor et al., 2002; Lal and Craig, 2001; Nilsson et al., 1997). A driver's performance has been shown to progressively deteriorate as a result of experiencing increased drowsiness, and this has been shown to have serious implications for road safety (Dinges, 1995; Horne and Reyner, 1995). Increasing levels of drowsiness and the associated lower levels of arousal have been shown to be associated with decreased vigilance and cognitive attention to the road, slowed motor reactions, decreased ability to recognize signs of danger ahead, reduced ability to take corrective action, and reduced ability to estimate appropriate braking distances (Dinges et al., 1997; Lal and Craig, 2001; Lamond and Dawson, 1999). Furthermore, drowsy drivers raise the risk of not only injuring or killing themselves, but also injuring others such as their passengers, other road users and pedestrians

(Williamson et al., 1996). It is, therefore, prudent that drivers are made aware of risk factors associated with experiencing drowsiness whilst driving, given the personal and financial costs associated with road accidents (Lal and Craig, 2001; The Parliament of the Commonwealth of Australia, 2000). To optimize our capacity to provide effective road safety management strategies, it is essential that we understand better the determinants of these risk factors.

One way of enhancing our understanding of the determinants of drowsiness is to conduct controlled research while a person is performing a monotonous task until they show signs of fatigue. However, it is important to distinguish between terms such as drowsiness, sleepiness and fatigue (Johns, 2000). It has been argued that sleepiness refers to the probability of falling asleep at a particular time (Johns, 2000), and that it takes into account factors such as sleep propensity that can vary according to time, posture and situation. On the other hand, drowsiness is thought to be a state that varies between wakefulness and sleep, with drowsiness usually thought to occur before the onset of stage 1 microsleeps (Broughton and Hasan, 1995; Johns, 2000).

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Fatigue has generally been referred to as a feeling of tiredness and reduced alertness that is associated with drowsiness, which impairs both capability and willingness to perform a task (Grandjean, 1988; Lal and Craig, 2001). It can also be defined as a change in performance of a task over time (Johns, 2000). Fatigue has been established to be both a physiological and a psychological experience (Williamson et al., 1996). Psychological factors associated with fatigue are highlighted in a definition provided by Brown (1994, p. 298) where he described fatigue as a “subjectively experienced disinclination to continue performing the task at hand.”

The physiological and psychological determinants of fatigue have been investigated in a variety of ways, for instance, by studying decrements in simulated driving performance by monitoring steering wheel behavior and road/lane departure errors (Thiffault and Bergeron, 2003; Verwey and Zaidel, 2000). Others have studied sleep behavior and work patterns related to fatigue (Neville et al., 1994). Many others have studied the physiological factors associated with becoming tired, such as brain activity, eye activity and heart rate activity and variability (Lal and Craig, 2001, 2002). However, there have been fewer attempts to study psychological factors associated with fatigue even though it is acknowledged that fatigue involves substantial cognitive effort (Brown, 1994; Lal and Craig, 2002). As a consequence, our understanding of fatigue may be limited. Early research by Bartley and Chute (1947) found that the measurable pattern of deterioration associated with fatigue was not necessarily mirrored by the subjective experience of fatigue. That is, an individual may not feel fatigued even though their performance is deteriorating, and alternatively, performance may be stable even though the individual is experiencing fatigue (Brown, 1994). Clearly, this incongruity strongly argues for further investigations into the association between psychological factors that may determine fatigue. This paper presents data on the psychological determinants of fatigue associated with continued performance on a cognitive-motor task that simulated driving behavior.

There is a distinction between the physiological and psychological factors associated with fatigue (Brown, 1994). Physiological factors have been found such as changes in brain activity patterns (e.g. changes in peak frequencies and amplitudes in the theta and alpha component of the electroencephalogram), eye movement activity (changes in eye blink rate and duration measured by the electro-oculogram or EOG), facial muscle activity changes, heart rate activity and variability (e.g. increased sympathetic activity), facial expression (yawning, nodding), and so on, as a person tires (Åkerstedt et al., 1982, 2001; Caffier et al., 2003; Campagne et al., 2004; Eoh et al., in press; Gevins et al., 1990; Jung and Makeig, 1994; Lal and Craig, 2002; Lehmann et al., 1995; Makeig and Inlow, 1993; Santamaria and Chiappa, 1987; Stern et al., 1994; Veldhuizen et al., 2003). In contrast, psychological

determinant research has mostly focused on changes in self-reported levels of fatigue or vigilance, or by assessing personality traits that may predispose a person to fatigue (De Vries and Van Heck, 2002; Lal and Craig, 2002; Matthews and Desmond, 1998; Thiffault and Bergeron, 2003; Verwey and Zaidel, 2000).

Research has begun to isolate psychological factors that may predispose a person to fatigue while driving. One of the more common areas to be investigated has been based on Eysenck's arousal theory (1967). Eysenck (1967) proposed that some personality traits such as extraversion predispose a person to experience fatigue with consequent vigilance decrements during boring and monotonous cognitive-motor tasks. While early research has not always supported the relationship between extraversion and susceptibility to fatigue (Koelega, 1992) and the explanation as to why extraverts may be higher at risk has not been clarified (Thiffault and Bergeron, 2003; Tran et al., 2001), latest research has found positive associations between the likelihood of experiencing fatigue during monotonous cognitive-motor tasks and psychological traits that involve aspects of extraversion, control, arousability and sensation seeking (De Vries and Van Heck, 2002; Jonah, 1997; Lal and Craig, 2002; Thiffault and Bergeron, 2003; Verwey and Zaidel, 2000). Verwey and Zaidel (2000), for instance, found that fatigue measured by deviations on the road during simulated driving, was positively associated with high scores on the extraversion-boredom construct. Interestingly, they also observed a poor association between physiological and more subjective measures of fatigue. A number of studies have shown a link between sensation seeking traits and impaired driving behavior (Jonah, 1997). Extending this argument, Thiffault and Bergeron (2003) found an association between fatigue and higher sensation seeking trait scores, suggesting that people who seek thrills and novelty will react negatively to boring tasks. Extraverted people who score highly on sensation seeking traits were also found to be at risk of fatigue (Thiffault and Bergeron, 2003).

Research also suggests that higher levels of trait anxiety may be a risk factor that predisposes a person to experience greater levels of fatigue (Jiang et al., 2003; Lal and Craig, 2002). Jiang et al. (2003) found that persons with higher levels of trait anxiety also reported higher levels of fatigue. Lal and Craig (2002), in a study in which 35 non-professional drivers were monitored during their performance of a monotonous simulated driving task till they showed signs of drowsiness, found that fatigue symptoms were predicted by higher levels of trait anxiety and external locus of control.

The aim of this study was to determine whether psychological factors contribute to fatigue by conducting a controlled study in which non-professional drivers performed a monotonous cognitive-motor task that simulated driving, till they showed signs of fatigue. A broad range of psychological factors were investigated, including those previously found to be related, such as aspects of

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