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Usage and perceived effectiveness of fatigue countermeasures for professional and nonprofessional drivers

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ABSTRACT

Background: Drivers adopt various strategies in order to cope with fatigue and falling asleep at the wheel. These strategies include a wide range of activities that may invigorate the body and/or the mind.
Objectives: To compare usage patterns and to evaluate the perceived effectiveness of different coping behaviors adopted by professional and nonprofessional drivers in order to maintain alertness.
Method: The study was conducted using a large-scale survey, filled by 100 professional and 90 nonprofessional drivers.
Results: Listening to the radio and opening the window were the most frequently used and also perceived as highly effective coping behaviors by both groups of drivers. Talking on a cellular phone or with a passenger were more frequently used by nonprofessional drivers whereas, planning rest stops ahead, stopping for a short nap and drinking coffee were more frequently used by professional drivers. These methods were also perceived as more effective by professional than by the nonprofessional drivers and their usage frequency highly correlated with their perceived effectiveness.
Conclusions: Nonprofessional drivers counteract fatigue only at the tactical/maneuvering level of the drive. Hence, they tend to adopt methods that help them pass the time and reduce their feeling of boredom but do not require advance preparations or adjustments in the driving. In contrast, professional drivers counteract fatigue also at the strategic/planning level of driving, and use a much larger repertoire of coping-behaviors.
Implications: Fatigue countermeasures should include all levels of the driving task hierarchy, and experience-based countermeasures used by professional drivers should be considered for experimental validation.

1. Introduction

Falling asleep at the wheel is one of the leading causes of fatal accidents and injuries, accounting for up to 15–20% of all traffic accidents in the developed countries (Horne and Reyner, 2001a,b; Connor et al., 2002; Karrer and Roetting, 2007). The estimated personal, social and economic costs of fatal accidents are very high, especially when a truck or a heavy vehicle is involved (Shinar, 2007). Fatigue related accidents are mainly influenced by the drivers' psycho-physiological state and the road infrastructure. Driving on an inter-urban monotonous road can often be regarded as a repetitive task which requires sustained attention and can be fatiguing even for a relatively wakeful driver (McCartt et al., 2000; Thiffault and Bergeron, 2003; Gershon et al., 2009a,b). In contrast, driving on an urban road, often involves a high rate of environmental stimulation and continuous changes in the driving scenery, persistently maintaining drivers' attention (Horne and Reyner, 1999; Mavjee and Horne, 1994). Oron-Gilad et al. (2008), for example, evaluated fatigue levels in different simulated environments and found that the risk of being involved in a fatigue related accident increases as time-on-task progresses. In that study drivers also compromised their driving differently in various types of roads in a manner that was most compatible with the forgiveness of the road.

The effects of fatigue on driving are well documented in the literature and acknowledged by both professional and nonprofessional drivers (Arnold et al., 1997; Oron-Gilad and Shinar, 2001; Friswell and Williamson, 2008). It has been shown that drivers have extensive knowledge about the factors that influence fatigue while driving, and most of them are aware of the effectiveness that different methods such as a short nap have in counteracting fatigue (Nordbakke and Sagberg, 2007). Despite this knowledge, and in order to comply with time constraints, drivers often tend to continue driving while fatigued and adopt various strategies that are only partially effective in coping with fatigue and falling asleep at the wheel (Oron-Gilad and Shinar, 2001). A survey conducted

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by Nordbakke and Sagberg (2007) indicated that drivers' experience and age influences the coping methods that they selected in order to maintain alertness. Older drivers prefer to use more valid methods such as "stopping for a nap" whereas younger drivers tend to adopt coping methods that are easy to manage and do not require stopping the car (e.g., "eating candies" and "singing"). In a survey conducted by Royal (2003) the most commonly reported coping activities were pulling over to take a nap (43%), opening the window (26%), drinking a hot or cold caffeinated drink (17%), pulling over or getting off the road (15%), increasing the radio volume (14%), stopping for a stretch and/or exercise (9%), switching drivers (6%), eating (3%), and singing or talking to oneself or others (3%). Oron-Gilad and Shinar (2001) surveyed professional military truck drivers and found that over 50% reported that drinking coffee or water "helps a lot" in staying awake, and approximately 40% reported that drinking caffeinated soft drinks (e.g., Cola) and smoking cigarettes "helps a lot" in staying awake. In contrast, over 60% reported that alcohol makes them sleepy, and nearly 40% reported that chewing gum has no effect at all on their wakefulness. Drivers' responses obtained from a survey conducted by Maycock (1995) imply that when fatigued, they tend to engage in mental games or any other task which mentally challenges them.

Despite the fact that these surveys provide some face validity to drivers' beliefs, according to a report of an expert panel convened by the U.S. National Center on Sleep Disorders Research and the U.S. National Highway Traffic Safety Administration, with the exception of a short nap and caffeine, which can provide a temporary relief, all other coping activities have no scientific basis to support their effectiveness in counteracting fatigue (Strohl et al., 1998). In spite of the expert panel's conclusions, it may be unwise to discount the experience-based activities that drivers, especially professional drivers, use to counteract fatigue. Only an empirical evaluation of intuitive countermeasures can reveal their actual utility. Some of these widely used methods such as, "opening the window", have in fact been empirically tested and found to have no effect in counteracting fatigue, and other techniques such as "slapping oneself in the face" and "sticking the head out of the window" even have negative effects on the driver and the driving task (Horne and Reyner, 2001a,b; Oron-Gilad and Shinar, 2001). However, there are also positive and valid examples of experimentally validated intuitive countermeasures. The positive effect of "shelling and eating sunflower seeds" was previously noted only anecdotally by Turner (2004) and Oron-Gilad and Shinar (2001). Based on these repeated testimonies of professional drivers – who are always on the lookout for fatigue countermeasures – Gershon et al. (2009a,b) conducted an empirical evaluation of this behavior in a driving simulation environment and demonstrated that shelling and eating sunflower seeds seems to have a fatigue suppressing effects. Additionally, the consumption of products containing chemical stimulants – such as coffee, "energy drinks", and chocolate, which were perceived among professional drivers as highly effective in maintaining alertness, was also found to be empirically effective (Horne and Reyner, 2001a,b; Gershon et al., 2009a,b).

As much as it is worthwhile to examine drivers' strategies for coping with fatigue, it is also important to distinguish between the coping-behaviors used by professional and nonprofessional drivers, as each group of drivers embraces different driving skills and driving objectives. Based on the Michon's hierarchical structure of the road user task (Michon, 1985) we claim that some of the differences in tactics used by professional and nonprofessional drivers can be attributed to the hierarchical level in which they "choose" to counteract fatigue. The extended hierarchical model (Hatakka et al., 2002) classifies drivers' behavior into four levels: (i) Goals for life and skills for living, (ii) Goals and context of living (strategic level) (iii) Mastering traffic situations (tactical level), and (iv) Vehicle maneuvering. We hypothesized that nonprofessional drivers allocate fatigue management to the maneuvering level of the driving plan (the 3rd level) which may indicate that they do not anticipate being fatigued and consequently deal with it only once they actually experience it; i.e., at the tactical level. On the other hand, professional drivers will relate to fatigue on the strategic level of driving (Goals for life and skills for living), and will therefore report using a much larger repertoire of coping behaviors that include stopping and pre-planning of their driving route.

The goals of the current survey were to map usage patterns of coping behaviors used by professional and nonprofessional drivers in order to counteract fatigue, and to evaluate the perceived effectiveness of these methods. In evaluating both usage patterns and perceived effectiveness of the coping behaviors we can provide more comprehensive, detailed information not only on the type of methods drivers adopt but also on their beliefs about the methods' efficiency in counteracting fatigue. This knowledge can ultimately influence the drivers' willingness to engage in these behaviors. As such, the outcomes of this study can be used to establish the rationale for experimental evaluations of the various methods, and – to the extent that professional drivers operate at different strategic levels – utilize that information for guidelines for non-professional drivers.

2. Method

A 52-item survey was administered to 100 professional drivers and 90 nonprofessional drivers. "Professional drivers" were defined as drivers for whom driving is part of their work requirements (e.g. truck, bus, and taxi drivers). "Nonprofessional" drivers are those who drive a vehicle but not as a primary component of their job. The study samples were random within limits of availability. Participation in the study was voluntary and all participants were approached directly at their workplace by the experimenter. Refusals were quite rare (less than 10%). Approximately 10% of the non-professional drivers who filled out the questionnaires were excluded from the sample because they were under 25 years old. Before the administration of the questionnaire, each driver received detailed information on the purpose of the study and an explanation on how to fill the questionnaire. In all cases, no personal identifying information was collected, and the drivers were assured that their responses would remain completely anonymous. The questionnaire included four sections: Demographic data (10 items); Driving characteristics (10 items); Methods used to counteract fatigue (17 items); and Perceived effectiveness of those methods (17 items). The drivers graded both the extent to which they used each method and its perceived effectiveness on a Likert scale. For frequency of use the categories were: (1) Never, (2) Rarely, (3) Sometimes, (4) Often, and (5) Always. For perceived effectiveness the categories were (1) Not relevant, (2) Not helpful at all, (3) Slightly helpful, and (4) Very helpful. Estimated time to complete the survey was approximately 15 min. The methods used in the current study were adopted from Oron-Gilad and Shinar's (2001) survey that was conducted on both civilian and military professional drivers. The 17 coping methods included in our study were identical to the ones used by Oron-Gilad and Shinar (2001): taking a short nap; eating chocolate snacks; drinking coffee; drinking energy drink; smoking; shelling and eating sunflower seeds; eating salty snacks; opening the car window; listening to the radio; talking on the cellular phone; talking with a passenger; driving barefoot; stopping the vehicle and exercising; washing their face; changing the seat position; watching the view; thinking personal thoughts.

2.1. Data analysis

The questionnaires were analyzed using nonparametric statistical tools. Mann–Whitney *U*-tests were used to assess the