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Sleepiness and hazard perception while driving

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Abstract

Young drivers are involved disproportionately in serious vehicle crashes, and are involved disproportionately in sleepiness-related crashes. Specific difficulties in perceiving road hazards, and further impairment of this skill when sleepy, may contribute to this problem in young and inexperienced drivers. Perception, and response, to potential driving hazards is typically better in experienced drivers than in inexperienced drivers. However, the relationship between driver experience and sleepiness is not known. A sample of 34 young, and inexperienced, drivers (aged 17-24 years, with less than three years driving experience) and 33 older, and experienced, drivers (aged 28-36 years, with at least ten years driving experience) completed a video-based hazard perception task, in which they were instructed to anticipate a range of genuine traffic conflicts filmed locally. Their average response time to the traffic conflicts was calculated. Drivers were either tested at a time of increased sleepiness (3am) or at a point of decreased sleepiness (10am). As expected, the young, inexperienced drivers were significantly slower at identifying hazards than were the older, experienced drivers. While no overall effect of sleepiness on hazard perception was found, inexperienced drivers were slower on this measure at night. It appears that the hazard perception skills of the older, more experienced, drivers were relatively unaffected by mild increases in sleepiness while the hazard perception skills of the younger, inexperienced drivers, were significantly slowed by a mild increase in sleepiness. The results may explain the increased risk of driving while sleepy for young adult drivers. Sleepiness impairs elements of driving performance that are critical to safe driving, including hazard perception.

Notes

(1) Road Safety Grant Reports are disseminated in the interest of information exchange.
(2) The views expressed are those of the author(s) and do not necessarily represent those of the Australian Government.

CONTENTS

EXECUTIVE SUMMARY

It is well-established that young, inexperienced drivers are disproportionately involved in motor vehicle accidents. This is particularly the case for sleepiness-related accidents. It was proposed that hazard perception, a skill that develops with driving experience, could provide one mechanism for this disproportionate involvement. It is already known that poorer hazard perception is associated with greater accident involvement. It is also known that driver inexperience is associated with poorer hazard perception. As such, young, inexperienced drivers may have increased difficulty in perceiving driving hazards initially, and further hazard perception impairments when sleepy. It was expected that the well-learned hazard perception skills of older, more experienced, drivers would be less susceptible to the negative effects of sleepiness. This potential interaction of driver experience and sleepiness has not been studied previously.

A sample of 34 young, and inexperienced, drivers (aged 17-24 years, with less than three years driving experience) and 33 older, and experienced, drivers (aged 28-36 years, with at least ten years driving experience) completed a video-based hazard perception task, in which they were instructed to anticipate a range of genuine traffic conflicts filmed locally. Their average response time to the traffic conflicts was calculated. Drivers were either tested at a time of increased sleepiness (3am) or at a point of decreased sleepiness (10am). As expected, the young, inexperienced drivers were significantly slower at identifying hazards than were the older, experienced drivers. While no overall effect of sleepiness on hazard perception was found, inexperienced drivers were slower on this measure at night. We also found that simple response times (reacting to the appearance of rectangles on the screen) were faster for the young inexperienced group but that both groups of drivers were slower at night than during the day.

It appears that the hazard perception skills of the older, more experienced, drivers were relatively unaffected by mild increases in sleepiness while the hazard perception skills of the younger, inexperienced drivers, were significantly slowed by a mild increase in sleepiness. These findings are consistent with the disproportionate sleepiness-related accident involvement of young, inexperienced drivers. Specific interventions aimed to (1) improve hazard perception skill in young drivers and (2) reduce exposure to sleepiness while driving in young drivers are recommended.

ACKNOWLEDGEMENTS

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ABBREVIATIONS

ANOVA	Analysis of Variance
DITRDLG	Department of Infrastructure, Transport, Regional Development and Local Government
QSHPT	Queensland Spatial Hazard Perception Test
SSS	Stanford Sleepiness Scale
SD	Standard Deviation

1 INTRODUCTION

1.1 Driver sleepiness

Sleepiness has been identified as a major contributor to young driver crashes. Sleepiness is regarded as a significant contributor to motor-vehicle crashes (Mahowald, 2000). Most literature suggests that the proportion of all vehicle accidents related to sleepiness is in the order of 20 per cent (Garbarino et al., 2001). Most importantly, sleepiness-related crashes are likely to be more severe than other crashes, and are more often fatal (Åkerstedt, 2000). Young adults are involved in more crashes related to sleepiness than older drivers (Lyznick et al., 1998). For example, young adults are four times more likely to be involved in fall-asleep crashes than older drivers and account for almost two-thirds of all sleepiness related crashes (Horne & Reyner, 1995; Maycock, 1996; Knipling and Wang, 1994; Pack et al., 1995). There are a number of reasons why young adults are likely to experience chronic sleepiness. These reasons include social factors (Breslau et al., 1997), maturational changes, and disrupted sleep patterns (Carskadon and Roth, 1991). Young drivers are also likely to experience acute sleepiness, particularly when driving late at night and in the early morning. We have previously reported that young drivers frequently drive while at increased risk of a sleepiness-related crash and at times they felt themselves to be sleepy (Smith, Carrington & Trinder, 2005).

The mechanisms of sleepiness-related crashes can include frank sleep episodes (such as microsleeps; defined as 1-15 seconds of Stage 1 sleep), but can also include sleepiness-related deficits in attention, vigilance and information processing while awake (e.g. Arnedt et al., 2005; Banks & Dinges, 2007). Previous research using simulators has found that sleep deprivation increases driving accidents and also degrades specific aspects of vehicle control, such as speed and lane control (Peters et al., 1998). Significantly, this research found that accidents usually were not preceded by microsleep events. Instead, increased 'inattention and distractibility' associated with sleep deprivation comprises the majority of simulator driving failures. In a related study by Gugerty and Brooks (2000), drivers became less able to detect hazards in their lane and in the blind-spots to their right and left, and less able to recall the locations of nearby traffic after sleep deprivation. This research suggests that many crashes currently reported as due to 'inattention' may be related to sleepiness. Critically, increased sleepiness is likely to impact on a range of cognitive processes that are vital for safe driving.

1.2 Hazard Perception

Hazard perception is an important component of crash avoidance. Hazard perception has been defined as "the process whereby a road user notices the presence of a hazard" (Haworth et al. 2005). Hazard perception can be considered as the first stage in responding to the presence of actual or potential hazards, with subsequent steps including a decision about the hazard, and then an appropriate response. Quimby et al. (1986) examined the relationship between crash frequency and the time taken to detect and respond to hazard, termed hazard perception latency. They found that a long hazard perception latency was associated with higher crash rates after controlling for age, driving exposure, and simple reaction time. This relationship between hazard perception skill and accidents has been replicated by a number of researchers (McKenna & Horswill, 1999; Hull & Christie, 1992; Drummond, 2000; Watts & Quimby, 1979).

Young drivers are disproportionately involved in car crashes. It is well established that young novice drivers are involved in more car crashes than older drivers. In Australia, 16 to 24 year olds comprise about 15 per cent of the driving population, but account for around 35 per cent of fatal and

50 per cent of injury crashes (Triggs & Smith, 1996). Novice drivers learn the basic vehicle handling skills and traffic laws quickly, even within only 15 hours of driving (Hall & West, 1996). However, the task of driving safely is extremely complex, and young drivers have limited experience to develop the complex, higher-order perceptual and cognitive skills required to safely interact with the traffic environment. A number of factors are associated with the accident peak in this age group, such as social deviance, drinking, and even car preference. However, driving experience remains an important underlying cause when many other factors are partialled out (Crundall et al, 2002).

Experienced drivers have much better road hazard perception than inexperienced drivers. Experienced drivers react faster to hazards than novice drivers (McKenna & Crick, 1997). In addition, compared to more experienced drivers, young drivers display a smaller range of horizontal scanning of the road environment; look closer to the front of the vehicle; check the mirrors less frequently; glance at objects less frequently; utilize peripheral vision less efficiently; and fixate on fewer objects. Novice drivers also fixate more on stationary objects; whereas experienced drivers fixate more on moving objects (see review by Simpson, 2003). Experienced drivers are more able to integrate information quickly and consider hazardousness as a holistic attribute of the driving environment (Milech et al., 1989).

Drivers who display long hazard perception latencies may not necessarily show slow reactions in other contexts. For example, Quimby and Watts (1981) found that drivers under the age of 25 displayed faster simple and choice reaction times than older drivers. Despite this, the younger drivers also displayed longer hazard perception latencies. This research suggests that novice drivers detect hazards less quickly and efficiently, despite unimpaired simple reaction times. This is in part due to novice drivers adopting less efficient information gathering strategies. With experience, drivers adopt more efficient search patterns and their ability to detect hazards increases. They also learn to associate specific hazards with certain parts of the traffic system. For example, they acquire knowledge about the dynamic characteristics of other road users, which allows them to predict the nature of hazards presented by moving objects (Brown & Groeger, 1988).

1.3 Interaction of Sleepiness and Hazard Perception

Sleepiness and circadian phase may contribute to hazard perception. Models of the role of attention in the perception of road hazards have not been well developed, however hazard perception is a skill with a high cognitive component. As such, general attention and vigilance factors are significant contributors to performance on hazard perception tests. Attention and vigilance are strongly influenced by both circadian rhythm phase and by sleep deprivation (Van Dongen et al. 2003). Sleep deprivation studies repeatedly show negative impacts on mood, cognitive performance, and motor function due to an increasing sleep propensity and destabilization of the wake state. Specific neurocognitive domains including executive attention, working memory, and divergent higher cognitive functions are particularly vulnerable to sleep loss (Durmer & Dinges, 2005). Motor reaction time and decision time across the day also reflect the underlying circadian rhythm (Kraemer et al, 2000). This is reflected in significantly impaired performance on general driving simulator tasks (Åkerstedt et al., 2005). Although the effects of sleepiness and circadian phase on hazard perception are not specifically known, it is likely that increasing sleepiness will impair hazard perception.

The possibility that an interaction between the factors of driving experience and sleepiness could determine hazard perception skill has not been examined previously. There is some evidence that older drivers are more resistant to sleepiness and fatigue than younger drivers (Philip et al. 1999). However, the mechanisms of this resilience are unknown. Older drivers are likely to have greater driving experience than younger drivers. As such, improved hazard detection may be one factor that contributes to decreased risk of crash in sleepy older drivers when compared to sleepy younger drivers. That is, driving experience may confer some resistance to sleep deprivation, and hazard perception may provide a mechanism for this resistance. It is also possible to argue the opposite: that the hazard perception advantage of experienced drivers decreases with fatigue. McKenna & Farrand (1999) found that experienced drivers were more susceptible to distraction than novices when performing a video-based hazard perception task (they were reduced to the performance level of novices by a secondary task). This suggests that experienced drivers gain their advantage over novices by allocating more cognitive resources to perceiving hazards.

1.4 Study Aims

The aim of the present study was to test the potential interaction of sleepiness and hazard perception. We expected that experienced drivers would perform faster than inexperienced drivers on a hazard detection task both during the day (when alert), and at night (when sleepy). We expected that both experienced and inexperienced drivers would perform worse on the task when they are sleepy. We expressly expected an interaction between these two factors, such that inexperienced drivers exhibit disproportionate deficits in hazard detection when they are sleepy. However, as noted above, the possibility remained that experienced drivers may be more affected by sleepiness than novices. The present study was designed to determine which of these alternative positions is correct.

2 METHOD

2.1 Study Objectives

The specific objectives of the project were to:

- To assess differences in hazard perception when drivers are sleepy or alert;
- To assess differences in hazard perception between inexperienced and experienced drivers; and
- To assess the interaction between experience and sleepiness on hazard perception.

2.2 Methodology

2.2.1 Participants

Participants included a group of 34 young adult drivers (aged 17-24) with limited driving experience (up to 3 years) and a group of 33 older drivers (aged 28-36) with extensive driving experience (10 to 20 years). Inclusion criteria for each group included a current driving licence, good vision (corrected if necessary), and no physical restrictions to driving. Participants were recruited through advertisement in the UQ news (email to staff and students at the University of Queensland), through advertisement in the paid subject pool at the School of Psychology, and through the ‘What’s on’ section of the local papers.

Participation in the study was voluntary, and the participants were free to withdraw from the study at any stage. All participants were provided with an information package, and gave written consent to participate. Participants were compensated for their time, and were provided with taxi travel where requested. The study had approval from the Human Research Ethics Committee of The University of Queensland.

2.2.2 Materials and Procedure

Participants were pre-screened for eligibility. Eligible participants were sent a questionnaire pack that contained the participant information sheet and the written consent to participate form. Eligible participants also completed the Epworth Sleepiness Scale and The Pittsburgh Sleep Quality Index. In no case did their responses suggest the presence of a sleep disorder associated with excessive daytime sleepiness. Participants then attended two sessions at the University of Queensland in which they completed the Stanford Sleepiness Scale (SSS: Hoddes et al., 1973), which is a self-report measure that assesses alertness. Participants were instructed to rate their level of alertness at this point in time on a seven-point Likert scale with 1 = feeling active, vital, alert or wide awake through to 7 = no longer fighting sleep, sleep onset soon, having dream-like thoughts. Participants were further instructed that a rating of 1 is common during the day and a rating above 3 when they should be alert indicates sleep need.

Following this, participants completed a measure of simple reaction time followed by the Queensland Spatial Hazard Perception Test (QSHPT). The simple reaction time task involved participants responding to rectangles appearing on a computer monitor by clicking on them as fast as possible using the computer mouse. There were 33 rectangles and the average reaction time across all 33 responses was calculated. The QSHPT involved participants viewing various genuine traffic situations filmed from the driver's perspective. The footage included a number of potential traffic conflicts (in which the camera car was required to take evasive action to avoid a collision or near collision with another road user). A typical example would be a car turning in the road ahead, forcing the vehicle immediately in front of the camera car to brake. Scenes were chosen to allow potential for the anticipation of traffic conflicts; that is, participants who were looking further ahead down the road, proactively searching for hazards, might be able to predict that the turning car would eventually lead to a traffic conflict, some time before the vehicle in front actually braked. The footage was shown on a 15-inch computer monitor and participants were required to anticipate the potential traffic conflicts by clicking on them using the computer mouse. Specially-developed software recorded the time and location of each mouse-click and yielded a reaction time to each traffic conflict detected. Key features of this test included the following: (1) all the traffic conflicts were genuine (previous tests have been criticised for using staged events), (2) the mouse-click response mode yielded precise information on what is being responded to (in earlier tests, participants pressed a button when they detected a hazard and this could result in response ambiguity in complex situations). If a participant missed a potential traffic conflict, the mean reaction time score for their group for that event was substituted. That is, participants were not penalised for failing to respond. This is an accepted approach to analysis of hazard perception responses. The overall hazard perception score was the average reaction time across all the potential traffic conflicts.

Two alternative forms of the hazard perception test were developed in order to allow repeat testing (both around 20 minutes in length and featuring 44 potential traffic conflicts). A pilot study was conducted in which 23 participants (17 females, 6 males, mean age of 22.65 years, SD = 3.63), who were not involved in the main study, completed both versions in a counterbalanced order. The correlation between the two versions was significant ($r=0.66$, $p<.01$) indicating that the two forms were approximately equivalent. Note that it was assumed that the simple reaction time measure would not experience practice effects and so participants received the same test in both testing sessions.

The study was run as a repeated measures design, with participants being tested on two occasions (10am, low sleepiness, or 3am, high sleepiness). The two forms of the Hazard Perception Test and the level of sleepiness were fully counterbalanced (day then night versus night then day; test 1 then test 2 versus test 2 then test 1) within each participant group (young novice versus older experienced). The test sessions occurred at least one week apart. This design was intended to minimize order effects, practice effects, and potential crossover effects.

Participants were asked to attend the laboratory at 12 midnight for the 3 am testing session, and to abstain from caffeine or other stimulants from 10pm. This was to provide some control of autonomic arousal prior to testing. The testing took place on each occasion in a laboratory at the University of Queensland. Ambient light and temperature were controlled between conditions, and the task administration was standardized.

3 RESULTS

3.1 Sleepiness check

To check that participants were indeed sleepier during the night session than the day session, we inspected the means of the SSS. The average daytime score was 2.22 (Standard Deviation, SD = 1.16) and the average night-time score was 4.32 (0.99), indicating that participants were significantly more sleepy during the night-time session, $t(64) = 12.20$, $p < .001$.

3.2 Check of counterbalancing assumptions

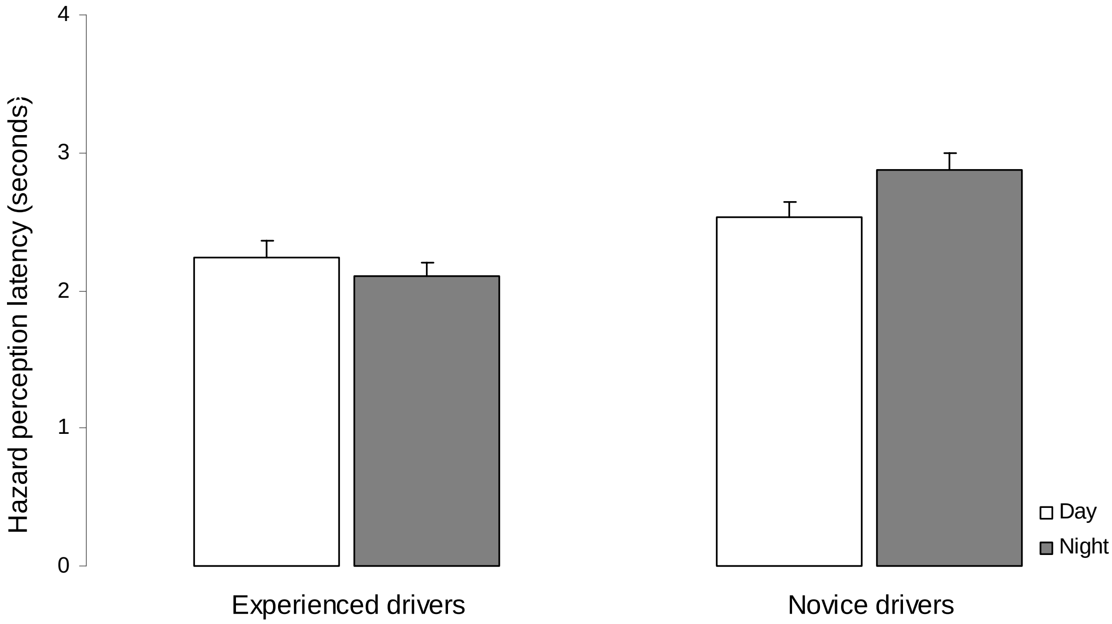
Analysis of the data indicated that a fundamental assumption of counterbalancing was violated in this dataset because a significant interaction was found between the practice effect (session 1 score versus session 2 score) and day/night order (day–night versus night–day), $F(1,47) = 4.42$, $p = .04$, and there was a significant main effect of practice, $F(47,1) = 5.35$, $p = .02$. Tests of simple effects revealed that those tested in the night condition followed by the day condition were found to exhibit significant practice effects on the task, $t(25) = 3.26$, $p = .003$, while, for those tested in the day then night condition, there was no practice effect, $t(25) = .07$, $p = .95$. The effect of practice was significantly greater in the night–day than the day–night condition, $t(50) = -2.36$, $p = .022$. This asymmetric transfer means that it is inappropriate to use a counterbalanced design. Instead, we analysed only the first session for each participant and changed the study to a purely independent samples design. This is a more conservative approach to analysis, as it introduces more between-subject error variance into the data, but it overcomes the problem of asymmetric transfer.

3.3 Analysis of hazard perception data as independent samples design

An ANOVA was carried out with experienced versus novice drivers and day versus night as independent variables, and mean hazard perception response time as the dependent variable. The scores for the second alternate form of the hazard perception test were converted into a z-score and then re-standardised to have the same mean and standard deviation of the first alternate form of the hazard perception test.

The main effect of experienced versus novice drivers was significant, $F(1,58) = 23.23$, $p < .001$, indicating that experienced drivers were faster at responding to traffic conflicts than novices. The main effect of day versus night was not significant, $F(1,58) = .85$, $p = .36$, and the experience x day/night interaction was significant, $F(1,58) = 4.77$, $p = .03$. Simple effects analyses indicated that there was no significant day/night difference for the experienced drivers, $t(28) = .96$, $p = .34$, but novices were significantly slower at night compared with during the day, $t(30) = -2.08$, $p = .046$. The interaction can be seen in Figure 1.

Figure 1: Hazard perception response times (Mean and Standard Error of the Mean)

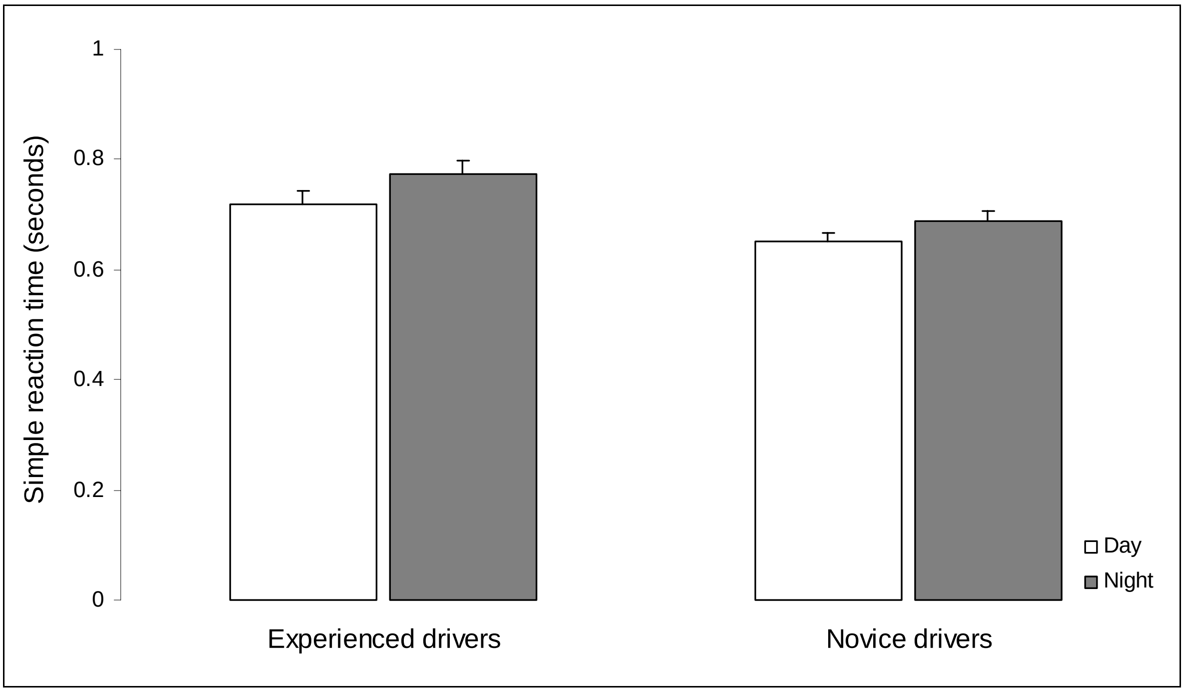


3.4 Analysis of simple reaction time data (repeated measures design)

The simple reaction time data did not suffer the same practice effect problem as the hazard perception data and hence we were still able to use a repeated measures analysis, with a fully counterbalanced design. That is, day/night was used as a repeated measures independent variable, with experienced/novice as an independent sample independent variable, and mean reaction time as the dependent variable.

A significant main effect of novice versus experienced driver was found, $F(57,1) = 8.88$, $p = .004$, indicating that the younger novice drivers were faster than the older experienced drivers. A significant main effect of day versus night was also found, $F(57,1) = 14.00$, $p < .001$, indicating that participants were faster in the daytime session than in the night-time session. There was no significant interaction between the two independent variables. The results can be seen in Figure 2.

Figure 2: Simple reaction times (Mean and Standard Error of the Mean).



4 DISCUSSION

The results indicated that younger novice drivers were significantly slower at anticipating traffic conflicts when tested at night compared with during the daytime, in contrast to older experienced drivers for whom there was no significant difference. This suggests that mild sleepiness has a greater safety consequence for young novice drivers. This is consistent with previous suggestions (e.g. Philip et al. 1999) and consistent with the expectation of an interaction between sleepiness and specific driving skills.

The general finding of slower hazard perception in the less experienced drivers, during both day and night, is also consistent with previous work (McKenna & Crick, 1997; Quimby & Watts, 1981).

The finding of no overall time-of-day effects on the QSHPT was contrary to expectations. Hazard perception is a highly cognitive task influenced by attention and vigilance factors (McKenna & Horswill, 1999). Attention (Kraemer et al., 2000) and vigilance (Dinges et al, 1997; Froberg, 1977; Monk et al., 1997) are influenced by the interaction of circadian-mediated alertness nadir, and increased homeostatic sleepiness; however, no previous research has investigated differences between daytime and night-time hazard perception. It must be reiterated that the degree of sleep deprivation associated with this study was very minor (e.g. perhaps 3-4 hours of extended wake for most participants), and potentially reflects a lower bound estimate of the impact of sleepiness on hazard perception skill. Also, the test duration was relatively short (20 minutes). As such, these results cannot be interpreted to suggest that more experienced drivers are ‘protected’ from sleepiness-related impairment by their driving skills.

How can we reconcile these findings with McKenna and Farrand’s (1999) finding that experienced drivers gain their safety benefit through the deployment of additional cognition resources? One possibility is that performing a dual task is not equivalent to being sleepy, with respect to limiting available cognitive resources. If we conceptualize experienced drivers as employing a more sophisticated proactive mental model of the driving environment (which is interfered with by a dual task), then it could be that this model is robust to the effects of sleepiness. In contrast, if novices are employing a more reactive, passive approach to hazard perception then features such as simple reaction time may become more important in determining their hazard perception skill. This approach may be less likely to be interfered with by a dual task but more likely to be interfered with by sleepiness. Consistent with this speculation, we found that simple reaction time did slow up significantly in the night-time testing session; as did the hazard perception responses of the novices, though not the hazard perception responses of the experienced drivers.

To give an idea of the implications of the effect sizes found in this study, we converted the differences in hazard response times into additional distance travelled if drivers were proceeding at 60 km/h. The difference between experienced and novice drivers’ reactions at night was .77 seconds, which equates to an additional 12.80 metres of travel at 60 km/h. The difference between night and day hazard response times for novices was .34 seconds, which equates to an additional 5.68 metres of travel at 60 km/h.

4.1 Study Limitations

A potential limitation of this study lay in the degree of sleepiness imposed by the 3am test session time. This time of day was chosen as it would provide a mild degree of sleep deprivation for most participants, and also occurs near to the circadian-mediated nadir in alertness during the night. However, the degree of sleepiness induced by this strategy will vary from individual to individual depending on their habitual sleep and wake times. As such, the manipulation produced very little sleepiness in some participants.

Better estimates of the circadian nadir for each individual participant could be provided by circadian-phase measures such as Actigraphy, core body temperature, or dim light melatonin onset (Monk et al., 1997). This may produce a more effective manipulation of circadian-mediated sleepiness. Further, it is not uncommon for drivers to accumulate sleep debt over days and weeks (i.e. chronic partial sleep deprivation). This may also increase sleepiness beyond the degree reported by the participants in the current study. Nevertheless, the levels of sleepiness attained are also very readily achieved in everyday life. Higher levels of sleepiness (e.g. after full or partial sleep deprivation) would be expected to result in more substantial effects on hazard perception.

5 CONCLUSIONS

The disproportionate involvement of young, inexperienced drivers in sleepiness-related motor vehicle accidents is a significant societal issue. An understanding of the mechanisms underlying the sleepiness-related accidents of young, inexperienced drivers will enable preventative and/or corrective action to address this young driver problem. This study is the first to investigate the impact of sleepiness on hazard perception, and has important implications for understanding sleepiness-related accidents in young, inexperienced drivers. It was found that young, inexperienced drivers were slower to respond to traffic hazards than older, experienced drivers and this difference increased when participants were sleepy. This suggests that those skilled at hazard perception (i.e. older, experienced drivers) are relatively unaffected by mild sleepiness under the conditions encountered in this study, while those poorer at hazard perception (i.e. young, inexperienced drivers) are significantly affected by mild sleepiness. This is consistent with the disproportionate sleepiness-related accident involvement of young, inexperienced drivers.

5.1 Recommendations

The current data suggests two areas in which action can be taken: (1) improvement of the hazard perception of young, inexperienced drivers and (2) reduction of sleepiness in young, inexperienced drivers.

Research has established that the hazard perception of inexperienced drivers can be improved with hazard perception training. McKenna & Crick (1997) found that three hours of classroom video-based training improved the hazard perception latency of novice drivers to the level of experienced drivers. Furthermore, Mills, Hall, McDonald and Rolls (1998) found that a combination of classroom training and on-road training resulted in the greatest reduction in hazard perception latency. Hazard perception training could be made a mandatory component of the learner licence year: drivers would be required to complete a mandated number of hours of hazard perception training (i.e. classroom and on-road based). Furthermore, a number of Australian states and other countries have developed tests to assess hazard perception at the provisional stage of licensing (for a review, see Haworth et al, 2005). In 2007, the Queensland Government introduced a set of young driver safety initiatives (Queensland youth on the road and in control: Discussion paper, 2005). These initiatives include the introduction of a two-phase provisional licence system: drivers must, after 12 months on Phase One, complete a hazard perception test to progress to Phase Two. Mandated training and assessment of hazard perception, as a requirement of provisional licensing, should result in young drivers with improved hazard perception.

The disproportionate involvement of young, inexperienced drivers in sleepiness-related accidents could also be reduced through decreased exposure to sleepiness. To avoid sleepiness-induced decrements in hazard perception young, inexperienced drivers should avoid driving at times when the underlying circadian rhythm promotes sleepiness. Night-time driving restrictions have been introduced elsewhere during the provisional years of licensure, and prohibit driving during times of increased circadian-mediated sleepiness (Williams, 2003). Additionally, public education campaigns could provide more information on our underlying circadian rhythm and its associated periods of increased sleepiness, as many people are naïve to its existence and impact on human performance. Public education campaigns could also advise against driving during times of increased circadian-mediated sleepiness, and when acutely or chronically sleep deprived.

Recommendation 1. Strategies to improve hazard perception skill among young drivers should be further investigated.

Recommendation 2. Strategies to reduce exposure to acute and chronic sleepiness while driving among young, novice drivers should be further investigated.

5.2 Planned Research Outputs

The results of this study will be used to develop a model of the relationship between the key factors of sleepiness and driving skill involved in crash risk for young adults. We are preparing a paper based on this project, with the expectation of submission of final results for publication in a high quality, high impact, international peer-reviewed journal. In addition, preliminary findings of this study were presented at the WorldSleep conference, Cairns, 2007, and we expect to present the results at another international conference in 2008. All publications and conference presentations will expressly acknowledge the financial support of the DITRDLG. Copies of all publications will be provided to the DITRDLG.

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7 APPENDIX

7.1 Demographic Questionnaire

Please complete the following questionnaire as honestly and accurately as possible. Take care to write clearly where required, and remember to answer all the questions.

Do you hold a provisional or open driving license issued in Australia (Y/N)?______

Please indicate how many years it has been since you passed your driving test for this license, OR if you have previously held a foreign driver's license, please indicate how many years it has been since you passed your foreign driving test. ________yrs

Age: ______ yrs

Sex (M/F):____

Have you had advanced driving training (Y/N)?______

If yes, please give details:

In general, over the last three years, approximately how many kilometres per year on average have you driven? (If you prefer, estimate the number of kilometres per week. It may help you to think of how many kilometres you would travel to work and back in the course of a week, and then add extra journeys.)

__________kilometres per year (or _________kms per week)

How many accidents have you been involved in over the last three years? For our purposes, an accident may be defined as an incident in which you were driving and there was damage to property or persons (if none write zero):

__________accidents over the last three years

How would you rate your familiarity with a mouse such as the one you used today? Please circle the appropriate response below:

1. Very familiar (frequently use one)
2. Comfortable with using one (don't necessarily use one frequently though)
3. Have little experience with one
4. Have never used one before this day

7.2 Epworth Sleepiness Scale

ID: ________________ Date: ____________

Instructions:
How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you. Use the following scale to choose the most appropriate number for each situation:

0 = would never doze
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

Situation	Chance of dozing
Sitting and reading	_______________
Watching TV	_______________
Sitting, inactive in a public place (e.g. a theatre or a meeting)	_______________
As a passenger in a car for an hour without a break	_______________
Lying down to rest in the afternoon when circumstances permit	_______________
Sitting and talking to someone	_______________
Sitting quietly after a lunch without alcohol	_______________
In a car, while stopped for a few minutes in the traffic	_______________

7.3 Stanford Sleepiness Scale

I D: ________________ Date: __________

Instructions:

This is a quick way to assess how alert you are feeling. If it is during the day when you go about your business, ideally you would want a rating of a one. Take into account that most people have two peak times of alertness daily, at about 9 a.m. and 9 p.m. Alertness wanes to its lowest point at around 3 a.m. and 3 p.m. After that it begins to build again. If you go above a three when you should be feeling alert, this is an indication that you have a serious sleep debt and you need more sleep.

Rate your alertness.

Degree of Sleepiness	**Scale Rating**
Feeling active, vital, alert, or wide awake	1
Functioning at high levels, but not at peak; able to concentrate	2
Awake, but relaxed; responsive but not fully alert	3
Somewhat foggy, let down	4
Foggy; losing interest in remaining awake; slowed down	5
Sleepy, woozy, fighting sleep; prefer to lie down	6
No longer fighting sleep, sleep onset soon; having dream-like thoughts	7
Asleep	X