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Fatigue and coping with driver distraction

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Distraction while driving can divert attention away from the driving task and can, as a consequence, have irretrievable effects on driving performance. Driving is a task that particularly requires selective attention from moment to moment as well as sustained attention over the duration of a drive. Factors, such as fatigue, that reduce the capacity to pay attention to the driving task can seriously impair driving performance. In fact, fatigue can be viewed as an internal source of driver distraction due to its effects on attention. On the other hand, some effects of fatigue suggest that tired drivers may be less affected by distraction. This presentation will review the findings of research on the effects of fatigue on performance, including the effects on vision, reaction speed, selective and sustained attention and decision-making. The implications of these findings for driving and for coping with distraction while driving will be discussed.

Fatigue is recognized as one of the major problems for road safety. Fatigued drivers are at considerably higher risk of crashing due to their reduced capacity to respond to the information processing demands of the driving task. For example, the Auckland Car crash case-control study showed that the risk of injury-related crashes increased significantly for self-reported sleepy drivers, for drivers with five hours sleep or less and for drivers on the road between 02:00 and 05:00 hours (Connor et al, 2002). Similarly, Cummings et al (2001) showed a clear relationship between long distance driving and increased crash risk, with drivers doing more than 600 mile journeys showing a more than ten times increased risk of crashing. Current estimates of the involvement of fatigue in crashes suggest that in NSW fatigue plays a role in around 20 percent of fatal crashes (RTA, 2002). This is a similar level of involvement to the role of alcohol in fatal crashes.

Fatigue presents greater problems for road safety, however than other driver behaviour-related problems like alcohol and speeding. Fatigue is a hypothetical process which cannot be measured directly. Fatigue measurement relies on measures of its effects, such as on self-rated feelings, driver performance and changes in physiological state. Definitions of fatigue emphasise factors like tiredness, adverse effects on performance in response to repeated stimulation by the same stimulus, problems of sustained attention and a range of effort-related experiences such as unwillingness to continue with the task or the inability to continue putting effort into the task. These characteristics make management of driver fatigue a challenge for road safety.

In the context of a discussion on driver distraction, the issue of fatigue may be relevant on at least two levels. First, fatigue, itself may be considered to be a distractor. Second, vulnerability to the effects of distractors while driving may vary when a driver is fatigued. In this presentation, each of these aspects will be considered in turn.

Fatigue as a distractor:

Fatigue can be thought of as a form of internal distraction. Many definitions of driver distraction specify that it is a form of inattention that shifts attention away from the task at hand. For example, the US National Highways and Transport Safety Administration categorised four distinct types of driver distraction including visual, auditory, physical and cognitive distraction. The last category is particularly relevant to the current discussion of fatigue and distraction. The NHTSA definition of cognitive distraction includes “any thoughts that absorb the driver’s attention to the point where they are unable to navigate through the road network safely and their reaction time is reduced” (NHTSA, 2002).

Definitions of fatigue similarly include reductions in attention, especially under conditions requiring sustained attention and in tasks with little variety. For example Brown (1994) defined driver fatigue as a disinclination to continue performing the task at hand and a progressive withdrawal of attention from road and traffic demands. Such definitions are consistent with the idea that fatigue is an internal distractor from the driving task as they include attentional withdrawal from the driving task.

The effects of fatigue on performance are also similar to the effects of external distractors. Fatigued drivers show slowing of reaction speed and missing of relevant information, especially visual signals compared to drivers who are not fatigued (Dinges, et al, 1997). These performance effects tend to increase markedly with increasing time on task, an effect called the vigilance decrement (Davies and Parasuraman, 1982; Warm, 1984). This effect is accentuated when the task is monotonous such as is often the case when driving. Under these conditions the continuous requirement to sustain attention at a sufficiently high level to maintain good driving performance produces a high workload for the driver (Hancock and Warm, 1989). The level of workload increases with increasing time at the wheel, also making fatigue effects increasingly more likely.

Other effects of fatigue include changes in mood states (Broadbent, 1979), attentional narrowing (Easterbrook, 1959), less analytical processing of information, especially poorer planning and tendency to perseverate on particular strategies (van der Linden, Frese and Meijman, 2003) and reduced effort in the task (Smit, Eling and Coenen, 2004). All of these effects are likely to have adverse effects on driver performance and safety. These effects contribute to the evidence that fatigue and the effects of fatigue have the effect of distracting the driver away from the primary task of driving.

Fatigue occurs due to three main causes: time on task, time of day and the length of time awake or amount of sleep obtained recently. The effects of fatigue differ somewhat depending on the cause, although slowing of responses, missing of signals and the tendency to apply less effort seem to be outcomes of fatigue no matter what the cause. It can be concluded then that fatigue effects on driving look like the sorts of effects we see when a driver is distracted, although the causes are due to the driver’s internal state, not to an external distraction.

Fatigue and vulnerability to external distractions

The second link between fatigue and driver distraction relates to the extent to which tired drivers are vulnerable to the effects of external distractors. Some of the effects of fatigue are likely to have an effect of moderating the driver’s response to external distractors. As mentioned above, there is some evidence that attentional narrowing is more likely under

conditions of fatigue. While this narrowing effect may reduce the amount of attention being paid to the task of driving, it may also reduce the driver's susceptibility to external stimuli and so make them less vulnerable to the distraction effect. Related to this is the fatigue-related effect of changes in effort being applied to the task (Hancock and Warm, 1989). This effect has been shown to result in concentration on aspects of the task that are simpler and require less effort. This effect may result in drivers focusing only on the main task of driving, so again making them less vulnerable to external influences that are potential distractors.

There is some evidence for greater vulnerability of tired drivers to external distractors. There is evidence that drivers attempt to control their increasing fatigue levels, especially those relating to monotony and the requirements for long periods at the same task, by increasing the amount of stimulation available in the task environment. For example, research on long distance truck drivers shows that they employ a range of different strategies to help them overcome the effects of fatigue (Williamson, Feyer and Friswell, 2000). These include listening to the radio, talking on the mobile telephone or CB radio, eating, drinking or smoking cigarettes. Most of these strategies have been implicated as potential external sources of distraction. It is possible then, that the strategies that tired drivers use to moderate the effects fatigue may increase the amount of distraction so further increasing their level of inattention to the main task of driving.

Conclusions

Fatigue may be related to driver distraction due to its similar affects of withdrawing attention from the main task of driving. In this sense fatigue could be considered to be an internal distractor due to the effect of the current state of arousal and alertness of the driver. Furthermore, some of the strategies that drivers use to manage fatigue while driving fall into the category of external distractors (including using mobile phones and conversing on the CB radio) and so are also likely to increase the withdrawal of attention from the driving task in drivers who are beginning to experience fatigue. On the other hand, some of the characteristics of the effects of fatigue may actually reduce the vulnerability of a fatigued driver to attentional capture by external features in the driving environment. Effects due to tunneling of attention and the tendency to move to simpler and less effortful approaches to the driving task may reduce the inclination for drivers to be distracted by external stimuli. Further research is needed to establish whether fatigue effects do moderate the effects of external distractors while driving.

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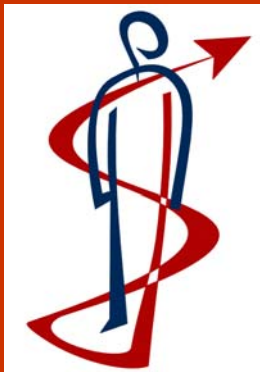
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PRESENTATION SLIDES

Fatigue and coping with driver distraction



A/Prof Ann Williamson

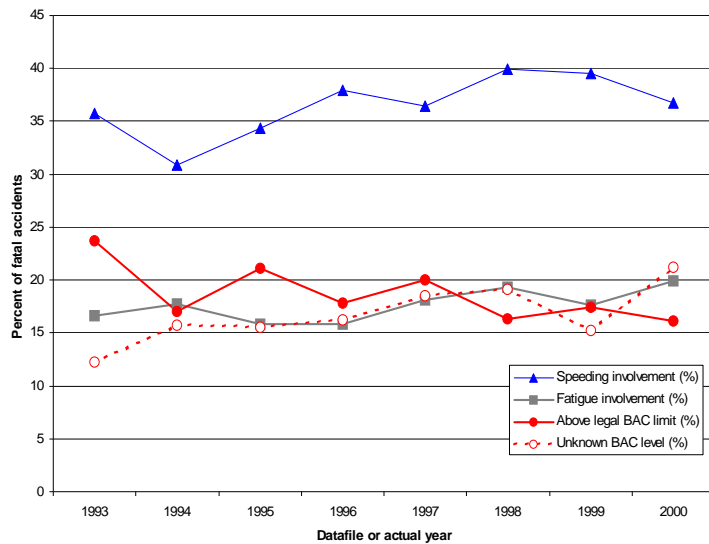
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Effects of fatigue on performance, eg: driving

Percent of fatal accidents involving fatigue, alcohol, and speeding: 1993-2000



Cognitive distraction (NHTSA)

- * “Any thoughts that absorb the drivers’ attention to the point where they are unable to navigate through the road network safely and their reaction time is reduced”



Fatigue and distraction

Fatigue = internal distractor

Evidence that effects of fatigue reduce driver’s capacity “to navigate the road environment safely and reduce their reaction time”



Fatigue - what is it?

- Of 18 different definitions, common fatigue characteristics include:
 - subjective state, tiredness,
 - change in psychophysiological state
 - response to sustained performance
 - change in alertness/ vigilance/ attention (effects)
 - reduction in performance
 - effort-related features (e.g., unwillingness to continue, resistance to apply further effort, aversion to investing further effort into task, dislike of current activity).



Causes of fatigue

- Time on task (including monotonous conditions, prolonged time at work, especially with enforced repetition of the same actions)
- Time of day
- Time awake/amount of sleep



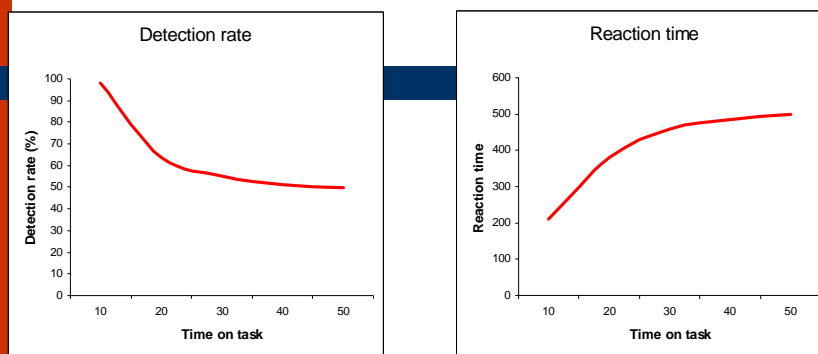
Effects of fatigue

(especially relevant to distraction)

- vigilance decrement - reduced capacity to sustain attention
- slowing reaction time
- missing signals (including visual information)
- narrowing of field of attention (including visual field)
- less analytical information processing
- reduced effort applied to task

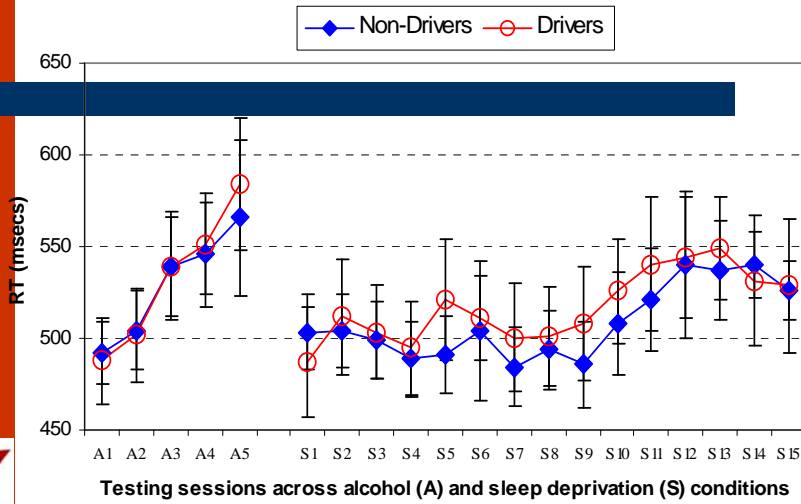


Time-on-task effects: The vigilance decrement

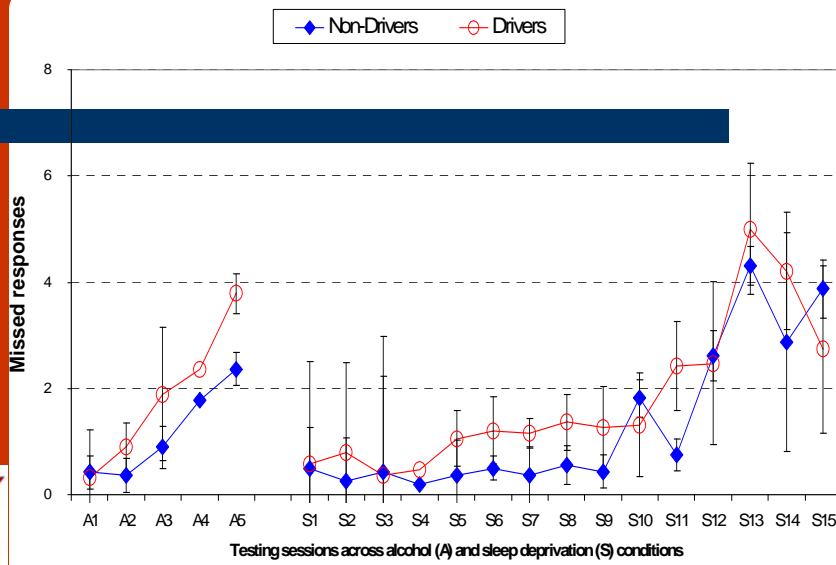


(Davies and Parasuraman, 1982; Warm, 1984)

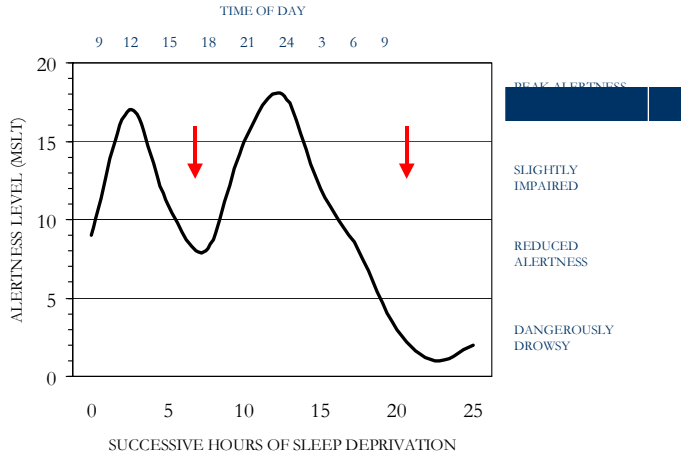
Reaction time - speed of response



Reaction time: Number of missed responses



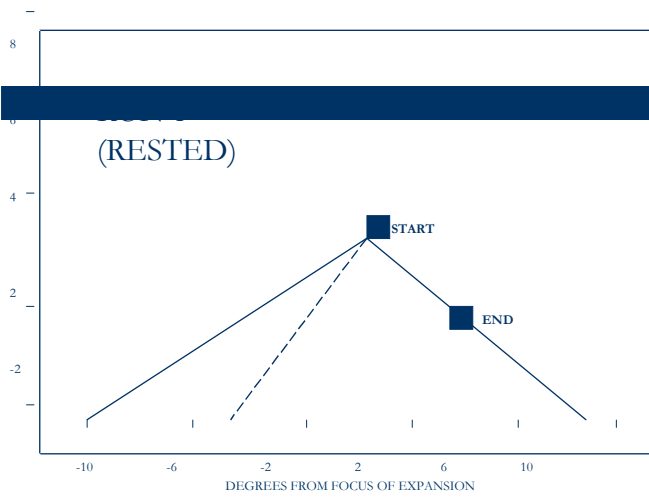
Effects of interaction between sleep deprivation and time of day



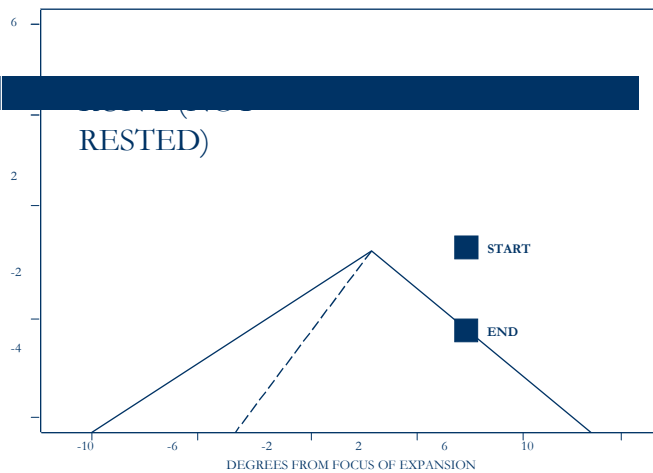
↓ Periods where internal 'distraction' most likely



Effects of sleep deprivation on vision while driving



Effects of sleep deprivation on vision while driving

Fatigue effects that *could* moderate driver distraction

- Attentional (and visual) “narrowing” that occurs with increasing fatigue may reduce driver susceptibility to distractors due to external stimuli
- Tendency to reduce effort by perseverance with aspects the task that are simpler, easier or require less “work” may cause tired drivers to focus on the main task of driving.



BUT

- Some of the strategies tired drivers use to maintain alertness and overcome fatigue may be distractors, e.g.;
- listening to the radio, talking on CB, singing, eating, drinking, smoking, *using mobile phone etc.....*



Conclusions

- Fatigue results in an internal state for the driver that can distract from the driving task
- Fatigue affects driving performance in similar ways to the effect of external distractors
- Specific effects of fatigue (attentional narrowing) may moderate the effects of external distractions on driving
- Measures taken by drivers to control fatigue may cause driver distraction.

