Reassessing action on driver fatigue: Driver responsibility for fatigue risk management

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Fatigue: road safety issue

• Recognised as a contributor to crashes
  – Estimated 18% of fatal crashes
  – Fatigue-related crashes more serious
• ? classification of fatigue involvement in crashes
  – single vehicle off road, at night etc
  – (known poor validity of classification)
• (also a problem for other transport modes)
Current and traditional approaches to reduce driver fatigue....

• Primary approach:
  Telling drivers to stop and take a break (rest, power nap, etc) when they feel tired or note the symptoms of fatigue
  – Common in every state in Australia and many international jurisdictions

• But what if drivers can’t tell when they should stop?
If drivers CAN’T predict

- Advising drivers to stop driving when tired will not be effective

→ Need solutions that provide drivers better information about their current state, e.g., in-vehicle drowsiness detection devices, vehicle performance measures that provide information to drivers

If drivers CAN predict

- Drivers are aware of current state so **should** be able to make the decision to stop.

→ Need solutions that increase motivation to do the right thing, e.g., penalties for driving while fatigued, including fines, loss of points, prosecutions.
What do we know already?

- People can detect:
  - ↓ alertness, ↑ fatigue, ↑ sleepiness

Drivers asked to drive until too tired to keep going:
- Almost everyone gave up at same level of subjective fatigue, but differed in rate of becoming fatigued (range 40 to 180 mins). *(Nilsson et al, 1997)*

- Advice to stop after a certain time (e.g., 2 hrs) will not suit everyone, better to respond to fatigue symptoms
Evidence

• Mixed effects on prediction of ↓ performance

• Low to moderate and variable correlations between predicted/actual performance across performance tests in lab (Dorrian, et al, 2000; 2003)

• ↑Subjective sleepiness associated with ↑ incidents in driving simulator (Reyner and Horne, 1998)

• No relation between self-related fatigue and performance in on-road studies (Belz et al., 2004; Williamson, et al., 2000)
Evidence

• Poor prediction of sleep onset.

  – Likelihood of sleep higher before sleep than if sleep didn't occur, (78% Vs 42% likelihood) but association poorer for first sleep episode (55% Vs 42%) (Kaplan et al., 2007)
  – Overestimation of time to fall asleep and lack of awareness of being asleep (Baker et al. 1999)
  – People can maintain simple, skilled performance in early stages of sleep (eg., in lab, Ogilvie, et al., 1999; US truck drivers, Mitler et al., 1997)
Aim

• To examine the relationships between awareness of decreasing alertness, increasing fatigue and drowsiness and driving performance in a simulator.

How well can drivers predict the onset of sleepiness, falling asleep and crash risk before crashing?
Method

Design:

• Two hour simulator drive in monotonous terrain.
• Sleepiness increased by:
  Participants asked to have 5 hours sleep on night prior (actigraph validated) and testing between 14:30-16:30h

➢ Purpose:
  To ensure that drivers will be tired
Study design

- 90 Drivers made judgements of current state over 2 hour drive.
- 3 conditions:
  1. Unprompted button press for likelihood of crashing
  2. Prompted ratings (~every 200secs) of sleepiness, likelihood of falling asleep and likelihood of crashing in the next few minutes
  3. Prompted ratings (~every 200secs) of sleepiness and likelihood of falling asleep, unprompted button press for likelihood of crashing

- Purpose:
  Counterbalancing of potential re-arousing effects of driver self-ratings during the drive (prompted or unprompted ratings)
Simulator and Procedure

- STIMSIM PC-based simulator
- Prompted conditions, ratings at beep every ≈ 200 secs
- **Sleepiness** measured by KSS (9 point scale)
- **Likelihood of falling asleep** or **likelihood of crashing** over the next few minutes by 5 point scale
- Unprompted button press (likely to crash) as required by participant
- Drowsiness measured by Optalert
- Driving performance: lane deviation, speed compliance
- Crashes and centreline crossings
Results

• Analysis format:

Fatigue/Sleepiness - Ratings → Performance - Lane excursions → Crashes

This presentation looks at:
Do feelings of fatigue/sleepiness, likelihood of falling asleep and likelihood of crashing precede crashes or centreline crossings?
Participants

- Mean age = 45.8 yrs (21-68yrs)
- Female = 56.8%
- Most had drivers licence > 10yrs (83.5%)
- Most drove at least once per week (90.6%)
- Mean usual distance driven = 140km (2 – 800km)
- BMI = Australian range of normal (28% overweight, 19% obese)
- Epworth Sleepiness scale within normal range, low frequency of sleep problems, Apnea risk low
- No difference between three groups for any of above
Sleep before test session

- Instructed to maintain normal daily practices (eg., caffeine, alcohol); no participants exhibited excessive behaviour.
- No statistically significant difference between three groups.

Sleep before test session

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average sleep time</strong> (diary/actiwatch validated)</td>
<td>4:24hrs</td>
<td>00:47-5:52</td>
</tr>
<tr>
<td><strong>Rated Sleep quality</strong> (/100, high=best)</td>
<td>57.9</td>
<td>7-100</td>
</tr>
<tr>
<td><strong>Rated Refreshed on waking</strong> (/100, high=best)</td>
<td>36.7</td>
<td>0-83</td>
</tr>
<tr>
<td><strong>Time: waking to test</strong></td>
<td>8:02hrs</td>
<td>4:37-11:31</td>
</tr>
</tbody>
</table>

- No difference between three groups for any of above
Comparing Conditions

![Graph showing similar increasing patterns for all rating measures across the drive.](Image)

Few differences between groups so data combined
Patterns of safety-related outcomes

- 34.5% drivers had at least one crash, nearly half crossed centreline and almost all crossed road edge at least once.
- No differences in number of first crashes between groups
- Crashers/no crashers not different on any demographic, personal or recent behavioural characteristics.
- Button press to signify likelihood of crashing not related to actual crashes
Changes in ratings over drive: crashers and non-crashers
Ratings for drivers with and without centreline crossings
Do ratings predict crashes?
Survival analysis using Cox regression

- Ratings of falling asleep predicted first off-road crashes ($X^2_{(1)}=6.24, p<0.01$)

- Drivers rating falling asleep as possible/likely/very likely in the next few minutes increased hazard of first off-road crash by 4.3 times compared to those rating crashing as very/unlikely.

- Neither Sleepiness or Likelihood of crashing predicted crashes
Do ratings predict centreline crossings?

- Ratings of sleepiness and falling asleep predicted first centreline crossings ($X^2_{(1)}=6.24, p<0.01$)

- Rating high sleepiness in the next few minutes = 10.4 times higher hazards of crossings.

- Rating high likelihood of falling in the next few minutes = 9.4 times higher hazards of crossings.
Conclusions – Study design

1. Simulated drive produced increasing sleepiness (KSS), ratings of likelihood of falling asleep and of crashing.
   ➡️ Study manipulation was effective

2. Prompting ratings did not affect numbers of crashes or rating levels
   ➡️ No unintended effects of prompts
Can we detect when we are too tired to drive?

YES

- Drivers are clearly aware of increasing sleepiness and likelihood of falling asleep and of crashing
- Drivers who felt that they possibly could fall asleep in the next few minutes, were at least four times more likely to crash and showed 9 times the hazard of centreline crossings.
- Drivers who rated sleepiness as likely subsequently crossed centrelines 10 times more often than those who were alert
- Drivers’ prediction of crash likelihood (prompted or not) was not as good.
What does this mean?

• Drivers ARE aware of increasing sleepiness, and increased likelihood of falling asleep BEFORE safety-related outcomes occur.
• Effect does not extend to crash likelihood.
• Higher ratings associated with safety-related outcomes.
• Drivers can make an ‘informed decision’ about the safety of their driving when fatigued.
What do we tell drivers about fatigue management?

Message to drivers:

• Drivers DO know that they are getting increasingly more tired so can choose to do something about it or not.

• Driving when tired is a road safety decision the same as the decision to drink and drive or to drive above the speed limit.
How do we influence drivers?

• We need solutions that increase motivation to manage fatigue (stop and rest or change to different activity), e.g.:

Punitive approaches: penalties for driving while fatigued, including fines, loss of points, prosecutions.

Facilitatory approaches: providing rest areas especially those that encourage people to use them, education on the need for responsible fatigue management as a driver.
Acknowledgements

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Survival plots for ratings preceding CRASHES
Survival plots for ratings preceding Centreline Crossings