The efficacy of driver performance and subjective measures for investigating fatigue and distraction: A simulator study

Christine Mulvihill[a], Tim Horberry[a], Michael Fitzharris[a], Michael G. Lenne [b], Jonny Kuo [b], Nico Riquelme[b], Darren Wood[c], Mitch Peden[d]

[a]Monash Univeristy Accident Research Centre, Monash University, VIC, Australia; [b]Seeing Machines Ltd, 1/11 Lonsdale St, Braddon, ACT, Australia; [c]Ron Finemore Transport Services Pty Ltd, Wodonga, VIC, Australia; [d]Volvo Group Australia, Wacol QLD, Australia

Abstract

Driver fatigue and distraction contribute to a significant proportion of traffic fatalities and injuries worldwide. This paper presents a sub-set of results from an ongoing collaborative research program to develop and evaluate driver state monitoring technology to reduce road trauma. Seventy participants completed simulated drives and a secondary task distraction protocol under both drowsy and alert conditions. Preliminary results show that under the drowsy and distracted conditions, drivers experienced a higher proportion of lane exceedances and crashes than when they were alert and non-distracted, and were more likely to self-report higher levels of subjective sleepiness when drowsy.

Background

Driver fatigue and distraction remain significant contributing factors to crashes worldwide. In Australia it is estimated that 20-30 percent of all fatal crashes are due to fatigue (Williamson & Friswell, 2013). Distraction is a similarly pervasive problem, accounting for as many as one in ten fatalities on Australian roads (Centre for Road Safety, 2017).

Driver state monitoring technology offers great potential to reduce trauma associated with driver impairment (Lenne & Fitzharris, 2016; Fitzharris, Liu, Stephens & Lenne, 2017). Despite a recent surge in research in this area, much of it is informed by single measures of drive state only. In order to be effective, the technology should be based on those measures that are most sensitive to detecting changes in driver state in four broad areas: physiological, subjective, visual behaviour and subjective measures. This project uses all four measures to inform the development and evaluation of driver state monitoring technology to reduce fatigue and distraction related incidents. The current presentation examines the efficacy of a sub-set of these measures - driver performance and subjective workload, based on the results of a driving simulator study.

Method

Participants

80 car drivers are being recruited from the Monash University Accident Research Centre (MUARC) participant database and via advertisements placed on billboards and on-line (Ethics Approval No. 8247). At the time of writing, 70 drivers have completed the study.

Advanced driving simulator

The MUARC Advanced Driving Simulator consists of a Holden Calais cab mounted on a 4 degrees-of-freedom motion platform in a climate controlled room with a half cylinder forward screen and a flat rear screen. The programmed simulator scenario comprised a monotonous drive on a rural two-lane highway ranging between 80-100 km/h. Ambient traffic was present but infrequent, with light levels maintained at a low, constant level.

Experimental design

Participants completed three sessions on separate visits to MUARC: a briefing session to screen for simulator sickness and obtain consent, and then an 'alert' and 'drowsy' session in counterbalanced order. The latter two sessions comprised two 30 minute blocks of baseline driving and two 30 minute blocks of secondary task driving. The secondary task comprised 10 minute blocks of visual distraction, cognitive distraction and combined visual and cognitive distraction (high workload). Task ordering of the secondary task blocks was counterbalanced across participants.

Results

A 2 (Drowsy or Alert) x 2 (Distraction or Baseline) repeated measures ANOVA will be used to analyse the data. Indicative results show that under the drowsy condition, drivers experienced a higher proportion of lane exceedances and crashes than when they were alert, and were more likely to self-report higher levels of subjective sleepiness. Under the distraction condition, drivers experienced a higher proportion of lane exceedances and crashes than baseline, and were more likely to self-report lower levels of subjective sleepiness. Results of the full analysis will be shown in the presentation.

Conclusions

Driving performance and subjective measures appear to be effective for measuring fatigue and distraction under simulated driving. Future stages of this research program will examine the efficacy of the full suite of measures in both simulator and on-road environments to inform the design of an effective driver state monitoring system.

References

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