Distraction in Shift-Workers During Naturalistic Driving

Jonny Kuo [1a], Michael G. Lenné [a,b], Megan Mulhall [c,d], Tracey Sletten [c,d], Clare Anderson [c,d], Mark Howard [c,d,e], Shantha Rajaratnam [c,d]

[1]jonny.kuo@seeingmachines.com
[a] Seeing Machines Ltd, 1/11 Lonsdale St, Braddon ACT, Australia
[b] Monash University Accident Research Centre, Monash University, VIC, Australia
[c] Cooperative Research Centre for Alertness, Safety and Productivity, VIC, Australia
[d] Monash Institute of Cognitive and Clinical Neurosciences, School of Psychological Sciences, Faculty of Medicine, Nursing and Health Sciences, Monash University, VIC, Australia
[e] Institute for Breathing and Sleep, Austin Health, VIC, Australia

Abstract

Driver drowsiness is a significant public health problem and has previously been linked to an increase in driver distraction (Anderson & Horne, 2013). This relationship has yet to be examined under naturalistic driving conditions, where task demands may differ from lab-based experimental studies. Using a continuous driver monitoring system, shift-workers (N=20) were observed on their commutes to and from work. Our findings showed that measures of visual distraction increased significantly with drowsiness in real-world driving. This study presents a world-first application of continuous monitoring of behavioural and physiological signals associated with distraction in real-world driving.

Background

Driver drowsiness is attributable to between 13 – 21% of all crashes and has previously been shown to be associated with an increased propensity to become distracted (Anderson & Horne, 2013; Tefft, 2012). Assessment of such driver states in previous studies been a significant challenge due to a reliance on manual analysis of video data. Real-time driver monitoring, as used in this study, presents significant advantages in this context in terms of supporting the collecting of a wider range of driver features and with greater accuracy while also removing the need for hundreds of hours of video analysis. This study aimed to examine the behavioural and physiological antecedents to driver distraction and under naturalistic driving conditions where task demands may differ from controlled experimental studies and where drivers may freely engage in additional secondary behaviours.

Method

The current study observed shift-workers (N=20) during their commutes to and from work over alternating periods of day and night shifts. Participants drove a study vehicle (Honda Jazz with automatic transmission) equipped with Seeing Machines' proprietary automotive-grade driver monitoring system. For the purposes of this study the DMS classifies a driver's direction of attention through a real-time analysis of head pose, gaze and pupil metrics and eyelid opening.

Participants drove the instrumented study vehicle for a period of up to two weeks, balanced across baseline and night shift driving. No constraints were placed on participants' usage of the study vehicle or engagement in secondary behaviours.

Drowsiness was assessed via PERCLOS, a measure of the proportion of time that the eyes are closed over a given percentage calculated as percentage eye closure > 80% over a 20-minute window (Wierwille et al., 1994). Trips with max PERCLOS levels of at least 0.15 were classified as drowsy.

Driver attention was assessed via total eyes-off-road, lap glances, and centre console glances. Total eyes-off-road was operationalised as the rate per hour of glances away from the forward roadway

for durations of at least 3 seconds. Lap and centre console glances were defined as the rate per hour of glances toward the respective regions of any duration. All gaze-based metrics (including PERCLOS) were derived automatically from the driver monitoring system.

Linear models with participant as random factor were specified for each of the dependent variables, with drowsiness as the independent variable.

Results

All models showed statistically significant differences between drowsy and non-drowsy trips, with drowsy trips generally being associated with increases in potentially distracting glance behaviours except for console glances which demonstrated a small decrease (Table 1).

Table 1 – Descriptive statistics and linear modelling outputs for glance based metrics

	Drowsy		**Not Drowsy**		**Linear Modelling**		
	M	SEM	M	SEM	F (1,255)	β	*P*
Off-road glance rate (>3s)	29.77	2.12	25.86	1.68	9.88	0.09	0.002
Lap glance rate (all)	309.31	27.80	289.30	18.94	54.52	-0.07	<0.000
Console glance rate (all)	14.76	1.37	15.84	0.81	19.46	0.18	<0.000

Impact

This study presents the first application of a continuous automated and real-time analysis of naturalistic driver-facing video. The present findings on visual distraction closely follow previous lab- and simulator-based studies on drowsy drivers showing increased propensity to distraction following sleep deprivation. Our findings carry substantial impact not only within the topics of drowsiness and distraction, but are also broadly applicable in the context of naturalistic driving methodology where real-time assessment of driver state can facilitate the analysis of large naturalistic datasets.

References

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