

SYMPTOMS OF DRIVER FATIGUE ON LONG CAR JOURNEYS AND RECENT COLLISION INVOLVEMENT

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INTRODUCTION

Automobile accidents are a major cost to modern society through death, injury, physical and psychological trauma, road network disruption, emergency service deployment, and elevated personal insurance and inconvenience costs. Sleep-related vehicle accidents (SRVA's) are a common form of highway accidents (Horne and Reyner, 2001). Research from Loughborough Sleep Research Unit has indicated that at least 10% of all UK road accidents and one in five of accidents on motorways and trunk roads are caused by driver sleepiness (Horne and Reyner, 2000). Both drivers and passengers of cars become fatigued during long hours spent driving (El Falou et al, 2003). Referred to as time-on-task effect, this is known to produce a deterioration of driving performance (Thiffault and Bergeron, 2003). Fatigue involves both physiological and psychological processes and Brown (1994) characterised fatigue on the road as a "disinclination to continue performing the task at hand and a progressive withdrawal of attention from road and traffic demands".

SRVA's typically involve running off the road or into the back of another vehicle, with no braking beforehand. Sagberg (1999) reported that sleep or drowsiness was a contributing factor in 3.9% of all accidents reported by 9200 Norwegian accident-involved drivers. This factor was strongly over-represented in night time accidents (18.6%), in running-off-the-road accidents (8.3%), accidents after driving more than 150km on 1 trip (8.1%) and personal injury accidents (7.3%). Fatigue is often implicated in single-vehicle crashes, and on average these result in more severe injury than multi-vehicle crashes (Connor et al, 2001).

Driving while tired is one area where research has informed current UK road safety policy and practice. For example, the LARSOA website currently carries a story about Road Safety Officers targeting motorists at a motorway service station at Easter 2004 and dispensing information:

"Instead of trying to fight off drowsiness by opening a window or turning up the radio – which have been proven not to work – drivers were advised to:

- Plan their journey to include a 15-minute break every two hours*
- Find a safe place to stop if they feel drowsy – not the hard shoulder*
- Drink two cups of coffee or a high-caffeine drink, then take a short nap to allow the caffeine to kick in*
- Don't start a long trip if already tired*
- Remember the risks of an unusually early start to a long drive*
- Try to avoid long trips between midnight and 6am."*

This paper reports data from a study of drivers in the Strathclyde region of Scotland (Campbell and Stradling, 2003a, b) who were questioned *inter alia* about the frequency with which they made long car journeys, the circumstances under which they did so, and the frequency of a number of behaviours identified in recent research as associated with elevating or reducing involvement in crashes while

driving tired. While respondents were not asked about their involvement in sleep-related road traffic accidents, it was possible to make comparison between the fatigue-related behaviours on long car journeys of those who had and those who had not been involved in any RTA as a driver in the previous 3 years.

SURVEY SAMPLE

A quota sample of 1121 drivers completed a twenty-minute in-home interview conducted by NFO System Three Social Research in the 12 local authority areas within the region covered by Strathclyde Police. This report focuses on the responses of 1091 respondents who held current car driving licences and had driven within the previous year and did not also drive an HGV (21 respondents) or bus or coach (7 respondents). 52% of these respondents were male, 48% female. The age of respondents varied from 17 to 86. The survey over-sampled the number of 17 to 24 year-olds interviewed. Further information on sampling strategy and demographics is given in Campbell and Stradling (2003a).

FREQUENCY OF LONG CAR JOURNEYS

Respondents were asked to indicate how often they drove by car on journeys of more than 2 hours or of over 100 miles, as part of their work and for personal business. Table 1 cross-tabulates the responses showing total percentages.

TABLE 1

FREQUENCY OF DRIVING FOR MORE THAN 2 HOURS OR ABOVE 100 MILES BY CAR, FOR WORK AND FOR PERSONAL BUSINESS

As part of work	Most days	On personal business						Total
		Once or twice a week	About once a fortnight	About once a month	Several times a year	About once a year or less	Never	
Most days	2	0	0	0	0	0	0	4.0%
Once or twice a week	0	0	0	0	0	0	0	1.8%
About once a fortnight		0	0	0	0	0	0	2.0%
About once a month		0	0	2	0	0	0	4.0%
Several times a year	0	0		0	3	0	2	6.6%
About once a year or less	0			0	0	1	0	2.7%
Never	3	3	3	7	23	13	28	79.0%
Total	5.5%	4.8%	3.5%	10.8%	28.9%	15.2%	31.3 %	100.0%

Total %. N = 1091

6% made long journeys 'most days' on personal business, 4% as part of work. 2% did both. 79% 'Never' made a long journey by car as part of their work, 31% never on personal business. Overall a quarter of the sample (28%) did neither and are omitted from subsequent analyses.

SYMPTOMS, CONTRA-INDICATED CONDITIONS AND PROPHYLACTIC BEHAVIOURS

On a 6-point scale from 1 Never to 6 Nearly all the time, respondents rated how often they experienced 24 sleep-related driving behaviours when on long journeys. Items were drawn from recent research showing, for example, that SRVA's peak around 2-6am and 2-4pm, when daily sleepiness is naturally higher (Horne and Reyner, 2001). Thiffault and Bergeron (2003) discuss how the 24h physiological circadian rhythm, or time-of-day effect, is a major factor that accounts for fatigue. Driving patterns that run counter to circadian rhythms have been shown to result in falling asleep while driving and causing crashes (Morrow and Crum, 2004).

TABLE 2

ROTATED COMPONENT MATRIX SHOWING ITEM WEIGHTINGS FOR 3 FACTOR SOLUTION

... on long journeys	1	2	3
Find your eyes closing or going out of focus by themselves	.67		
Have trouble keeping your head up	.66		
Find you have to keep jerking the vehicle back into lane	.57		
Find you cannot stop yawning	.56		
Continue when close to your destination even though feeling drowsy	.56	.36	
Have wandering, disconnected thoughts	.55		
Open a window or turn up the air conditioning to combat drowsiness	.53		
Turn up the volume on the radio/tape player/CD to combat drowsiness	.52		
Find that your journey schedule requires you to continue driving when feeling drowsy	.52	.52	
Find you can't remember driving the past few miles	.51		
Wander between lanes, close follow the vehicle ahead or miss traffic signs	.50		
Sing to yourself to combat drowsiness	.49		
Drift off the road	.47		
Drive after taking medication that advises against operating machinery			
Drive between 1am and 5am in the early morning		.74	
Drive when you would normally be falling asleep at home		.73	
Start after a full day or a full shift		.55	
Find that your journey schedule requires you to exceed the speed limit		.50	
Drive more than 400 miles without an overnight stop		.49	
Take a break of at least 15 minutes			.85
Take a break every 2 hours or 100 miles			.79
Take a caffeine-based drink during breaks			.67
Take a brief nap during breaks			.42
Drive between 2pm and 4pm in the afternoon		.33	.39

Table 2 reports the factor structure of a principal components analysis of responses to these 24 items (KMO .877; Bartlett's Test of Sphericity significant at .000; display criterion 0.32; varimax rotation to 3-factor solution accounting for 38.86% of variance).

Three factors passed the scree test and these were interpreted as Symptoms of fatigued driving, Contra-indicated conditions, and Prophylaxes. Several items loaded on more than one factor, but the separation of the three factors suggests that levels of drowsiness (e.g., *Find your eyes closing or going out of focus by themselves on long journeys*) and loss of vehicle control (e.g., *Find you have to keep jerking the vehicle back into lane on long journeys*) which load on Factor 1, Symptoms, are statistically independent in this sample of Scottish car drivers of frequency of driving when fatigued (e.g., *Drive when you would normally be falling asleep at home on long journeys; Start after a full day or a full shift on long journeys*) which load on Factor 2, Contra-indicated conditions, and that both are statistically independent of the frequency of complying with recommended behaviours (e.g., *Take a break every 2 hours or 100 miles on long journeys; Take a caffeine-based drink during breaks on long journeys*) which load on Factor 3, Prophylactic measures.

Factor scores were saved for subsequent analysis.

Tables 3, 4 and 5 give an indication of the frequency with which each of these three types of behaviours were reported by all car driving respondents, showing the percentage reporting each Quite Often, Frequently or Nearly all the time (scale points 4 - 6) and the percentage reporting it ever (more often than 1 Never).

TABLE 3
FREQUENCY OF REPORTING SYMPTOMS OF FATIGUE ON LONG CAR JOURNEYS

[as % of those who make long car journeys]	More often than Never	Quite Often or more
Symptoms		
Open a window or turn up the air conditioning to combat drowsiness	63%	23%
Have wandering, disconnected thoughts	48%	9%
Find you cannot stop yawning	45%	7%
Continue when close to your destination even though feeling drowsy	42%	12%
Find you can't remember driving the past few miles	36%	7%
Turn up the volume on the radio/tape player/CD to combat drowsiness	32%	10%
Sing to yourself to combat drowsiness	25%	7%
Find your eyes closing or going out of focus by themselves	23%	2%
Wander between lanes, close follow the vehicle ahead or miss traffic signs	22%	1%
Have trouble keeping your head up	13%	<1%
Find you have to keep jerking the vehicle back into lane	11%	<1%
Drift off the road	8%	<1%

1 Never – 6 Nearly all the time

TABLE 4

**FREQUENCY OF REPORTING CONTRA-INDICATED CONDITIONS FOR
FATIGUE ON LONG CAR JOURNEYS**

[as % of those who make long car journeys]	More often than Never	Quite Often or more
Contra-indicated Conditions		
Drive between 2pm and 4pm in the afternoon	81%	40%
Find that your journey schedule requires you to continue driving when feeling drowsy	42%	12%
Find that your journey schedule requires you to exceed the speed limit	41%	8%
Drive when you would normally be falling asleep at home	38%	6%
Start after a full day or a full shift	35%	9%
Drive between 1am and 5am in the early morning	34%	6%
Drive more than 400 miles without an overnight stop	22%	3%
Drive after taking medication that advises against operating machinery	7%	1%

1 Never – 6 Nearly all the time

TABLE 5

**FREQUENCY OF REPORTING PROPHYLACTIC MEASURES TO COUNTER
FATIGUE ON LONG CAR JOURNEYS**

[as % of those who make long car journeys]	More often than Never	Quite Often or more
Prophylactic Measures		
Take a break of at least 15 minutes	84%	57%
Take a break every 2 hours or 100 miles	80%	51%
Take a caffeine-based drink during breaks	69%	43%
Take a brief nap during breaks	25%	7%

1 Never – 6 Nearly all the time

ASSOCIATION WITH SELF-REPORTED RTA INVOLVEMENT

While respondents were not asked directly about their involvement in sleep-related crashes, they did report the total number of road traffic accidents they had been involved in as a driver in the previous 3 years. 17% of the car drivers (19% of the males: 13% of the females) reported recent RTA involvement. General RTA involvement was not related to reported frequency of undertaking long car journeys as part of work or on personal business (it was related, though, to whether or not drivers had been flashed by a speed camera in the previous 3 years (Campbell and Stradling, 2003b) with drivers who had been recently detected speeding twice as likely to have also been RTA-involved).

Tables 6, 7 and 8 report comparison between those drivers who had and those who had not been crash involved in the previous 3 years of the mean scores on each of the symptoms of fatigue items (Table 6), contra-indicated conditions (Table 7) and

prophylactic measures (Table 8). The tables shows mean scores on the 1 – 6 scale for each group and the p value of the associated t-test. Items are arranged in descending order of p values.

TABLE 6

LEVEL OF FATIGUED DRIVING SYMPTOMS ON LONG CAR JOURNEYS FOR DRIVERS WITH AND WITHOUT RECENT RTA INVOLVEMENT

		RTAs last 3 y	
	p for t	None	Some
Symptoms			
Find your eyes closing or going out of focus by themselves	.000	1.29	1.55
Find you cant remember driving the past few miles	.000	1.63	2.00
Find you cannot stop yawning	.002	1.74	2.05
Continue when close to your destination even though feeling drowsy	.003	1.83	2.19
Open a window or turn up the air conditioning to combat drowsiness	.020	2.43	2.75
Have trouble keeping your head up	.025	1.16	1.27
Have wandering, disconnected thoughts	.026	1.88	2.13
Wander between lanes, close follow the vehicle ahead or miss traffic signs	.031	1.27	1.40
Turn up the volume on the radio/tape player/CD to combat drowsiness	.035	1.62	1.86
Sing to yourself to combat drowsiness	(.067)	1.49	1.69
Drift off the road	(.099)	1.09	1.15
Find you have to keep jerking the vehicle back into lane	ns	1.13	1.20

1 Never – 6 Nearly all the time

Drivers with a recent crash history show elevated symptom levels across all items, significantly so ($p < .05$) on 9 of the 12 symptoms.

TABLE 7

LEVEL OF CONTRA-INDICATED CONDITIONS FOR FATIGUED DRIVING ON LONG CAR JOURNEYS FOR DRIVERS WITH AND WITHOUT RECENT RTA INVOLVEMENT

		RTAs last 3 y	
	p for t	None	Some
Contra-indicated			
Find that your journey schedule requires you to exceed the speed limit	.000	1.67	2.20
Find that your journey schedule requires you to continue driving when feeling drowsy	.001	1.39	1.67
Drive when you would normally be falling asleep at home	.008	1.60	1.85
Drive between 2pm and 4pm in the afternoon	ns	3.09	3.25
Start after a full day or a full shift	ns	1.67	1.80
Drive between 1am and 5am in the early morning	ns	1.56	1.70
Drive more than 400 miles without an overnight stop	ns	1.36	1.49
Drive after taking medication that advises against operating machinery	ns	1.11	1.13

1 Never – 6 Nearly all the time

Drivers with a recent crash history showed elevated levels of commission across all items, but significantly so for only 3 of the 8 conditions.

TABLE 8

LEVEL OF PROPHYLACTIC MEASURES TO COUNTER FATIGUED DRIVING ON LONG CAR JOURNEYS FOR DRIVERS WITH AND WITHOUT RECENT RTA INVOLVEMENT

		RTAs last 3 y	
	p for t	None	Some
Prophylactic			
Take a brief nap during breaks	(.086)	1.47	1.63
Take a break of at least 15 minutes	ns	3.59	3.73
Take a break every 2 hours or 100 miles	ns	3.42	3.30
Take a caffeine-based drink during breaks	ns	3.03	3.13

1 Never – 6 Nearly all the time

Drivers with a recent crash history were no less likely to adopt fatigue counter-measures.

Table 9 shows the Pearson correlation coefficients between factor scores for the three fatigued-driving behaviour factors and RTA involvement, together with a number of other variables known to be associated with the latter: sex, age, years driving experience, annual mileage and whether the driver had recently been detected speeding.

TABLE 9

CORRELATION OF FATIGUED DRIVING FACTOR SCORES AND OTHER VARIABLES WITH RTA INVOLVEMENT

	r	p
Sex	-.08	.036
Age	-.14	.000
Years driving experience	-.11	.002
Annual mileage	.14	.000
Stopped by police for speeding or flashed by speed camera last 3 years	.17	.000
Symptoms factor score	.14	.000
Contra-indicated factor score	.08	.020
Prophylaxis factor score	.02	ns

Subsequent inclusion of all variables in linear stepwise regression analysis selects four of the predictor variables, in the order: detected speeding; age; Symptoms factor score; annual mileage.

CONCLUSIONS

Amongst a large sample of car drivers in the Strathclyde area of Scotland, 6% made long journeys 'most days' on personal business, 4% as part of work, 2% did both, and a quarter of the sample (28%) did neither.

Factor analysis of responses to a set of 24 drowsy-driving related items from those who did make long car journeys elicited three factors, labelled Symptoms, Contra-indicated conditions and Prophylaxes.

Drivers who have a history of recent RTA involvement report significantly higher levels of drowsiness and loss of vehicle control on long car journeys, a higher likelihood of making long car journeys under some, but not all, contra-indicated conditions, and show no difference in frequency of utilisation of recommended journey break procedures.

REFERENCES

- Brown, I.D. (1994) Driver fatigue. *Human Factors* 36, 298–314.
- Campbell, M. and Stradling, S.G. (2003a). *Speeding Behaviours And Attitudes Of Strathclyde Drivers*. Report to Strathclyde Safety Camera Partnership, Transport Research Institute, Napier University, Edinburgh.
- Campbell, M. and Stradling, S.G. (2003b). 'Factors influencing driver speed choices'. In Behavioural Research in Road Safety XIII. London: Department for Transport.
- Connor, J., Whitlock, G., Norton, R., and Jackson, R. (2001). The role of driver sleepiness in car crashes: a systematic review of epidemiological studies. *Accident Analysis and Prevention*, 33, 31-41.
- El Falou, W., Duchêne, J., Grabisch, M., Hewson, D., Langeron, Y., and Lino, F. (2003). Evaluation of driver discomfort during long-duration car driving. *Applied Ergonomics*, 34, 249-255.
- Horne, J. and Reyner, L. (2000). Arrive alive: tackling the killer problem of driver sleepiness. Loughborough Sleep Research Centre.
- Horne, J. and Reyner, L. (2001). Sleep-related vehicle accidents: some guides for road safety policies. *Transportation Research Part F*, 4, 63-74.
- Morrow, P.C. and Crum, M.R. (2004). Antecedents of fatigue, close calls, and crashes among commercial motor-vehicle drivers. *Journal of Safety Research*, 35, 59-69.
- Sagberg, F. (1999). Road accidents caused by drivers falling asleep. *Accident Analysis and Prevention*, 31, 639-649.
- Thiffault, P. and Bergeron, J. (2003). Monotony of road environment and driver fatigue: a simulator study. *Accident Analysis and Prevention*, 35, 381-391.
- www.larsoa.org.uk/news_april04/news04_m1_fatigue.html