Driver stress in response to infrastructure and other road users: Simulator research informing an innovative approach to improving road safety

Bridie Scott-Parker[a], Christian Jones[b], Joel Tucker[c]

[a]Adolescent Risk Research Unit, Sunshine Coast Mind and Neuroscience – Thompson Institute, University of the Sunshine Coast; [b]Engage Research Laboratory, Faculty of Arts, Business, and Law, University of the Sunshine Coast; [c] Royal Automobile Club of Queensland

Abstract

Recent research suggests the psycho-biophysical impact of stress can negatively impact health long after stressor exposure, in addition to increasing on-road discourteous driving behaviour. Twenty-two drivers participated in a simulated drive during which biophysical markers of stress (e.g., heart rate) were measured in response to interactions with stress-inducing/reducing infrastructure (roadworks, roundabouts; straight roads), manoeuvres (merging, overtaking; open roads), and road users (rude/oblivious/distracted/nice drivers). Findings suggest drivers experience increased stress during stress-inducing interactions, therefore recommendations regarding minimising longer-term negative impact of stress and which also improves road safety through courteous driving include interventions framed within enforcement, engineering, education and/or engagement.

Background

As part of a larger research project, driving conditions and circumstances which increase stress and are associated with driving discourtesy (either generated by the participant or by other road users) elucidated through focus group research (Scott-Parker, Jones, & Tucker, 2015) were used to inform the development of a simulated drive. This study aims to deepen our understanding of the relationship between driving dis/courtesy of other road users, and the nature of the interaction and infrastructure, and the stress experienced by drivers in the simulated driving environment.

Method

Twenty-two drivers aged 21-76 years (average of 45 years, 8 females) participated in two simulated drives over consecutive weekends. During drive one, participants were exposed to rude and distracted (or nice and oblivious, 'courteous drive') drivers, and during drive two, participants were exposed to nice and oblivious (or rude and distracted, 'discourteous drive') drivers, as they drove the same simulated driving course which contained key stress-provoking infrastructure and required key stress-provoking manoeuvres. In addition, key stress-reducing infrastructure and stress-reducing manoeuvres were also incorporated. Bio-physical markers of stress included alpha amylase (pre- and post-drive) and cardiac indicators.

Results

Cardiac measures

For drivers who completed the courteous drive on their first drive, there was only a moderate increase in heart rate, central systolic pressure, and central augmentation index, suggesting that the drive generally was not experienced as a stressful drive (see Table 1). In comparison, for drivers who completed the discourteous drive on their first drive, there was a moderate increase in diastolic blood pressure, mean arterial pressure, heart rate, central systolic pressure, central augmented pressure, and central augmentation index, suggesting that these drivers experienced the drive as a stressful drive. Interestingly, drivers experienced considerably more (less) physiological stress when they completed the discourteous (courteous) drive on the second occasion.

Table 1. Comparison of biophysical measures for drivers by stressful nature of each drive, by driving order, n=12

Variables	Courteous day 1			Courteous day 2	
	Pre PD (*n*=5)	**Pre ED (*n*=5)**	**Post ED (*n*=5)**	**Pre ED (*n*=7)**	**Post ED (*n*=7)**
Systolic BP (mmHg)	143±15	140±12	141±10	124±2	122±3
Diastolic BP (mmHg)	85±5	87±5	87±5	79±2	79±3
Mean arterial pressure (mmHg)	105±7	104±7	105±6	93±2	92±3
Heart rate (bpm)	79±2	78±4	81±4	79±4	74±5
Central systolic pressure (mmHg)	128±12	124±10	126±9	110±2	109±3
Central pulse pressure (mmHg)	42±11	37±7	38±8	29±3	28±3
Central augmented pressure (mmHg)	11±6	8±3	8±4	3±2	2±1
Central augmentation index (mmHg)	23±8	18±7	22±8	8±5	7±3
Variables	**Discourteous day 1**			**Discourteous day 2**	
	Pre PD (*n*=7)	**Pre ED (*n*=7)**	**Post ED (*n*=5)**	**Pre ED (*n*=5)**	**Post ED (*n*=5)**
Systolic BP (mmHg)	124±4	127±3	128±11	132±11	139±11
Diastolic BP (mmHg)	77±4	79±4	83±4	81±4	87±4
Mean arterial pressure (mmHg)	91±3	93±4	98±4	98±7	105±6
Heart rate (bpm)	66±3	69±4	72±5	78±3	84±5
Central systolic pressure (mmHg)	111±4	113±3	115±5	117±9	123±8
Central pulse pressure (mmHg)	33±3	32±2	30±3	35±6	34±7
Central augmented pressure (mmHg)	4±2	2±2	4±3	6±3	5±3
Central augmentation index (mmHg)	7±5	3±5	9±8	16±8	16±8

Values are presented as the mean ± standard error. PD = Practice Drive; ED = Experimental drive.

Heart rate variability

The average heart rate for each participant was calculated for every consecutive 30-second segment of driving, with the magnitude of heart rate variability determined by subtracting the average heart rate for the preceding 30-second interval from the heart rate for each second of the drive (starting from 30 seconds after driving commences). For the purposes of these analyses, it is assumed that 5bpm (+/-) variability at rest is an indicator that the participant is not stressed, therefore +/- 10bpm is considered meaningful and indicative of increased/ reduced stress experienced by the participant during the simulator driving activities. Figure 1 graphically depicts the heart rate variability for Participant 1, showing the increased stress experienced during the discourteous drive (second drive) compared to the courteous drive (first drive).

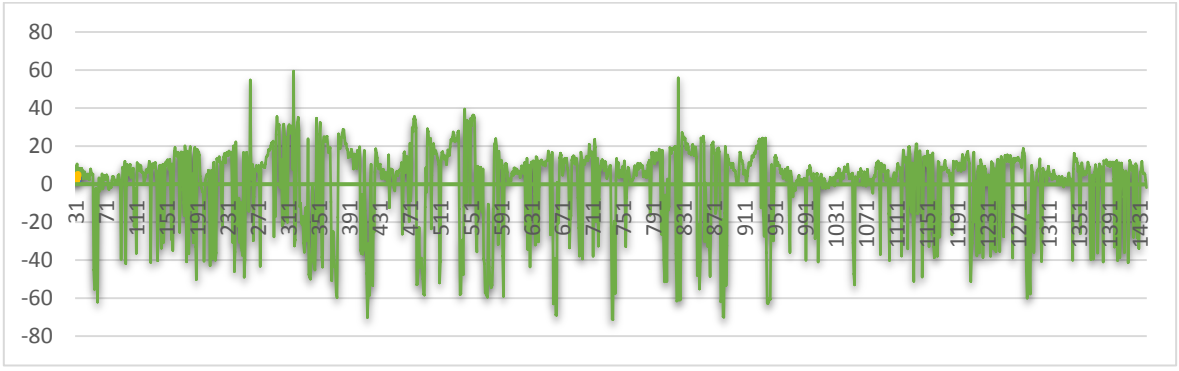

Figure 1a. Heart rate variability for Participant 1 during the courteous drive

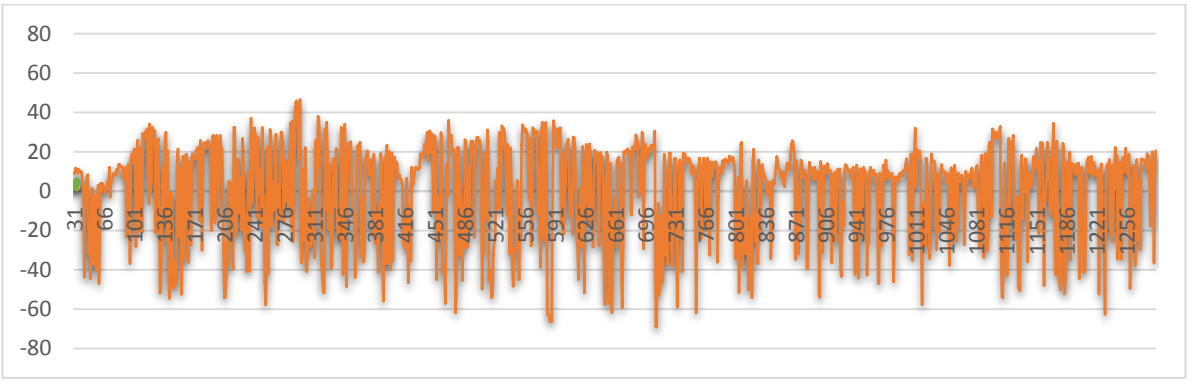

Figure 1b. Heart rate variability for Participant 1 during the discourteous drive

Analyses are currently underway in which the second-by-second heart rate response is examined in relation participant driving and other behaviours (e.g., gesticulations, speech) to (dis)courteous interactions. It is noteworthy that preliminary analyses indicate that driver behaviour changes in a negative manner, in addition to the biophysical markers of stress, in response to discourteous interactions. The study findings are expected to contribute to an innovative road safety campaign that improves road safety through increasing driver courtesy and decreasing driver discourtesy as a way to improve driver health both during and after the drive.

Conclusions

It appears there is a breadth of infrastructure-related and/or other-road-user-related interactions that contribute to driver stress which not only have impacts on the road user, both during and after the interaction, but that can potentially have long-term impacts on driver health beyond the road itself. In addition, such stress appears to evidence itself as discourteous driving behaviour during and immediately after the discourteous interaction. Intervention to reduce driving stress – a novel way of improving road safety – should focus upon education (e.g., merging rules), enforcement (e.g., posted speed limits), engineering (e.g., roadwork signage and practices), and engagement (e.g., encouraging road users to transfer non-stressful interactions and circumstances to stressful interactions and circumstances).

References

Scott-Parker, B., Jones, C. M., & Tucker, J. (2015). Holy crap that was close! A qualitative exploration of driving stress and driving discourtesy. In *Proceedings of the 1st Australasian Road Safety Conference*, Gold Coast Australia, 14-16 October 2015.