

Perceived risk, speed and countermeasures

Nicola J Starkey and Samuel G Charlton

Applied Cognitive Psychology/TARS Research Group, University of Waikato, New Zealand

Abstract

A large number of factors (including road design, traffic volume, complexity) have been shown to influence the risk that drivers feel in any given situation. Previously we have shown that curves, hills, road width and median barriers were the road features that best predicted drivers' perceptions of risk. The present study examined the relationship between drivers' perceptions of risk and the speed they choose to drive. High definition video footage of a series of rural road sections was presented to participants whilst they were seated in the driving simulator. During the first part of the task, participants were asked to adjust the speed of the car to whatever they would choose if they were driving their own car. After this, participants were shown the same clips again (either at the speed they chose or at the speed the footage was recorded) and were asked to provide a continuous rating of how safe or unsafe they felt. Analyses revealed that higher speeds were associated with lower levels of perceived risk. In general, scenarios with high traffic volumes were driven at lower speeds and rated as higher risk compared to low traffic scenarios. Interestingly though, neither speed or risk ratings changed as a result of high traffic volume on roads with a wire rope median barrier. The presence of a police car led to the greatest reduction in speed. These findings provide insights into the relationship between risk and speed and the effectiveness of a range of countermeasures.

Introduction

The role of risk as an important factor in driver behaviour has been the focus of numerous studies. Some researchers have suggested that individuals drive in such a way as to maintain a zero level risk of crashing (e.g., Summala, 1988) whereas others (Wilde, 1998; Fuller 2008) suggest that each driver has 'preferred' or 'target' levels of risk and their driving behaviour (e.g., speed) is altered to ensure an acceptable level of risk is maintained. Indeed, several studies have found that perceived risk increases as speed increases (e.g., Fuller, 2008).

We already know that drivers form subjective judgements about risk as they drive (e.g., Groeger & Chapman, 1996; Pelz & Krupat, 1974; Watts & Quimby, 1980). More recently, Charlton et al (2014) investigated the relationship between drivers' perceived level of risk and the objective risk of a sample of New Zealand's state highways. In general, drivers' perceived ratings of risk corresponded well with the levels of objective risk and curves, hills, road width, and median barriers explained 80% of the variance in the participants' ratings of perceived risk. While this study provided useful information about factors that contribute to perceptions of risk on rural roads, we do not yet know how perceived risk influences the speed that drivers choose, and how this relates to specific risk countermeasures (e.g., lane markings, median barriers, signs). Thus, the aim of this study was 1) to investigate the relationship between drivers' perceived levels of risk on rural NZ roads and the speed they would choose if they were driving those roads and 2) determine the influence of specific road features on drivers' speed and perceived risk.

Method

Participants (n=52; 24 male, 28 female) with full driving licences were recruited for the study, and had an average age of 34 years ($SD=11.97$, range = 18-58 years). Ethical approval for the

recruitment and test protocols was received from the School of Psychology Research Ethics Committee at the University of Waikato.

On arrival at the laboratory participants provided written informed consent. They then completed a simulator based speed and risk rating task. In brief, participants viewed high definition video of a series of road sections (recorded from the driver's perspective) whilst seated in the driving simulator. In the first part of the experimental session participants were asked to view the video clips and adjust their speed (using the accelerator and brake pedal) to a level that they feel comfortable with. After a short break, they viewed the same set of video clips and provided moment-to-moment judgments of driving risk (from "Safe" at one end and "Unsafe") using a small thumbwheel attached to the car's steering wheel that displayed their risk rating on a scale overlaid on the right hand side of the driving scene (based on Pelz and Krupat, 1974). During this part of the experimental session the speed of the vehicle was played back at either the speed the footage was recorded ($n = 23$) or the speed the participant chose during the first part of the session ($n = 29$) (a "linked" condition). After this, participants completed demographic and driving history questionnaires and were thanked and given a \$20 voucher.

Of particular interest were the speed and risk ratings for sections of video clips containing four types of road median (dashed white lines, double yellow lines, wide centre line and wire rope barrier) under high and low traffic conditions. In addition drivers' speed and risk ratings in response to two speed warnings, a police car and a high crash area sign were also compared.

Results

The correlation between perceived risk and speed was significant for the group that rated risk at the speed that the footage was recorded ($r = -.76$, $p < .001$) and for those rating risk at the speed they chose to drive ($r = -.55$, $p < .001$); in both cases lower ratings of risk were associated with faster speeds.

The speed that drivers chose under high and low traffic conditions with each of the four types of median is presented in Figure 1. A 2 (traffic) x 4 (median) repeated measures ANOVA revealed a significant interaction [$F(3,150) = 22.35$, $p < .001$, $\eta_p^2 = 2.31$] and significant main effects of traffic [$F(1,50) = 298.73$, $p < .001$, $\eta_p^2 = .86$] and median type [$F(50, 150) = 42.18$, $p < .001$, $\eta_p^2 = .46$]. High traffic conditions resulted in slower speeds, apart from in the presence of a wire rope barrier. Under low traffic conditions, speeds were significantly slower in the presence of a wide centre line compared to a dashed white centre line ($p < .001$), but a wire rope barrier resulted in significantly higher speeds ($p < .001$). With high traffic, double yellow lines and a wide centre line led to reduced speeds compared to a dashed white line ($p < .001$) but as with the low traffic condition, the presence of a wire rope barrier led to increased speeds. Figure 1 also shows participants' speeds before and after passing a police car and a 'high crash area' sign. A 2 (hazard) x 2 (time) repeated measures ANOVA revealed a significant interaction [$F(1,50) = 44.47$, $p < .001$, $\eta_p^2 = .47$], and a significant main effect of hazard [$F(1,50) = 24.13$, $p < .001$, $\eta_p^2 = .33$] and time [$F(1,50) = 100.93$, $p < .001$, $\eta_p^2 = .67$]. Both hazards resulted in a significant decrease in speed (both p 's $< .001$), but the police car led to a much greater decrease (15km/h compared to 2km/h).

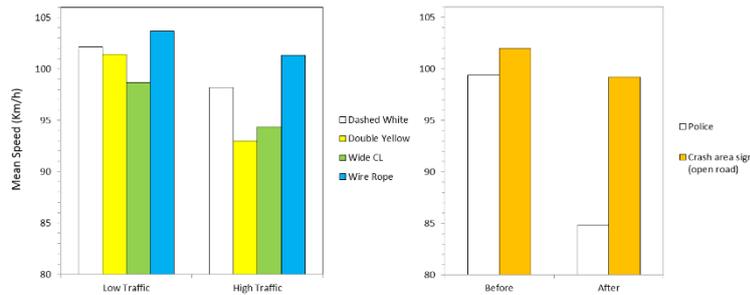


Figure 1. Mean speed in 1) high and low traffic conditions on roads with various median treatments and 2) Before and after passing a police car and high crash area sign.

Participants’ ratings of perceived risk for each of the four median types in the high and low traffic conditions are shown in Figure 2. Participants rated high traffic conditions as more risky than low traffic conditions [$F(1,46) = 93.9, p < .001, \eta_p^2 = .67$] and there were significant differences in risk rating associated with the different median treatments [$F(3,138) = 15.07, p < .001, \eta_p^2 = .25$] with the double yellow lines being associated with the highest risk ($M = 3.60$), followed by wide centre lines ($M = 3.26$), and wire rope barriers ($M = 2.93$) and dashed white lines ($M = 2.97$) receiving similar ratings. There was a marginally significant trend for the group that rated risk in the linked condition to give higher ratings [$F(1,46) = 3.58, p = .06, \eta_p^2 = .07$], compared to those seeing the video at the initial speed. Across all of the clips, the speed participants chose to drive ($M = 99.10, SD = 3.8$) was significantly higher ($t(7) = 9.31, p < .001$) compared to the initial speed driven when the footage was recorded ($M = 94.20, SD = 3.1$).

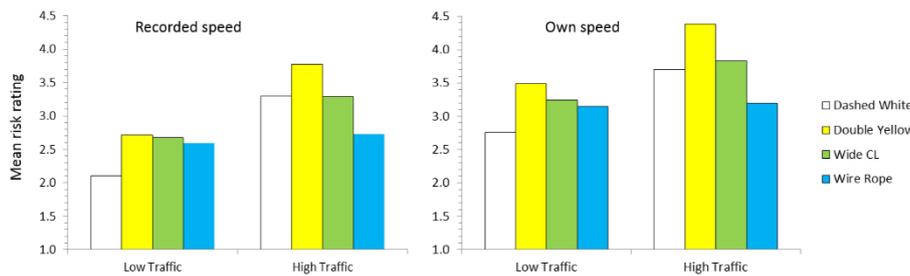


Figure 2. Mean risk ratings for participants in the high and low traffic conditions with four median treatments 1) viewing the clips at the recorded speed and 2) viewing the clips at the speed they chose to drive.

The risk ratings the two groups of participants gave when passing the police car and the high crash area sign are shown in Figure 3. Overall participants’ risk ratings were significantly higher in the presence of the police car compared to the high crash area signs [$F(1,46) = 4.72, p < .001, \eta_p^2 = .09$]. Risk ratings were higher after passing the speed warnings compared to before [$F(1,46) = 13.39, p < .001, \eta_p^2 = .23$] and the participants’ ratings in the linked speed condition gave significantly higher risk ratings those giving ratings at the initial recorded speed [$F(1,45) = 12.2, p < .001, \eta_p^2 = .11$], even though there was no significant difference ($p > .05$) between participants’ chosen speeds ($M = 96.35, SD = 7.8$) and the speeds driven when the video was recorded ($M = 90.46, SD = 10.0$).

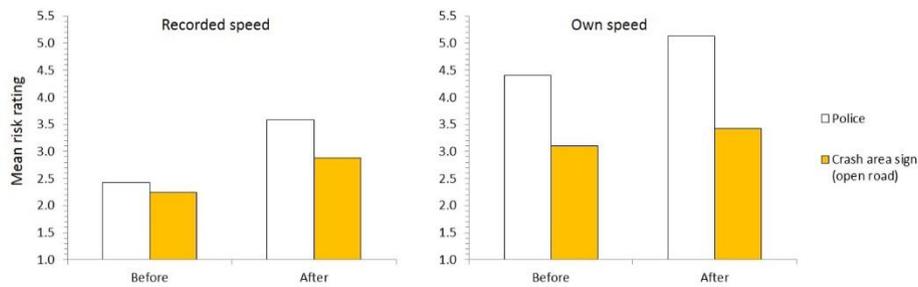


Figure 3. Mean risk ratings for participants passing the police car and high crash risk signs when 1) viewing the clips at the recorded speed and 2) viewing the clips at the speed they chose to drive.

Discussion

The aims of this study were to investigate the relationship between drivers' choice of speed and their perceived levels of risk on rural NZ roads and also to determine the influence of specific risk countermeasures on drivers' speeds and perceived risk. There were significant correlations between risk and speed with higher risk ratings associated with lower speeds. This may be due to the fact that in situations of perceived high risk, drivers are inclined to reduce their speeds. In the present experiment, drivers chose slower speeds and gave higher risk ratings when traffic was heavy. Interestingly, the presence of wire rope barriers appeared to mitigate the effects of higher traffic volumes, with drivers selecting similar speeds across both traffic conditions and their risk rating remained low. This suggests that drivers do perceive physical barriers from on-coming traffic as conferring a safety benefit. Areas with double yellow lines and wide centre lines however, appeared riskier to drivers compared to roads with dashed white lines. It is possible of course that drivers were responding to the road per se rather than the median treatment, but we think this is unlikely as roads were matched as closely as possible to ensure they had a similar visual appearance. The presence of a police car led to large reductions in speed and increased ratings of perceived risk. These changes were much greater than those observed in response to a high crash area sign, suggesting that a visible police presence on the roads is an effective way to reduce speeding.

Finally, providing participants with the opportunity to evaluate risk at the speed they chose (the linked condition) resulted in higher ratings of risk compared ratings given when watching the footage at the speed it was recorded. This increase could be a result of the higher speeds chosen by participants, or it may be an indication that participants are accepting of a higher level of risk (or task difficulty) than the recorded footage allowed. Further research using pre-recorded video presented at varying speeds may help to shed light on this issue.

Acknowledgements

This research was funded by the New Zealand Automobile Association Research Foundation. The authors would also like to acknowledge the participants, research assistants, and technical support staff who worked with us on this project

References

- Charlton, S.G., Starkey, N.J., Perrone, J.A., and Isler, R.B. (2014). What's the risk? A comparison of actual and perceived driving risk. *Transportation Research Part F: Traffic Psychology and Behaviour*, 25, 50-64
- Fuller, R. (2005). Towards a general theory of driver behaviour. *Accident Analysis and Prevention*, 37, 461-472.

- Fuller, R. (2008). Task difficulty and risk in the determination of driver behaviour. *Revue Européene de Psychologie Appliquée*, 58, 13-21.
- Groeger, J. A., & Chapman, P. R. (1996). Judgment of traffic scenes: The role of danger and difficulty. *Applied Cognitive Psychology*, 10, 349–364.
- Pelz, D. C. and Krupat, E. (1974). Caution profile and driving record of undergraduate males. *Accident Analysis and Prevention*, 6, 45–58.
- Summala, H. (1988). Risk control is not risk adjustment: the zero-risk theory of driver behaviour and its implications. *Ergonomics*, 31(4), 491-206.
- Watts, G. R., and Quimby, A. R. (1980). *Aspects of Road Layout That Affect Drivers' Perception and Risk Taking*. TRRL Report 920. Crowthorne, Berkshire, England: Transport and Road Research Laboratory.