Drivers' perception of risk on rural New Zealand roads

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Abstract

Accurate perception of the risks associated with different types of road by drivers has the potential to improve driver safety and decrease the number of crashes and serious injuries on New Zealand roads. This research used multiple methods to investigate drivers' perceptions of risk across a range of rural New Zealand roads. One group of participants were shown videos of rural roads (filmed from the drivers' perspective in a vehicle driven at a safe speed) and provided risk ratings at points of interest. A second group drove the same set of roads (accompanied by a research assistant) and provided verbal risk ratings when prompted. The third group provided ratings at the same points when travelling as a passenger in the vehicle (driven at a safe speed). Overall, participants who drove the road rated the risk as significantly lower compared to those travelling as a passenger or viewing video footage of the same roads. These findings suggest that the degree of control of the vehicle plays a significant role in how perceptions of driving risk are formed and the degree of risk experienced. Whether this is related to being able to control the speed of the vehicle or a more general confidence in one's own driving ability is, as yet, unclear. It does suggest, however, that when drivers get behind the wheel they may significantly underestimate the risks associated with rural New Zealand roads.

Introduction

The role of risk as an important factor in driver behaviour has been the subject of extensive discussion and debate. 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 is altered to ensure an acceptable level of risk is maintained. Over the past fifty years studies have shown that drivers form subjective judgements about risk as they drive (e.g., Groeger & Chapman, 1996; Pelz & Krupat. 1974; Watts & Quimby, 1980), but until recently the relationship between drivers perceptions of risk and the objective level of risk on a particular road was poorly understood.

Charlton et al (2014) investigated the relationship between drivers perceived level of risk of across a New Zealand's state highways with the objective risk of those roads (using road protection scores from the KiwiRAP database). Findings indicated that generally drivers' perceived ratings of risk corresponded well with the levls of objective risk. That is, roads with high objective risk were perceived as high risk and those with low objective risk were rated as low risk. Interestingly, discrepancies between perceived and objective risk were apparent in some situations; the risk of curves and narrow roads were over-rated as compared to the objective risk, but intersections, roadside poles and ditches were under-rated. Further analyses revealed that curves, hills, road width, and median barriers explained 80% of the variance in the participants' ratings of perceived risk. The study used a multi-method approach (risk ratings were gathered in response to videos, stills, and actual on-road driving) which revealed some interesting differences in the relative magnitude of perceived risk across the different presentation modes. More specifically, the risk ratings of the photos were significantly higher compared to those from the video, which in turn were higher than those from the on-road study. Drawing on the work of Groeger and Chapman (1996) and Fuller (2005) it was suggested that differences in feelings of control may account for differences in risk ratings.

The current study was undertaken to directly investigate the relationship between control and perceived risk by obtaining ratings at pre-determined locations from three groups of participants who were either; 1) the driver in a car, 2) the passenger in a car (completing a journey around a pre-determined route) or 3) the viewer of video footage collected from the same driving route. Within a week of their risk rating session, participants were invited to attend the laboratory individually for a post-drive interview. They viewed video footage of their drive and provided verbal explanations about the kinds of things they noticed that made them give that rating.

Method

Participants

Three groups of participants ('Drivers', 'Passengers' and 'Viewers') were recruited via notices posted around the University of Waikato, local companies and businesses. The Driver group (n=15, 9 males) had an average age of 41.8 years (range 25-50 years).The majority (n=10) were of NZ European descent, with 1 self-identified as Maori and 4 as 'Other'. The participants in this group had held a driver license for 23.6 years on average (SD=2.5). The eleven participants who provided risk ratings as a Passenger in the vehicle (6 males, 5 females; average age 35.2 years, range 29-45 years; 4 of European descent, 2 Maori, 5 'Other') had been licensed drivers for an average of 13.5 years (SD=2.00). Fifteen participants (6 male, 9 females) were recruited to the Viewer group (average age 35.3 years, range 25-49 years). The majority were NZ European (n=11, 2 Maori and 2 'Other') and had held a driving licence for 19.7 years on average (SD=7.75).

Each of the participants in the Driver and Passenger groups received a $40 gift voucher at the end of the drive and another $10 voucher at the end of the interview session. Those in the 'Viewer' group received $10 for each of their 2 sessions. Ethical approval for the recruitment and test protocols was received from the School of Psychology Research Ethics Committee at the University of Waikato.

Apparatus

A 2012 Suzuki SX4 vehicle was fitted with two video cameras (HD quality, equipped with a standard lens, f=55 mm); the first was attached via suction cups to the front windscreen, recording the road scene ahead; the second was attached to the small window on the passenger side of the vehicle to record the driver's behaviour. A laptop computer generated a tone to prompt the participant (Driver or Passenger) to provide a verbal risk rating at predetermined GPS coordinates (points of interest) along the route. The computer also synchronised the video files from the two cameras and stored them.

For participants in the Driver and Passenger groups, 35 sec sections of the video (including audio) containing the locations of their risk ratings (25 seconds before the tone to 10 seconds after) were extracted from the full video of their drive. The participants viewed the edited videos on a flat-panel display screen (93cm x 52cm, 1920 x 1080 pixels) from a distance of 2.3m during a post-drive interview within a week of the initial session. The videos from the drive were preceded by two practice clips (the same for all participants) to familiarise the participants with the task. Participants were asked to verbally report the kinds of things they noticed that made them give the risk rating for each of the 13 locations. They were also given the opportunity to change the rating they initially gave if they wished to, and explain why they changed it.

A set of edited videos containing each of the locations of interest (preceded by 2 practice clips) was prepared for the Viewer group. The set was derived from video collected whilst Passengers gave on-road risk ratings and the car was driven by a research assistant. Footage from each location was selected to ensure there was minimal other traffic and dry weather. Participants in the Viewer group

were also invited back within a week of their original session, to view the video footage again and explain factors that contributed to their ratings of risk.

Route Selection

The route was a subset of the roads used in Charlton et al. (2014). It was selected from the NZ state highway system close to the University of Waikato and included roads with differing characteristics such as lane width, shoulder width, horizontal and vertical curves, and roadside objects such as guard rails, light poles, or drainage ditches. The drive (approximately 180 km round trip) could be completed within a reasonable period of time (approx. 2 - 2.5 hr). Participants were given a break at the mid-point of the drive. Participants provided risk ratings at 13 locations.

Procedure

For the Driver and Passenger groups, the purpose of study was explained upon arrival at the laboratory, the participant was shown a map of the route, any questions the participant had were answered, and the participant was then asked to sign a consent form and complete a demographic and driving history questionnaire. Participants in the Driver group were asked to comply with all normal road rules and regulations and drive as they would in their own car. Each participant was then taken on a short test drive (15-20 mins) to familiarise them with the vehicle and the tone that prompted them to provide a verbal risk rating between 1 and 10. The instructions to the participants were to report how safe or unsafe they felt as the driver with the "Safe" end (1) of the scale referring to feeling completely at ease such as while being at rest or parked while "Unsafe" (10) referred to feeling extremely threatened or in immediate danger of being involved in a serious accident. The verbal ratings of risk were recorded (using pen and paper) by the research assistant in the vehicle in addition to being captured as part of the video recording of each drive.

The procedure for the Passenger group was similar. They accompanied the research assistant on a short drive to familiarise them with the tone that prompted them to provide a risk rating. This was followed by a drive of the full route. The research assistant drove in a safe manner, at or below the posted speed limit and complied with all road rules. For this group, the verbal risk ratings provided by the passenger following the tone were transcribed from the audio/video recording of the drive on completion of the drive (the research assistant was driving and could not make a note of the rating).

For the Viewer group, the purpose of study was explained to the participant, any questions they had were answered, and the participant was then asked to sign a consent form and complete a demographic and driving history questionnaire. They were seated in a comfortable chair facing the display screen and the researcher explained that they would be shown fifteen video clips (including 2 practice clips), and during each clip a tone would prompt them to provide a verbal rating of how risky they felt the road was (from 1 safe to 10 very unsafe).

At the end of the risk rating sessions, arrangements were made for each participant to come back to the laboratory within 1 week. During the second session participants were told that they would be shown two practice video clips, followed by clips from their drive at the locations where they were prompted to provide risk ratings (the Viewer group saw the same footage as in the first session). Each clip was preceded by a 5 second on-screen countdown and ended with a blank screen. At the end of each clip participants were given the opportunity to change their original risk ratings (or leave them unchanged) and comment on road features that contributed to their ratings. These interview sessions took approximately one hour and were recorded (audio and video) for subsequent analysis. The participants' comments were reviewed and post-hoc categories of road features contained in the videos and/or mentioned in the comments (curves, visibility, traffic, terrain, narrow road, signs, straight road, bridge, road markings, junction, banks, weather, shoulders, speed, lane position, road surface, poles and ditches) were derived by two scorers. The

number of comments in each category were counted, regardless of whether participants mentioned the particular road feature to justify a high or low risk rating (the focus was on identifying features that informed risk ratings generally, rather than focusing on high risk features only).

Data analysis

Prior to analyses, data were checked for outliers, accuracy and variability. Data from three participants were excluded from subsequent analyses: two were in the Driving group (one extreme outlier and one due to failure of the in-car recording devices) and the other (in the Viewer group) showed no variability in the risk ratings they provided.

The first analysis explored differences in the average risk ratings between the three groups (Driver, Passenger, Viewer) and across the two test sessions. After this analyses were undertaken to determine if the different locations gave rise to different risk ratings across the three groups. The final section of the results focuses on the types of road features that participants reported as contributing to their ratings of risk.

Results

The demographic characteristics of the sample included in the analyses are presented in Table 1. Analyses (using one-way ANOVA or Chi square as appropriate) revealed that the Driver group had a slightly higher average age compared to the other two groups. The differences with regard to the gender balance of the groups, ethnicity and years of licensure were not statistically significant.

Table 1. Demographic characteristics of participants in the Driver, Passenger and Viewer groups.

	Driver (n=13)	**Passenger (n =10)**	**Video (n=14)**	**Test Statistic (F or X^2)**
Age in years				
Mean (SD)	41.2 (8.43)	34.2 (5.6)	35.07 (7.84)	$F(2,34)=3.14$, $p=.056$, $\eta_p^2=.16$
Gender				
Male n (%)	7 (54%)	5 (50%)	6 (43%)	X^2 (2)=.336, =.85
Ethnicity				
NZ European	9 (69)	4 (40)	7 (50)	
Maori	0 (0)	2 (20)	2 (14.)	
Other	4 (31)	4 (20)	5 (36)	X^2 (4)=3.44, p=.49,
Licensure in years				
Mean (SD)	22.6 (10.09)	14.1 (6.74)	19.6 (8.30)	$F(2,34)=2.80$, $p=.08$, $\eta_p^2=.14$

The average risk ratings for each group from sessions 1and 2 are presented in Figure 1.The average risk ratings obtained from video (containing the same locations) presented in a driving simulator to a larger group of 69 participants (from Charlton et al., 2014) are also shown for comparison purposes. As can be seen in Figure 1, the mean risk ratings from the Driver Group were lower than the Passenger or Viewer groups and the ratings for session 1 and session 2 were similar within each group. Interestingly, the risk ratings from the Passenger and Viewer groups were similar to those obtained from the Driving Simulator. A 2 (session) x 3 (group: Driver, Passenger, Viewer) mixed ANOVA on the average risk ratings across the clips revealed no statistically significant session x group interaction [$F(2,34)=.05$, $p=.95$, $\eta_p^2=.003$] and no significant main effect of session [$F(1,34)=.94$, $p=.34$, $\eta_p^2=.03$], however the effect of group was significant [$F(2,34)=3.48$, $p=.04$, $\eta_p^2=.17$]. Post-hoc analyses revealed that the Drivers' average risk rating was significantly lower than the ratings given by the Viewers ($p=.017$) and marginally lower than the risk ratings provided

by the Passengers (p=.064). There were no statistically significant differences between the Passengers and Viewers.

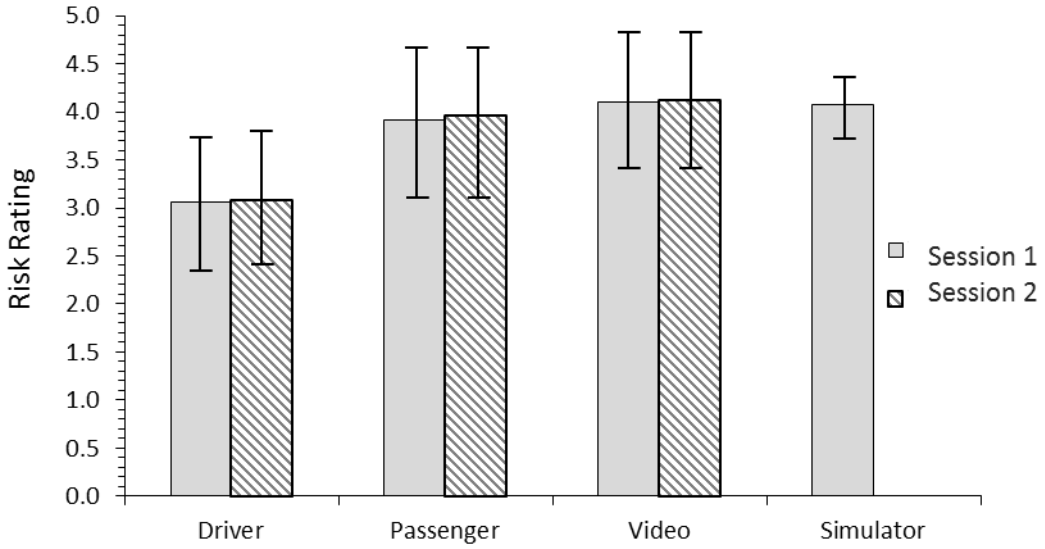

Figure 1. The average risk ratings during session 1 and session 2 for Drivers, Passengers and Viewers. The average risk rating from the same locations presented in a driving simulator video (Charlton et al., 2014) is shown for comparison purposes. Data are presented as mean and 95% confidence intervals.

As there were no significant differences in risk ratings across session, subsequent analyses used the ratings obtained during the first session. Pearson's correlations were conducted to examine the relationship between the risk ratings of the three groups across the 13 locations. Strong positive correlations were observed between the three groups (Driver v Passenger $r(13)$=.95, p<.001; Driver v Viewer $r(13)$=.66, p=.015; Passenger v Viewer $r(13)$=.66, p=.015).

To determine if there were certain road characteristics that gave rise to the differences in risk rating between the Drivers, Passengers and Viewers, a MANOVA was conducted using the individual risk ratings for each of the 13 locations. The MANOVA revealed a statistically reliable difference across the groups [$F(26,38)$=3.304, p < 001, η_p^2 .693]. The univariate F's indicated statistically significant (p<.05) between-group differences for five of the 13 locations and another two locations showed marginally significant differences between the groups (p<.08). Drivers gave significantly lower risk ratings compared to the Viewers for six of these locations (all p's <.05), and for two of the locations compared to the Passengers (p's<.05). Passengers gave significantly lower risk ratings compared to the Viewers for two locations (p's<.05). On closer inspection, the locations showing significant differences between the groups were all straight roads with good forward visibility. By contrast the other locations (that showed no group differences) included horizontal curves, hills, poor forward visibility and narrower lanes.

To further characterise these patterns in the data, two additional risk ratings were calculated for each group, one for the seven locations showing a significant difference between the three participant groups, and the other for six locations where there were no significant group differences. These data are presented in Figure 2. As can be seen in the Figure the pattern of risk ratings across these two location types are somewhat different. For locations with group differences, the Drivers gave the lowest (i.e., safest) risk ratings, followed by the Passengers and then the Viewers. For locations where there were no significant group differences, on average the Drivers once again gave the lowest ratings, but for these roads the Passengers ratings were higher than those of the Viewers. Interestingly for locations where there were no group differences, the risk ratings of the Drivers and the Passengers were higher than for the other locations; in other words this second group of

locations ceased to have significant differences between the groups primarily because of an increase in perceived risk ratings from the Drivers and the Passengers.

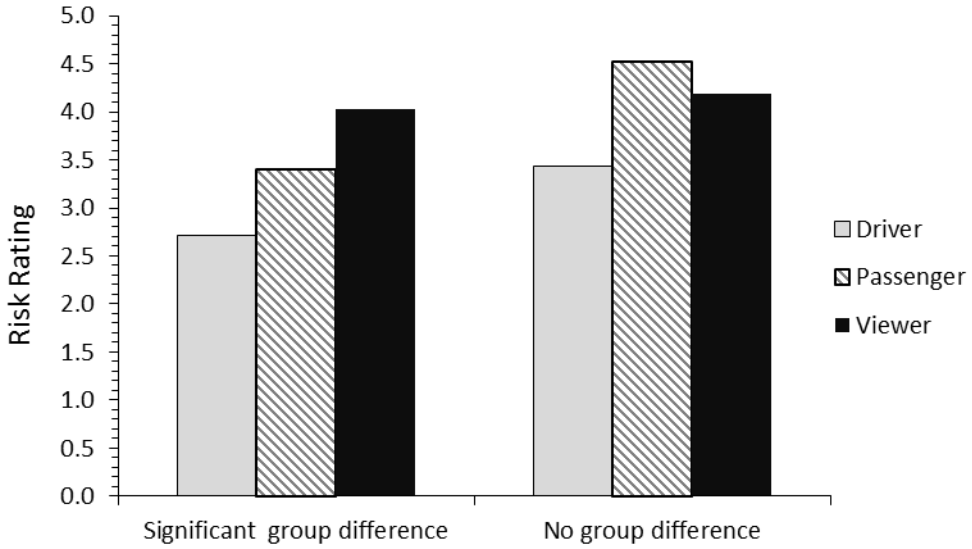

Figure 2. The average risk ratings for Drivers, Passengers and Viewers at locations with and without significant group differences in risk ratings Data are presented as the mean.

The next part of the analyses focused on the road features that the participants reported as contributing to their risk ratings. In terms of the total number of features reported, the Viewers described more than twice as many features (per participant) as compared to the Driver or Passengers (Drivers=21.5, Passengers=22.9, Viewers=39.7). The most commonly mentioned road features were curves, visibility, traffic and terrain. Figure 3 summarises the road features that contributed to the risk ratings for each of the three groups. Curves, visibility, road width and junctions received a similar proportion of comments from participants in each of the three groups. Of interest is the fact that road markings were noticed more often by the Drivers as compared to other groups. Features on the side of the road (e.g., shoulder, ditches) were noted more frequently by Passengers and Viewers as compared to Drivers. Interestingly, only Passengers and the Viewers commented on the speed of the vehicle, the lane position and the road surface.

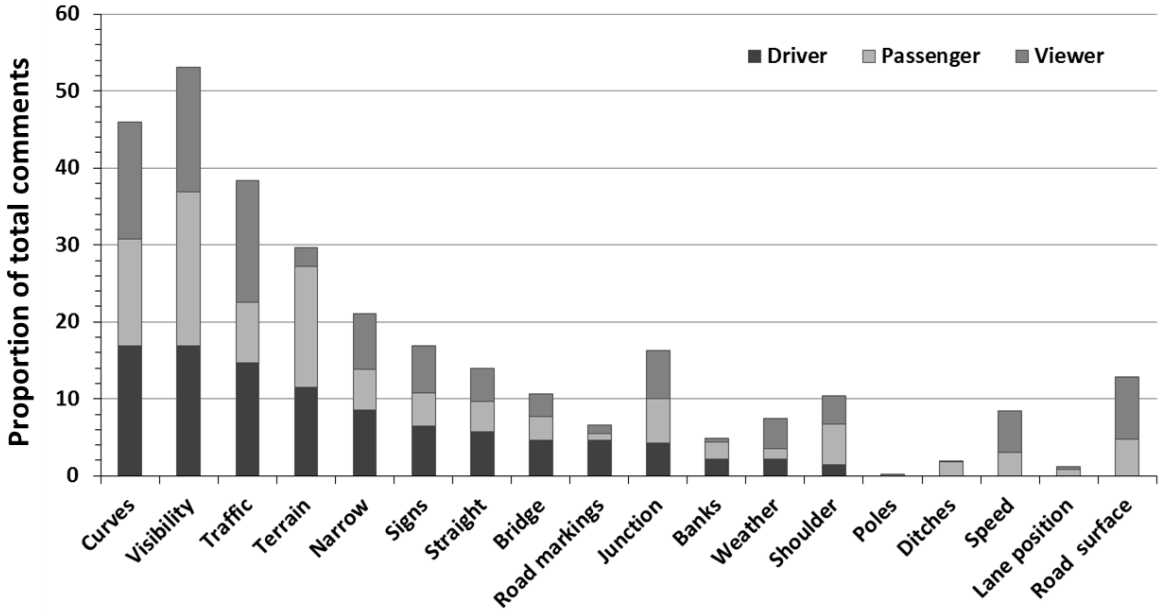

Figure 3. Road features contributing to the risk ratings of the Drivers, Passengers and Viewers. Data are presented as a proportion of the total comments for each group.

Discussion

Together these findings indicate that Driver's perceptions of risk on the road are significantly lower compared to those of Passengers or Viewers of video footage, supporting the suggestion that feelings of control appear to be important in perceptions of risk on the road (Groeger & Chapman, 1996; Fuller, 2005). However, these differences appear to be dependent upon location (or road characteristics), suggesting that factors other than feelings of control may also play a role. Wide straight roads with good visibility showed the greatest between group differences in ratings of perceived risk whereas narrow, winding roads failed to show this. Closer examination of the data (Figure 2) showed that Drivers and Passengers rated the narrow, winding roads as higher risk compared to the wider, straight roads, while the ratings of the Viewer group were similar across both road types.

The reasons underlying the increased ratings of perceived risk for the Driver and Passenger groups may be somewhat different. A driver faced with narrow, winding road is placed in a situation where the task demands (of driving) are much higher than on a wide straight road, and this increase may translate into higher ratings of perceived risk. This interpretation is in agreement with the Risk Allostasis Theory which suggests that each individual has a preferred range of risk and their driving behaviour alters to maintain risk within this range (Fuller, 2008). The level of perceived risk at any given moment varies a result of factors including driving task demands, motivation and perceived capability. The situation for the passenger is somewhat different however as their increased ratings of perceived risk are likely to be due to lack of control. They are entirely reliant upon the driver to safely navigate the rather challenging road ahead with no control over the speed or position of the vehicle. This situation may sound familiar, how often have you attempted to brake whilst travelling as a front seat passenger in a vehicle? The fact that the ratings from participants viewing the videos did not differ by location is also interesting and may be due to the mode of presentation (which failed to give an accurate 'feel' for the road), or the fact that their risk ratings were consistently quite high.

The fact that the narrow, winding roads were rated as higher risk is not unexpected and supports earlier findings indicating that the presence of curves (Kanellaidis & Dimitropoulos, 1994), narrow roads and bridges (Watts & Quimby, 1980) resulted in higher risk ratings. The current findings are also in in keeping with those of Charlton et al. (2014) who reported that curves, hills and road width explained a significant proportion of the variance in participants' ratings of perceived risk. Furthermore, the participant reports from the current study lend further support to these findings with the most commonly reported features being curves, visibility, terrain and road width.

Overall the findings from this study suggest that feelings of control and task demands play an important role in drivers' perception of risk on the road. Further research could also incorporate ratings confidence or capability of oneself (as the driver) or of the driver (from the passenger). Data collected data across a wider range of locations would also be informative. Finally the current research highlights the importance of taking into account the 'role' of the participant (as a driver, a passenger or watching video footage) in driving studies as this may have a significant impact on the conclusions of the study.

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