The role of control in risk perception on rural roads

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Abstract

Risk perception plays an important role in driver behaviour, particularly for speed choice. Risk perception studies use a range of techniques from on-road data collection to ratings of still photos, however participants' ratings differ depending on the study methodology, possibly due to their perception of control. To explore this we conducted a multiple methods study to investigate drivers' perceptions of risk on rural roads. One group of participants drove (Drivers, n=13) a 180km route along rural roads (accompanied by a research assistant) and provided verbal risk ratings at thirteen locations of interest. A second group (Passengers, n=10) provided ratings at the same points when travelling as a passenger in a vehicle (driven by a research assistant). The third group (Observers, n=14) were shown videos of the same rural roads (filmed from the drivers' perspective) and also provided risk ratings at the same locations. A week later participants were invited to the laboratory to review the video footage and comment on factors that contributed to the risk ratings. Overall, the Observers gave the highest risk ratings and Drivers the lowest. The Observers also provided twice the number of comments to justify their risk rating compared to the other two groups. The results suggest that control, and on-road experience play a significant role in how perceptions of driving risk are formed and the degree of risk experienced. These findings also bring into question the accuracy of using video-based tasks to assess drivers' risk perception (and speed choice), particularly if the findings are used to inform on-road safety interventions.

Keywords: illusion of control; passenger; on-road; video-based; perceived risk; speed

1. 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 adjust their driving to maintain a zero level risk (e.g., Summala, 1988; Vaa, 2014) whereas others (Wilde, 1998; Fuller et al., 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. There is evidence to support this proposition; for example Fuller et al. (2008) presented participants with a series of video clips of three different road types at increasing speeds and asked them to provide ratings of subjective risk (as well as task difficulty and collision risk) at the end of each clip. They found a positive linear relationship between subjective risk and speed (i.e. higher speeds were rated as more risky). Other studies suggest that the linear relationship between risk and speed only occurs once a certain threshold is reached. That is, ratings of subjective risk are low up to a certain speed, but once this speed is exceeded, risk ratings increase alongside increases in speed (Lewis-Evans & Rothengatter, 2009; Lewis-Evans, de Waard & Brookhuis, 2011). A threshold effect has also been reported for headway time, with risk ratings increasing once headways were below 2 seconds (Lewis-Evans, de Waard & Brookhuis, 2010). In on-road or simulator studies where participants were asked to provide ratings of perceived risk and then drive the same road at a speed of their choosing, roads with higher risk ratings tended to be driven at lower speeds (Charlton & Starkey, 2016). Drivers also showed better speed limit compliance on roads with higher ratings of subjective risk (Yao et al., 2019).

The research described above, and studies conducted by others have shown that drivers form subjective judgements about risk as they drive (e.g., Groeger & Chapman, 1996; Pelz &

Krupat. 1974; Watts & Quimby, 1980), and this influences their on-road driving behaviour. Until recently however, the relationship between drivers' perceptions of risk and the objective level of risk on a particular road was poorly understood. To address this Charlton et al (2014) investigated the relationship between drivers' perceived level of risk across a number of rural state highways with the objective risk of those roads (using road protection scores from the KiwiRAP database; Waible, Tate & Brodie, 2012). Findings indicated that generally drivers' perceived ratings of risk corresponded well with the levels 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. Curves, hills, road width, and median barriers explained 80% of the variance in the participants' ratings of perceived risk. Interestingly though, 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. Given the link between perceived risk and speed choice, the underestimation of risk in certain situations is concerning and further research to better understand factors that contribute to perceptions of risk is warranted.

The finding that drivers' perceptions of risk are generally correlated with the objective risk of the road is reassuring and suggests that lab-based or on-road studies assessing drivers' perception of risk are a useful tool to advance our understanding of driver behaviour. However it is important to be aware of the limitations of these approaches. Charlton et al., (2014) used a multi-method approach to assess the relationship between actual and perceived risk (ratings were gathered in response to stills, videos presented in a driving simulator, and on-road driving). The findings 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 of the video, which in turn were higher than those from the on-road study. As yet, the reasons for these differences are unclear. It may be that the increased cognitive demands of the on-road drive left the participants with fewer attentional resources to accurately evaluate the risk at any given moment, whilst the cognitive demands of the video- and photo-based rating tasks were lower, allowing more attentional resources to be directed towards the risk perception task.

As well as differences in the cognitive demands of the tasks, participants' perception (or in the case of the on-road study, ability) to control the situation differed across the three tasks. This relates to the concept of *illusion of control* (Langer, 1975) which McKenna (1993) suggested could lead to people believing that when they have personal control over a situation, the likelihood of a positive outcome is better than average. Thus, a person may take more risks when they are in control of a situation because they believe their skill, ability or performance would be better than others. To test this hypothesis, Horswill & McKenna (1999) asked participants to provide ratings of gap acceptance, following distance, overtaking and speed choice whilst watching video footage of a drive filmed from the drivers' perspective. Half of the participants were asked to imagine that they were the driver of the vehicle (i.e., in control) and the remainder were asked to imagine they were the passenger (no control). Analyses revealed that the 'drivers' chose significantly higher speeds (9.97 km/h faster than the video footage) than the 'passengers' (6.32 km/h faster than the video). These findings were interpreted as supporting the concept of an illusion of control, and that risk taking behaviour was influenced by participants' perceived control.

The current study was undertaken to investigate the role of control in drivers' subjective ratings of risk. We obtained risk ratings at pre-determined locations from three groups of participants with different levels of control over the vehicle. Participants were allocated to one of three groups: 1) the driver in a car (i.e., in full control), 2) the passenger in a car (in partial control as they could communicate with the driver and influence their behaviour) or 3) an observer of video footage collected from the same driving route (no control). 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 their risk rating.

2. Method

2.1 Participants

Three groups of participants ('Drivers', 'Passengers' and 'Observers') were recruited via notices posted around the University of Waikato, local companies and businesses (n=10-14 per group). Data from two participants were excluded from the Driving group, one due to poor weather conditions during the drive and one due to failure of the in-car recording devices, and one in the Observer group who failed to follow instructions from the experimenter**.** The demographic characteristics of the participants included in the analyses are presented in Table 1.

Each of the participants in the Driver and Passenger groups received a $40 voucher at the end of the drive and another $10 voucher at the post-drive interview session. Those in the Observer 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.

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

	Driver (n=13)	**Passenger (n =10)**	**Observer (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, η_p^2=.16
Gender				
Male n (%)	7 (54%)	5 (50%)	6 (43%)	X^2 (2)=.336, p =.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, η_p^2 =.14
No crashes (lifetime) Mean (SD)	1.15 (1.72)	1.00 (2.16)	1.14 (1.29)	F(2,34)=0.28, p=.97, η_p^2 =.01

2.2 Apparatus

A 2012 Suzuki SX4 vehicle (see top left Figure 1) 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 (middle left Figure1), recording the road scene ahead (middle right Figure 1); the second was attached to the small window on the passenger side of the vehicle (bottom left Figure 1) to record the driver’s behaviour (bottom right Figure 1). 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 (top right Figure 1).

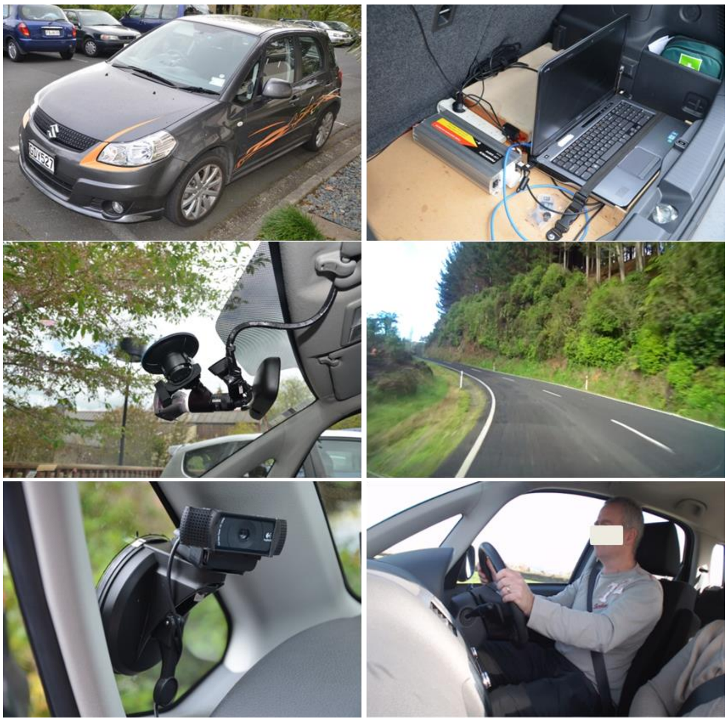

Figure 1. The car used in the current study. A Suzuki SX4 (top left) was equipped with a computer to sound a tone at predetermined GPS locations (top right). A camera was fitted the front windscreen (middle left) to record the road ahead (middle right), and to the passenger window (bottom left) to record the driver (bottom right).

2.3 Video stimuli

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 videos from the drive were preceded by two practice clips (the same for all participants) to familiarise the participants with the task.

For the Observer group, we prepared a set of edited videos containing each of the locations of interest (preceded by 2 practice clips). 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.

The participants viewed the edited videos of the 13 locations of interest 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 (Figure 2).

Figure 2. The room layout for the post-drive interview

2.4 Route Selection

The route (approximately 180km round trip) 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 route included roads with a range of objective risk ratings (determined by the Road Protection Score from KiwiRAP, the New Zealand Road Assessment Programme: http://www.kiwirap.co.nz/index.html). Road Protection Scores (RPS) are calculated using a complex formula incorporating traffic volumes and ratings taken every 100m for 13 road features (lane width, shoulder width, terrain (gradient), horizontal alignment, run-off road risk score, head-on risk score, intersection risk score, left roadside risk score, right roadside risk score, roadside hazard offset left, roadside hazard offset right, roadside hazard severity left, and roadside hazard severity right), which have been shown to influence three crash types (run-off road, head-on and intersection) (Waibl, Tate, & Brodie, 2012). The RPS scores of the 13 locations and a brief description of each location are presented in Table 2 (Note: Higher RPS scores indicate higher risk and are rated for every 100m of road). The trip took approximately 2- 2.5 hrs and drivers/passengers were given a break at the mid-point.

Table 2. RPS scores and description of each of the sections of road where participants provided risk ratings.

Location	RPS	Description
1	12.24	Narrow seal, narrow shoulder, ditch
2	9.07	Transition to road with standard seal and shoulder, wide verge
3	9.32	Narrow seal, standard shoulder, narrow verge, power poles
4	14.26	Standard seal, wide verge, gentle curves
5	11.27	Narrow seal, verge, curves
6	7.23	Standard width bridge
7	9.05	Narrow seal, ditch on left, gentle rise
8	5.74	Narrow seal, bank on left, gentle downhill
9	18.69	One lane bridge
10	16.42	Narrow seal, no shoulder, downhill curves, bank on right
11	12.02	Narrow seal, no shoulder, downhill curves, banks left and right
12	11	Narrow seal and shoulder, banks left and right
13	18.35	Seal narrowing, no shoulder

2.5 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.

Participants were 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). Participants in the Driver and Passenger groups were asked to keep conversation with the research assistant to a minimum (unless they had questions about the route) and the radio was turned off throughout the drive. There were two scheduled rest stops on the route.

For the Observer 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 using the same scale as the other conditions (i.e., 1 = safe to 10 = unsafe).

At the end of the risk rating sessions, arrangements were made for each participant to come back to the laboratory within 1 week to explore why participants gave the risk ratings they did. 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 Observer group saw the same footage as in the first session), to help them recall their recent trip (or previous session in the case of the Observers). 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 scoring categories relating to road features (i.e., curves, visibility, terrain, narrow road, signs, straight road, bridge, road markings, junction, banks, weather, shoulders, road surface, poles and ditches) or aspects of driver behaviour (traffic, speed, lane position) were derived by two scorers. The number of comments in each category were counted, regardless of whether participants mentioned the particular feature as justifying 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).

2.6 Data analysis

Prior to analyses, data were checked for outliers, accuracy and variability. First we carried out a 2 (session) x 3 (group: (Driver; full control, Passenger; partial control, Observers; no control) x 13 (location) mixed MANOVA to determine if the different locations gave rise to different risk ratings across the three groups. Further analyses explored the pattern of risk ratings for the locations with and without between group differences in risk ratings. We then examined the types of road features that participants reported as contributing to their ratings of risk, with comparison being made between the Drivers, Passengers and Observers. The final analyses explored the comments from the three groups for locations with and without differences in risk ratings.

3. Results

Figure 3 presents the average risk ratings for each group from sessions 1 and 2. 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. [The larger group of participants were seated in the driving simulator watching video footage of the roads, steering the car in the appropriate direction whilst providing continuous risk ratings using a thumbwheel mounted on the steering wheel.] As can be seen in Figure 1, the mean risk ratings from the session 1 and session 2 were similar within each group. Interestingly, the risk ratings from the Passenger and Observer groups were similar to those obtained from the Driving Simulator.

To explore differences in the risk ratings, a 2 (session) x 3 (group: Driver, Passenger, Observer) x 13 (location) mixed MANOVA was conducted. The analysis revealed a significant group x location interaction (F (24, 46)=2.91, p=.001, η_p^2=.60), and significant main effects of location (F(12,23)=15.29, p<.001, η_p^2=.89) and group (F(2,34)=3.25, p=.050, η_p^2=.16). The main effect of session (F(1,34)=0.62, p=.44, η_p^2=.02) was not statistically significant (as shown in Figure 3), nor were the other interactions (session x group *F*(2,34)=0.11, *p*=.90, η_p^2=.01; session x location *F*(12,23)=1.31, *p*=.28, η_p^2=.41; session x location x group *F*(24,46)=0.55, *p*=.94, η_p^2=.22). Bonferroni adjusted post-hoc analyses revealed that the Drivers' average risk rating was significantly lower than the ratings given by the Observers (*p*=.021) and marginally significantly lower than the risk ratings provided by the Passengers (*p*=.075). There were no statistically significant differences between the Passengers and Observers (*p*=.698)

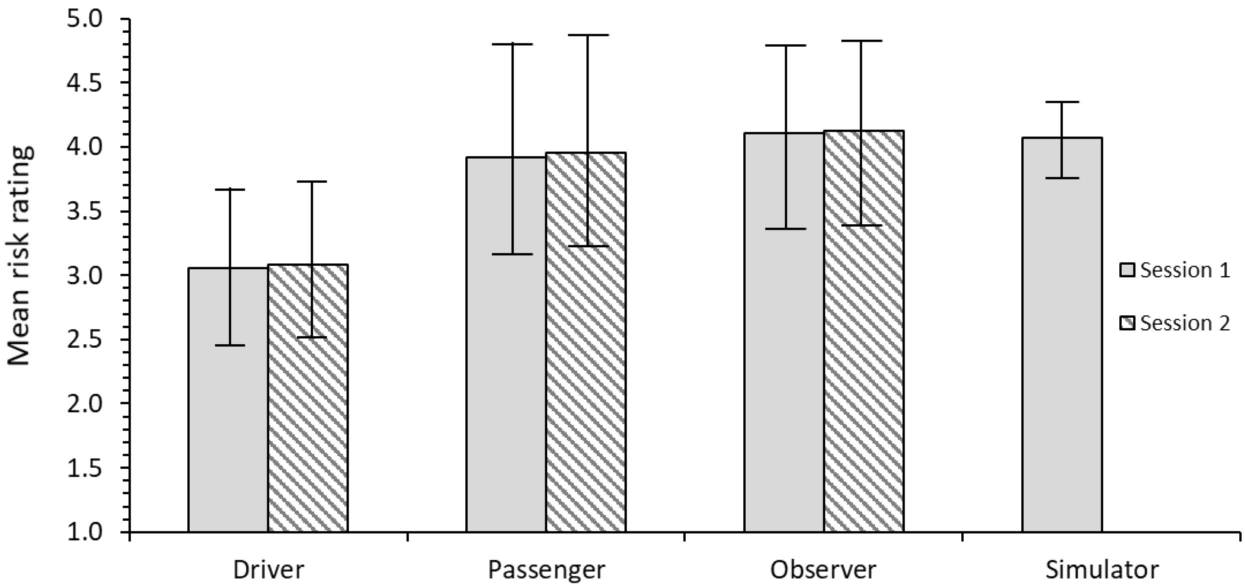

Figure 3. The mean risk ratings during session 1 and session 2 for Drivers, Passengers and Observers. The average risk rating from the same locations presented in a driving simulator video (Charlton et al., 2014) is shown for comparison purposes. Data are presented as mean and 95% confidence intervals.

As there were no significant differences in risk ratings across session, subsequent analyses used the ratings obtained during the first session for each location as these were collected during the on-road test for the Driver and Passenger groups and had the greatest ecological validity. Figure 4 shows the mean risk ratings by group for each location ordered by RPS score. The figure shows that participants' risk ratings do not follow the same pattern as the

RPS scores. Pearson's correlations between the RPS at each location and mean risk ratings for each group were not statistically significant (RPS v Observers $r(13)=.53$, $p=.063$; Passengers $r(13)=.37$, $p=.209$; Drivers $r(13)=.28$, $p=.352$).

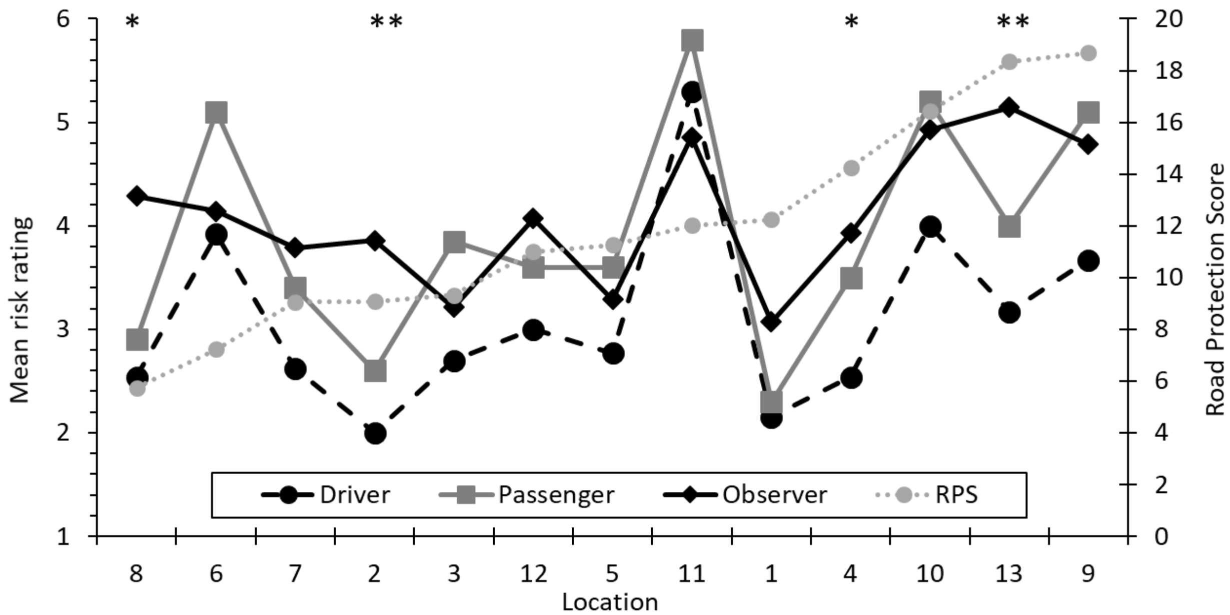

Figure 4. Mean risk rating in order of increasing RPS score for Drivers, Passengers and Observers at each location. Significant between-group differences are indicated with * $p<.05$, ** $p<.01$.

To further explore the significant group x location interaction identified from the MANOVA, a series of univariate ANOVAs were conducted on the risk ratings for each location. The univariate *F*'s indicated statistically significant between-group differences for four locations (Location 2, $F(2,34)=9.33$, $p = 001$, $\eta_p^2 =.354$; Location 4 $F(2,34)=4.90$, $p = 013$, $\eta_p^2 =.224$; Location 8, $F(2,34)=4.90$, $p = 014$, $\eta_p^2 =.224$ and Location 13, $F(2,34)=6.51$, $p = 004$, $\eta_p^2 =.277$. The Observers gave significantly higher risk ratings compared to the Drivers at each of these locations (Bonferroni corrected *p*s <.017), and significantly higher ratings than the

Passengers at Location 2 (p=.035). There were no statistically significant differences between the Drivers and the Passengers at these locations (all ps >.05). The locations showing significant differences between the groups were all straight roads with good forward visibility (Figure 5). By contrast the locations that included horizontal curves, hills, poor forward visibility and narrower lanes did not show any significant group differences.

Figure 5. Stills from the four locations showing significant differences in risk rating across the groups.

To further characterise these patterns in the data, two additional summary risk measures were calculated for each group, one for the four locations showing a significant difference between the three participant groups (Group 1), and the other for nine locations where there were no significant group differences (Group 2). As shown in Figure 6 the pattern of risk ratings across these two location types were somewhat different. A 2 (location type) x 3 (group) mixed ANOVA revealed a significant location type x group interaction ($F(2,34)=8.75$, p = 001, η_p^2 =.340), as well as significant main effects for location type ($F(1,34)=50.37$, p < 001,

η_p^2 =.597) and group (F(2,34)=3.51, p = .041, η_p^2 =.171). Post hoc tests (Bonferroni adjusted) showed that overall the Drivers risk ratings were significantly lower than the Observers (p=.017) and marginally significantly lower than the Passengers (p=.058). When looking at the change in risk ratings, Drivers and Passengers gave significantly lower risk ratings for locations with group differences (Group 1) compared to the more challenging locations (Group 2) (Drivers p=.004; Passengers p<.001). Interestingly, the risk ratings for the Observers did not differ significantly across the two location types (p=.145).

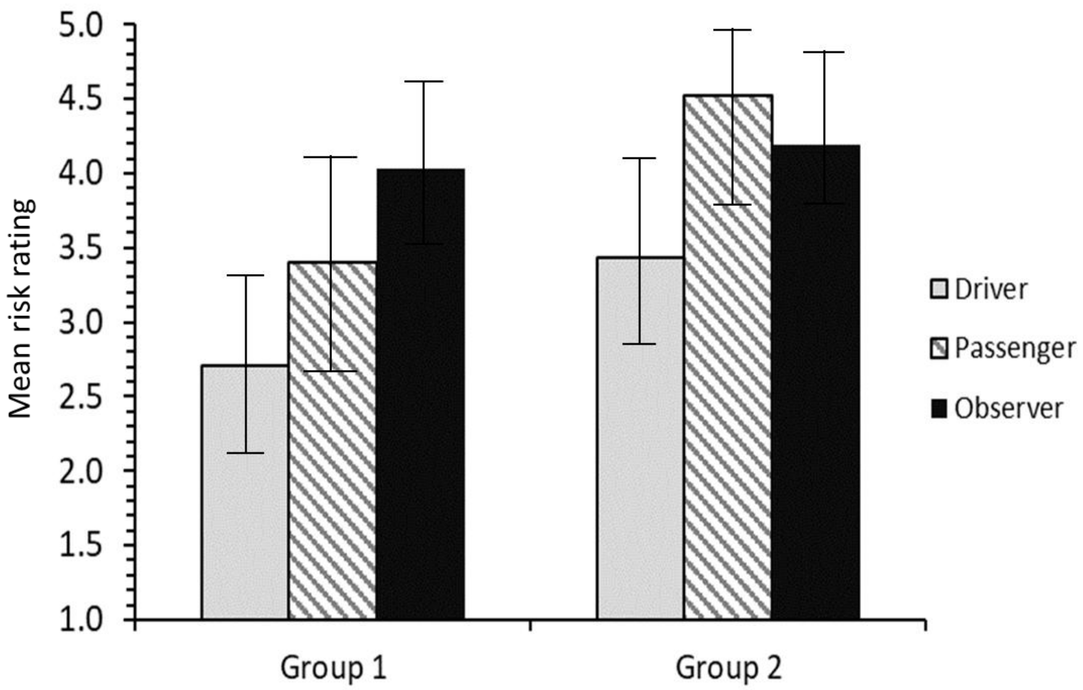

Figure 6. The mean risk ratings for Drivers, Passengers and Observers at locations with (Group 1) and without (Group 2) significant group differences in risk ratings. Data are presented as the mean and 95% confidence intervals

The next part of the analyses focused on the features that the participants reported as contributing to their risk ratings. In terms of the total number of features reported, the

Observers 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 features were related to the road (visibility, curves, terrain, road width, terrain, junctions, signs and roadside vegetation). Participants also mentioned factors relating to driver behaviour, including other traffic, speed and the lane position of the vehicle. The percentage of comments from the Driver, Passengers and Observers in each of these categories is summarised in Figure 7. There was no significant difference between the groups ($F(2,36)=2.478$, $p=.098$, $\eta_p^2=.121$).

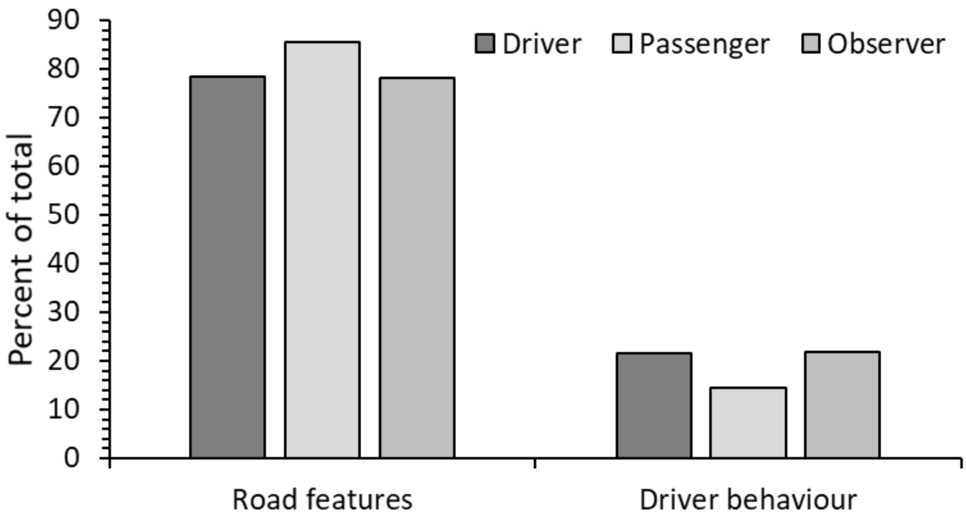

Figure 7. The percentage of comments relating to road features and driver behaviour for the Drivers, Passengers and Observers. Data are presented as a percentage of the total comments for each group.

To further explore how driver behaviour related to perception of risk, these comments were further divided into those relating to traffic (i.e., presence of other cars, and uncertainty about the behaviour of the driver), speed (of the driver and other vehicles on the road) and the lane position of the car (Figure 8). Passengers made the greatest percentage of comments about other traffic, and Observers made the greatest percentage of comments about speed, and the lane position of the vehicle. There was no significant difference in the percentage of comments made by each group in relation to traffic (F(2,36)=0.727, p=.490, ηp^2=.039) or speed (F(2,36)=1.625, p=.211, ηp^2=.083). Comments about lane position were only made by those in the Observer group and this difference was statistically significant (F(2,36)=4.73, p=.015, ηp^2=.208).

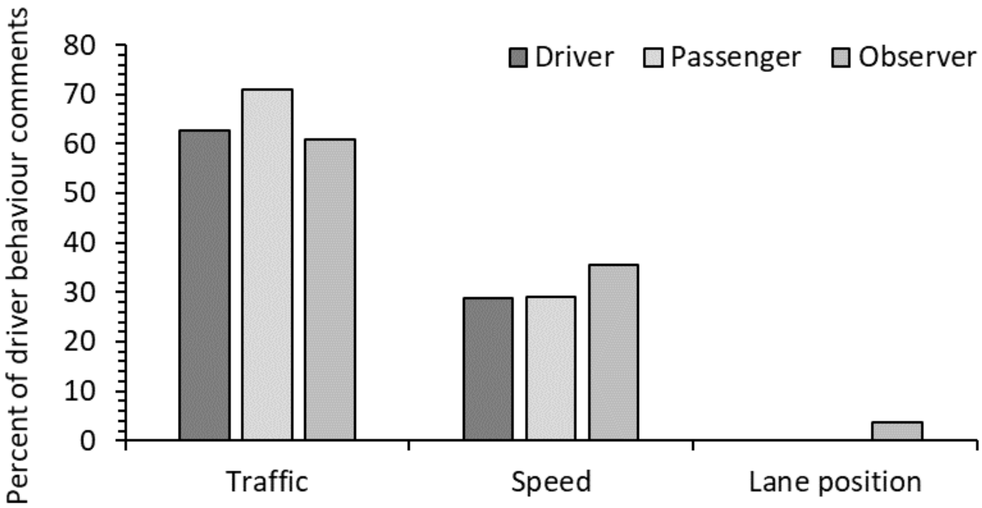

Figure 8. The percentage of comments about traffic, speed and lane position for the Drivers, Passengers and Observers. Data are presented as a percentage of the total comments about driver behaviour for each group.

Next we examined participants' comments about the four locations that showed significant group differences in the risk ratings across the three groups (Group 1), and the locations that did not show group differences (Group 2). The percentage of comments relating to road features was similar for Group 1 (Driver, 78.9%; Passenger 86.4%, Observer 77.2%) and Group 2 (Driver 77.3%, Passenger 83.3%. Observer 77.2%). Figure 9 shows the percentage of comments about traffic, speed and lane position for the two types of locations. Group 2 locations generated a similar percentage of comments about traffic and speed from Drivers, Passengers and Observers. In contrast, for the Group 1 locations (where there were significant group differences in risk ratings), the percentage of comments relating to traffic was higher than Group 2. In addition, the Observers made a greater percentage of comments about speed compared to the Drivers and Passengers. It is interesting to note that the Passengers made no comments about speed at the Group 2 locations.

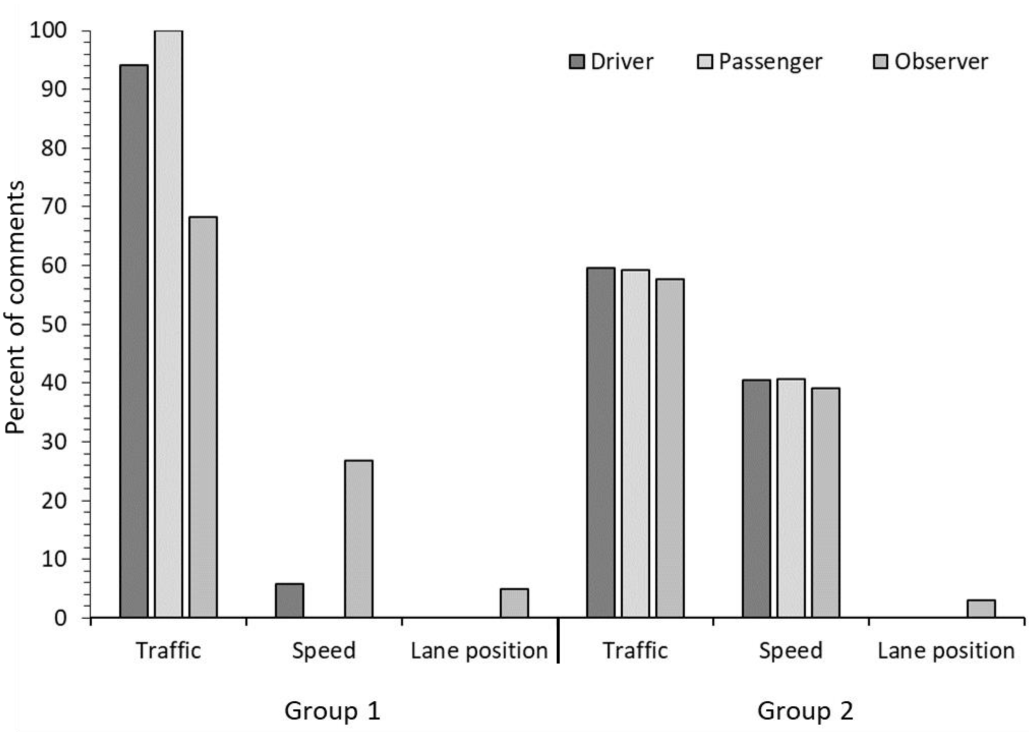

Figure 9. The percentage of comments about traffic, speed and lane position for the Drivers, Passengers and Observers for the two types of location. Data are presented as a percentage of the total comments about driver behaviour for each group.

4. Discussion

The current study was undertaken to investigate the role of control in drivers' subjective ratings of risk. Risk ratings were obtained from three groups of participants with different levels of control over the vehicle (Drivers with full control, Passengers with partial control and Observers with no control). Participants reviewed video footage of the drive a week later and provided verbal comments on the types of things that influenced their risk rating.

Analyses of the average ratings across the whole route revealed that Drivers' perceptions of risk were significantly lower than those of the Observers (and marginally lower than the ratings provided by the Passengers). Interestingly though, the risk ratings were not significantly different at every location; the significant differences between the Observers and Drivers were apparent on straight roads with good forward visibility, rather than the more challenging locations with hills and curves. Overall the findings support the suggestion that feelings of control (or in this case actual control) appear to be important in perceptions of risk on the road (Horswill & McKenna, 1999; Groeger & Chapman, 1996; Fuller, 2005). The lower risk ratings given by the Drivers may be a result of them being in control and altering their driving behaviour to maintain an acceptable level of risk (Wilde, 1998; Fuller et al., 2008), whereas the Passengers and Observers were unable to directly alter how the vehicle was being driven. Whilst we did not record driver behaviour at the risk rating locations, it is likely that one mechanism by which the Drivers maintained their preferred level of risk was by altering their speed. Previous research has shown that roads with higher risk ratings tend to be driven at lower speeds (Charlton & Starkey 2016), and drivers are more likely to comply with the posted speed limits (Yao et al, 2019).

Whilst the Drivers were able to modify their driving behaviour, and hence their subjective feelings of risk, there was still variability in the risk ratings across the 13 locations (Figure 4), indicating that factors other than speed also contributed to the risk ratings. 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 6) showed that Drivers and Passengers rated the narrow, winding roads as higher risk compared to the wider, straight roads, while the ratings of the Observers 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 et al., 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 direct control over the speed or position of the vehicle. In some situations this may even lead the front seat passenger in a vehicle to use their foot as though they had access to a brake pedal. The fact that the ratings from participants viewing the videos did not differ by location type 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 higher.

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. Interestingly, the majority (over 80%) of the participants' explanation for their risk ratings focused on road-related features, rather than factors that could be modified by the driver. Closer examination of the comments about driver behaviour revealed no significant differences between the Drivers, Passengers and Observers in relation to traffic or speed. This is somewhat surprising given that altering speed is one of the key ways to modify feelings of risk. This may, in part, be because the risk ratings were all fairly low (below the mid-point on the scale) and the speeds were not excessive; in all cases the roads were driven at or below the posted speed limit. Whilst some studies (Fuller et al., 2008) have found a linear relationship between risk and speed, others have reported that this relationship is only evident at higher speeds, once a particular threshold is exceeded (Lewis-Evans & Rothengatter, 2009; Lewis-Evans, de Waard & Brookhuis, 2010; Lewis-Evans, de Waard & Brookhuis, 2011). In the context of the present study, it is possible that participants' perception of risk were at an acceptable level, and below the threshold needed for participants to report that inappropriate speed contributed to their risk ratings. Overall it seems that when roads are driven at speeds at or below the posted speed limit, road-related factors are the key thing identified by drivers as contributing to their ratings of risk.

The findings from this study support the suggestion that control plays a role in drivers' perception of risk on the road. Interestingly though, participants did not identify speed as a key contributor to their risk ratings, suggesting other factors also play a role. The study has a number of limitations that could be addressed in future research. The first session was much longer for the Drivers and the Passengers as compared to the Observers. Future work using a shorter route would mean that lab-based observation sessions could use the whole route rather than a series of short excerpts. Further research could incorporate ratings confidence or capability of oneself (as the driver) or of the driver (from the passenger), collection of driver performance data, and on a wider range of roads (including urban locations).

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. The greatest differences in the current study were between the Drivers and the Observers; with the Passenger risk ratings falling between the two. In addition, the Observers identified twice as many factors as contributing to their risk ratings compared with those in the on-road conditions. This suggests that the experience of driving or being driven on the roads of interest made a material difference to participants’ risk ratings as well as their explanations for those ratings. This highlights the need for caution when generalising findings from video-based rating tasks, particularly when they are used to inform road safety interventions.

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6. References

1. 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.
2. Charlton, S.G., & Starkey, N.J (2016). Risk in our midst: Centrelines, perceived risk, and speed choice. *Accident, Analysis and Prevention*, *95*, 192-201.
3. Fuller, R. (2005). Towards a general theory of driver behaviour. *Accident Analysis and Prevention*, *37*, 461-472.
4. Fuller, R., McHugh, C., & Pender, S. (2008). Task difficulty and risk in the determination of driver behaviour. *Revue européene de psychologie appliqée*, 58, 13-21.
5. Groeger, J. A., & Chapman, P. R. (1996). Judgment of traffic scenes: The role of danger and difficulty. *Applied Cognitive Psychology*, *10,* 349–364.
6. Horswill, M. S. & McKenna, F. P. (1999). The effect of perceived control on risk taking. *Journal of Applied Social Psychology*, 29 (2), 377-391.
7. Kanellaidis, G., & Dimitropoulos, I. (1994). Subjective and objective evaluation of risk on roadway curves. *Traffic Engineering and Control*, *55,* 451–454.
8. Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology,* 32, 311-328.
9. Lewis-Evans, B., De Waard, D., & Brookhuis, K.A. (2010). That's close enough – A threshold effect of time headway on the experience of risk, task difficulty, effort, and comfort. *Accident Analysis and Prevention*, 42, 1926-1933.

10. Lewis-Evans, B., De Waard, D., & Brookhuis, K.A. (2011). Speed maintenance under cognitive load – Implications for theories of driver behaviour. *Accident Analysis and Prevention*. 43, 1497-1507.

11. Lewis-Evans, B., & Rothengatter, T. (2009). Task difficulty, risk, effort and comfort in a simulated driving task – implications for the Risk Allostasis Theory. *Accident, Analysis & Prevention,* 41, 1053-1063.

12. McKenna, F. P. (1993). It won't happen to me: Unrealistic optimism of illusion of control? *British Journal of Psychology,* 84, 39-50.

13. Pelz, D. C. and Krupat, E. (1974). Caution profile and driving record of undergraduate males. *Accident Analysis and Prevention*, *6*, 45–58.

14. Summala, H. (1988). Risk control is not risk adjustment: the zero-risk theory of driver behaviour and its implications. *Ergonomics*, 31(4), 491-206.

15. Vaa, T. (2014). From Gibson and Crooks to Damasio: The role of psychology in the development of driver behaviour models. *Transportation Research Part F,* 25, 112-119.

16. Waibl, G., Tate, F., & Brodie, C. (2012). The development of a proactive road safety assessment tool – KiwiRAP. In *Proceedings of Australasian Road Safety Research, Policing and Education Conference 2012*, 4 - 6 October 2012, Wellington, New Zealand, (pp 1-11), Mawson, ACT: Australasian College of Road Safety.

17. Wilde G. J. S. (1998). Risk homeostasis theory: an overview. *Injury Prevention*, 4, 89-91.

18. Watts, G. R., & 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.

19. Yao, Y., Carsten, O., Hibberd, D., & Li P. (2019). Exploring the relationship between risk perception, speed limit credibility and speed limit compliance. *Transportation Research Part F*, 62, 575-586.