

Naturalistic driving study analysing the effect of rainfall on driving behaviour for older drivers

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Abstract

We aimed to determine whether the amount of daily rainfall was predictive of driving behaviour among drivers 75+ years, in regards to driving exposure and the rate at which Rapid Deceleration Events (RDEs) occurred, acting as a surrogate safety event. Naturalistic driving data from 190 drivers aged 75+ years, monitored between one and 12 months was used in this analysis. By applying a T-distribution, we found older drivers tend to drive more during light rainfall (1-2mm) and less during heavy rainfall (10-20mm). Using logistic regression, we found the rate of RDEs decreases with increasing rainfall, suggesting cautiousness among older drivers.

Background

There has been an increase in road fatalities involving older drivers in Australia, over the last few years. The difficulties faced when driving are exacerbated by rainfall as crash risk increases (Qiu and Nixon, 2014). Further, evidence suggests that the volume normalised accident count on wet days is significantly higher than dry days, with this effect exacerbated by the amount of rainfall that falls on a given day (Keay and Simmonds, 2006). Given the increased risks and incidents associated with wet weather driving, we sought to determine whether drivers aged 75+ years travelled more or less in wet weather and if rainfall influenced their safety on the road.

Methods

A naturalistic driving study was conducted involving 190 older drivers (above 75 years of age) who were monitored for a period of up to one year. Time stamped acceleration and GPS location was gathered from an in-vehicle device (C4D, Mobile Devices Ingenierie, Villejuif, France) which was hardwired to the participant's vehicle, which transmitted this data back to a secure database via telecommunication networks (Greaves et al., 2007). As crash data requires a longer period of analysis and a larger study cohort, Rapid Deceleration Events (RDEs) were used as surrogate safety event measure. Rapid Deceleration Events are defined as deceleration of greater than 750 milli-g at any point the car was in motion. Using the Drivesafe/DriveAware score, an in-office test designed to predict fitness to drive, validated against on-road driving performance (Kay et al., 2009), participants were categorised as either 'safe' or 'needs further testing'. DriveSafe/DriveAware assessed participants' visual attention to the driving environment and awareness of their driving ability and functional limitations.

The average and standard deviation of the number of trips and the total time driven per participant was calculated on a daily basis throughout the duration of the study between June 2012 and May 2014. For each day during the study period, the amount of rainfall was categorized into 6 classes: [0-1mm], (1-2mm), (2-5mm), (5-10mm), (10-20mm) and 20+mm. A T-distribution was applied to determine any differences in driving exposure (number of trips and time driving) with daily rainfall.

Each trip was classed as either a RDE or non-RDE trip based on whether at any point there was deceleration greater than 750mg. Logistic regression was used to determine whether amount of rainfall was predictive of RDE trips adjusting for age, gender and the driver's DriveSafe/DriveAware score.

Results

Among the 190 study participants, average age was 80 years old and 54% were men (102/190) The DriveSafe/DriveAware predicted 43 drivers were 'safe' and 147 as recommended to 'need further testing'. During the 668 days where driving was monitored, on average participants travelled 2.71 ± 0.74 trips per day and drove on average 29.77 ± 9.22 minutes per day. . The Geographical distribution of trips is shown in Figure 1, shows the starting location of a given trip, with trips restricted to those starting within the boundaries shown below. The majority of trips started in the Hills Shire.

Table 1. Distribution of Rainfall

| Amount of Rainfall (mm) | Number of Days | Percentage of Days |
|-------------------------|----------------|--------------------|
| 0-1 | 535 | 80.09% |
| 1-2 | 19 | 2.84% |
| 2-5 | 37 | 5.54% |
| 5-10 | 26 | 3.89% |
| 10-20 | 34 | 5.09% |
| 20+ | 17 | 2.54% |

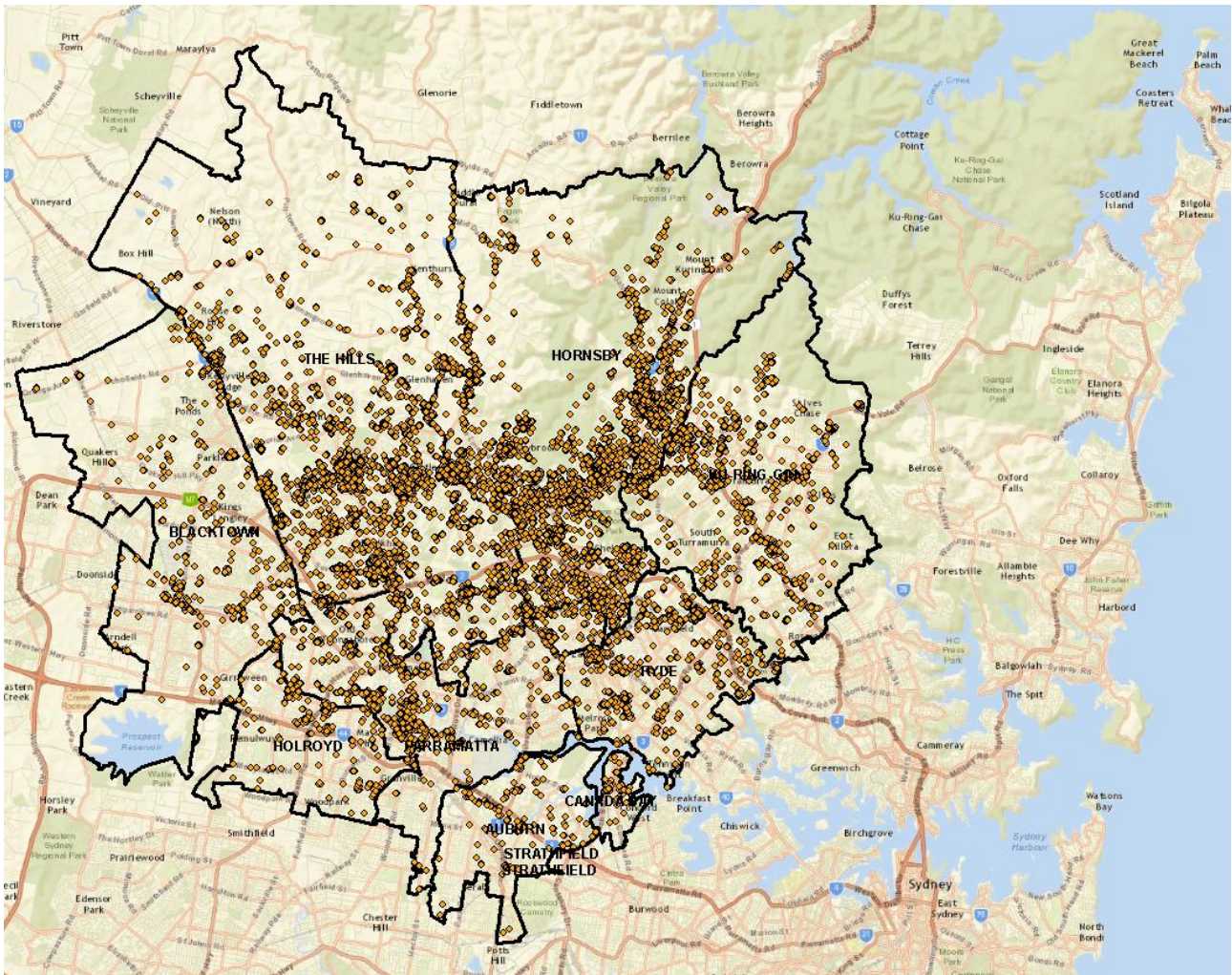


Figure 1. Geographical Distribution of Trips

Participants predicted as ‘safe’ drove more, both in terms of number of trips (2.86 ± 0.95 , p -value = 0.0002) and exposure (34.1 ± 13.97 minutes, p -value < 0.001) on days of rainfall 0-1mm than days with more rainfall. On the other hand, drivers that ‘need further testing’, had a peak in number of trips (3.35 ± 0.94 , p -value = 0.004) and greater driving exposure (36 ± 15.37 minutes, p -value = 0.047) on days with rainfall 1-2mm, and less trips (2.38 ± 0.59 , p -value = 0.001) and exposure (25.68 ± 6.73 minutes, p -value = 0.001) on days with rainfall 10-20mm. Results from the logistic regression indicate that the greater the amount of rainfall, the lower the rate of RDE trips (OR=0.91, CI: 0.85-0.97) and this relationship remained after adjusting for age, gender and DriveSafe/DriveAware score.

Conclusion

In general, older drivers drive more during times with little rainfall (1-2mm) and less during times of heavy rainfall. Given the reducing rate of RDEs with increasing rainfall, this suggests older drivers are more cautious as rainfall increases, regardless of their driving ability.

References

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