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Risk in our midst: Centrelines, perceived risk, and speed choice

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ABSTRACT

The idea that drivers' perceptions of risk affect their decisions and choices, particularly as regards their speed, is at the heart of many years of our education, engineering, and enforcement strategies to improve road safety. Our previous research has shown that horizontal curvature, road width, vertical curvature and separation from on-coming traffic are principal determinants to perceptions of risk on rural roads. The present study examined the relationship between drivers' perceptions of risk and the speeds they choose to drive. Participants drove high definition videos of familiar rural roads in a driving simulator and a smaller group of participants drove the same roads in a university fleet vehicle similar to the one used in the simulator. The results showed that double yellow and wide centreline markings were associated with lower speed choices and higher perceptions of risk, an effect magnified under high traffic conditions. Similarly, in both the simulator and on the roads, driving on narrow roads was associated with significantly lower speeds and increased risk ratings, while wider roads showed a small but significant increase in speeds as compared to standard width control roads. Finally, a range of other road and traffic conditions such as one-lane bridges, level crossings, police cars, and crash area warning signs were also found to be associated with lower speed choices and higher risk perceptions.

1. Introduction

Understanding why drivers drive the way that they do is a necessary prerequisite to developing a safe road transport system, whether it is by engineering safer vehicles and roads, or whether it is by implementing more effective education and enforcement. Drivers' choice of speeds in particular is a key element in the safety of road transport, high speeds increasing both the risk of crashes and the severity of injuries resulting from crashes (Aarts and Van Schagen, 2006; Elvik, 2013). Motivations for driving can be quite different, both from driver to driver, and from trip to trip. These differing motivations, in turn, can result in quite different speed choices depending on the purpose of the trip and the perceived risk of the road and traffic situation (Ahie et al., 2015; Oppenheim and Shinar, 2011).

The idea that drivers' perceptions of risk play an important role in guiding their on-road speed choices has been central to driver behaviour research for many years (Fuller, 2005; Gibson and Crooks, 1938; Näätänen and Summala, 1974; Taylor, 1964; Watts and Quimby, 1980; Wilde, 1988). Early models proposed that drivers adjust their speed and lane position according to a perceived "field of safe travel" (Gibson and Crooks, 1938) and that departures from this safety zone were associated with increasing levels of emotional tension or anxiety (Taylor, 1964). These ideas were used in developing Risk Homeostasis Theory (Wilde, 1988); the idea drivers possess an internal, target level of risk and they will increase or decrease the safety of their driving in order to reduce the difference between their momentary perceived level of situational risk and their target level.

Other driver behaviour models have also featured risk as a central factor in determining drivers' real-time speed choices. For example, Zero Risk Model (1974) proposed that a driver's decisions are governed by the balancing of inhibitory motives (subjective risk) and excitatory motives. When a critical threshold of subjective risk is exceeded, typically through the violation of learned safety margins, it affects on-going behaviour in a way to reduce the driver's experience of subjective risk. Similarly, Fuller's Task-Capability-Interface Model and its associated Risk Allostasis Theory (2005) assumed that feelings of risk, not perceptions of collision likelihood guide drivers' decision making. In this approach, drivers try to maintain a preferred level of task difficulty, depending on their goals and motivations, predominantly by changing their driving speed. Driving difficulty, and risk of a crash in turn are determined by a driver's capability and by the current demands of driving; if the task demands exceed the capability of the driver,

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Fig. 1. The four median treatments selected for testing. Clockwise from top left: Dashed white control, double yellow, wire rope barrier, wide centreline. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

then high levels of task difficulty and risk are experienced and the driver will slow down to avoid losing control of the vehicle. To test this model, Fuller et al. (2008) asked drivers to provide ratings of task difficulty, subjective risk and collision risk after watching short video clips of three different road types (with no other traffic) presented in order of ascending speeds (5mph increments). Ratings of task difficulty and subjective risk were highly correlated and both showed a linear relationship to speed. Interestingly though, not all studies have replicated the linear relationship between subjective risk and speed. Lewis-Evans and Rothengatter (2009) asked participants to drive a series of simulated roads at a variety of fixed speeds (presented in a random order) in a driving simulator and provide ratings of subjective risk after each drive. At lower speeds (at or below the legal speed limit), ratings of risk were very low or absent (i.e., 'no risk'), and there was no statistically significant relationship between risk ratings and speed. Once a certain speed had been reached, however (above the legal speed limit or the participant's chosen speed), risk ratings showed a moderate positive linear relationship with speed. Thus, the relationship between risk and speed (when speeds are not excessive) is not conclusively established. These differences may be partly due to the (in)accuracy of drivers' perceptions of risks and hazards. An early study in which drivers recorded their moment-to-moment judgments of risk by means of an "apprehension meter" while watching a film of highway driving showed that drivers with poor driving records in real life showed poor levels of caution in the laboratory (Pelz and Krupat, 1974). Similarly, on road tests have shown that there are many situations where risks are underestimated or overestimated by drivers (Watts and Quimby, 1980 Kanellaidis and Dimitropoulos, 1994; Kanellaidis et al., 2000). These authors suggested that differences between actual risk and perceived risk were associated with increased accident frequency, and that where subjective risk is viewed lower than the objective risk the presence of warning signs becomes most important in maintaining adequate safety margins.

Similarly, we used both laboratory and on-road tests to compare drivers' continuous perceptions of risk to an independent measure of the risk associated with those roads (road protection scores calculated as part of KiwiRAP) and found that although drivers' perceptions of risk were generally in agreement with the objective risk, that certain road situations were perceived as being riskier than the objective risk, and perhaps more importantly, the risk of other situations was significantly under-rated (Charlton et al., 2014).

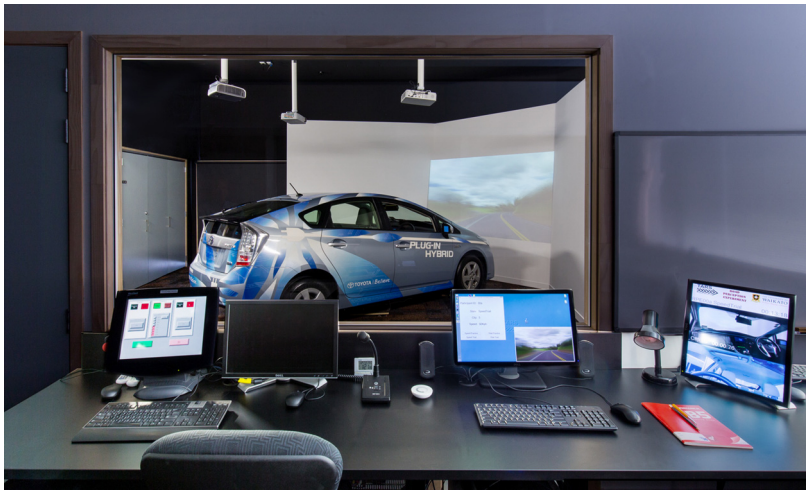

Fig. 2. The driving simulator as viewed from the experimenter's station.