AA ResearchFoundation

Road Safety Research Summary

How well do NZ drivers perceive risk?

Can safety measures help highlight risk so drivers choose safer speeds?

Driver Risk Awareness Research

Introduction

Road safety depends on drivers responding to risk. The research summarised in this document looked at how well drivers perceive risk, and what effect safety measures such as road markings, signs, and barriers have on their behaviour.

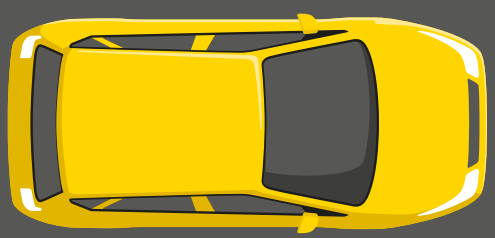
The New Zealand Automobile Association (AA) Research Foundation commissioned two research projects, which were undertaken by road safety researchers working at the University of Waikato School of Psychology.

Both studies were innovative, using technology to measure driver behaviour in simulations as well as real-world driving. The research follows a large body of previous research on risk and driving behaviour.

The two research projects were:

- a 2013 study comparing actual and perceived risk
- a 2015 study examining how countermeasures affect drivers' perception of risk and influence the speeds they choose.

This report summarises the key findings from both research projects and then provides detail on each of the two research projects separately (page 4 onwards).



Key findings

1

Drivers generally perceive risk well, but they underestimate some risks and overestimate others.

When judging the risk of a road, drivers take their strongest cues from bends, hills, road width, median barriers and traffic volume. These features account for nearly 80% of drivers' risk ratings.

However, drivers underestimate some risks and overestimate others:

- Drivers overestimate the risk from bends and narrow lanes.
- Drivers underestimate the risk from intersections and roadside hazards (such as narrow shoulders, ditches, trees and power poles). These road features are less likely to receive enough attention and care.

2

Safety measures can help highlight risk to drivers and lead to lower speeds.

Safety measures such as road markings, signs, and barriers help highlight risk to drivers and lead to lower speeds. Some safety measures have more effect than others. Seeing police cars had a major effect, although this could be due to the fear of a fine as well as signalling a hazard.

Traffic volumes are generally linked to perception of risk in all conditions – drivers perceive higher risk when there is more traffic and usually reduce their speed.

3

Highlighting risk improves safety.

Highlighting risk on the road can improve safety, slowing drivers to safer speeds near hazards. This means safety measures that highlight risk can help keep drivers safe, even if the safety measures don't physically protect drivers from hazards.

Most safety measures slow busy traffic more than light traffic. Wire rope barriers have a different effect. They lead to more consistent speeds whatever the traffic volume.

4

Wire rope barriers lead to consistent speeds.

Wire rope barriers that separate the two directions of traffic change people's perception of risk. Wire rope barriers protect drivers physically and the researchers found this safety benefit leads to low risk ratings in both heavy and light traffic conditions. Consequently they lead to more consistent speeds regardless of traffic volume.

FIGURE 1: Risks that drivers underestimate:

Intersections | Narrow shoulders | Ditches | Power poles/trees

Research Project 1

Comparing actual and perceived risk

This research compared drivers' perceptions of their risk on a range of roads to the objective risk associated with those roads.

The research aimed to answer these questions:

1. **What levels of subjective risk are experienced on hazardous New Zealand roads?**
2. **What road features do drivers use to judge driving risk?**
3. **What hazardous road situations are under-recognised by New Zealand drivers (ie. show the greatest dissociation between objective and subjective risk)?**

Methodology: driving simulator, eye tracking, and real-world driving

This research involved four complementary research tasks:

1. Driving simulator tests
2. Eye-tracking tests (recorded eye movements during tests)
3. Naturalistic driving tests (real-world driving tests)
4. Verification tests (testing participants' responses to video and still images of sections of the naturalistic driving test)

Participants rated the risk of roads while doing the tests. The different research tasks were used to collect a wide range of measures including:

- momentary ratings of risk
- where participants were looking during and just prior to their ratings
- verbal explanations of the reasons for their ratings.

Using different tasks meant the researchers could compare their findings across tasks to be more confident about them.

Innovative use of technology

The research used some innovative technology:

- using a realistic driving simulator
- measuring what people focused on by tracking eye movements and fixations.

Driving simulator

The driving simulator involved a complete car, from which the participant 'driver' viewed a high-definition video of a pre-recorded test route drive. The driver steered the car to respond to corners in the video. The driver rated risk throughout the test, using a thumbwheel on the car steering wheel.

The researchers compared these subjective risk ratings to a baseline – an objective measurement of risk for the test route. They calculated these from KiwiRAP scores – part of the International Road Assessment Programme (IRAP) that measures road safety.

The results showed how accurately drivers rated risk for various road situations.

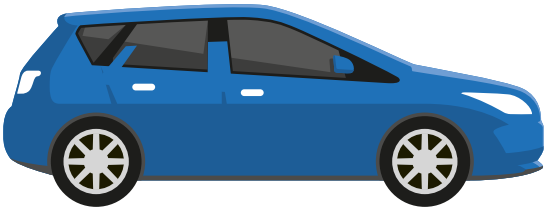
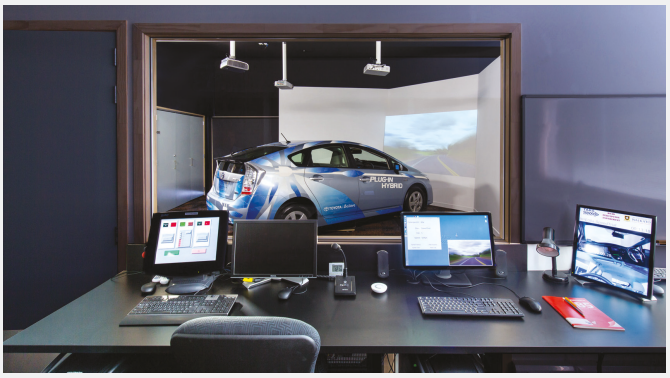


FIGURE 2: Images of the various testing methods

Top from left: Driving simulator video screenshot with on-screen risk scale; thumbwheel used to provide risk ratings; eye-tracking equipment.
Below: The AC/TARS driving simulator as viewed from the experimenter's station.



How participants were instructed:
"If you felt completely at ease – if you were at rest or parked and could completely take your mind off driving – you would keep the pointer at the SAFE end of the meter. But, if you felt extremely threatened, very unsafe, or in immediate danger of being involved in a serious accident or mishap you would move the pointer all the way to the UNSAFE mark at the top."

Eye tracking

Eye-tracking data showed where participants looked when viewing journey videos and providing risk ratings. The data shows what attracted their gaze. The purpose of this was to allow comparison between the explicit risk ratings and implicit measures of risk such as saccades (eye movements), pupil dilation, and blink rates.

Participants rated risk through a journey video, using the same thumbwheel and risk ratings as was used in the simulator and real-world driving tests. The researchers recorded eye movements by means of the TARS eye-tracking equipment. Eye-tracking data showed that participants in the eye-tracking experiment perceived risk the same as those in the driving simulator test.

The researchers analysed participants' eye tracking and fixations to see if participants looked at poles and ditches. Participants did not look at poles and ditches as much as corner warning signs.

Real-world driving

Real-world 'naturalistic' driving of part of the test route gave results that correlated well with the results from the video-based ratings. This confirmed the video-based ratings correspond well to people's perceptions of risk on the road.

Findings: Drivers generally perceive risk well, but they underestimate some risks and overestimate others.

- Drivers overestimate the risk from bends and narrow lanes.
- Drivers underestimate the risk from intersections and roadside hazards (such as narrow shoulders, ditches and power poles). These situations are therefore likely to be misunderstood, to not receive enough care, and to lead to serious crashes.

These results could have implications for highway design. For example, roads with low perceived risk may actually contribute to higher levels of objective risk because drivers are not taking due care at these locations.

Some observations researchers noted:

"The road width was also noted by participants, as were speed advisory signs, particularly heading into curves (eg. 35 km/h sign close to corner)."

"The presence of poles and ditches did not appear to influence the participants' risk ratings."

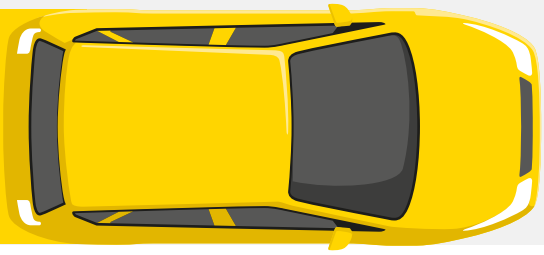
Research Project 2

How safety measures affect drivers' perceptions of risk and speed choice

This 2015 research built on the findings of the first study with a follow-on investigation into how perceptions of risk affect drivers' choice of speed on rural roads.

The research was designed to answer the following questions:

1. **What are the effects of rural road countermeasures (safety measures to deal with specific hazards) on drivers' perceptions of risk?**
2. **What speeds do drivers choose to drive in the presence of rural road countermeasures?**



Methodology: driving simulator and real-world driving

To answer these questions, the researchers recruited participants to:

- 'drive' a video of rural roads in the driving simulator – indicating what speed they would drive these roads in their own cars by using the accelerator and brake pedal
- indicate the level of risk they would feel while driving the road during a second showing of the video.

A separate group of participants drove a rural road route in real life and viewed the same route in the simulator, to verify the simulator results were representative of real-world behaviour.

The driving simulator used videos containing several road conditions of interest, including four types of road median (dashed white lines, double yellow lines, wide centre lines, and wire rope barriers) as well as roads with different lane widths, 'High Crash Area' signs, and a police car with flashing lights.

These safety measures are similar to the ones investigated in the first study – median lines and signs are low-cost safety measures currently in use on rural roads. Again, the signs and road-marking safety measures highlight risk without physically protecting drivers from the hazard. The wire rope barriers highlight risk and protect the driver physically. The police car signals a possible hazard, but also gives drivers a general visual warning to 'drive well'.

Analysing the data

To see how ratings of high risk correlated with choice of lower speeds, the researchers compared each participant's risk and speed ratings at each of 40 measurement points. The researchers also compared the participants' average speed choice and risk rating at each of the measurement points.

To find what speeds participants chose for different safety measures, the researchers compared participants' speed choice and risk ratings for several road median treatments. They compared data for dashed white lines, double yellow lines, wide centre lines, and wire rope barriers (Figure 3).

Findings: Safety measures such as road markings and signs increase drivers' perceptions of risk and lead to lower speeds.

Participants chose lower speeds in situations with higher risk ratings – both in general and for specific road conditions like the presence of a police car or narrow lanes. Safety measures that highlight risk may therefore reduce crashes.

Risk was not the only factor affecting speed. Other comparisons showed that participants also chose lower speeds for reasons other than increased risk (such as speed limits), and increased their speeds for reasons other than lower risk.

FIGURE 3: How drivers rated risk, and consequently adjusted their speed, for some of the safety treatments tested

The relationships shown on this graph are approximate. Detailed information is available in the full research reports.

Wire rope median barriers keep traffic flowing

An interesting finding was that where wire rope median barriers are present, drivers appear confident to maintain their speed regardless of traffic volume.

Some road safety treatments have more effect than others

Simple centre line markings can alter drivers' perceptions of risk, particularly under high traffic conditions. Narrow roads, one-lane bridges and level crossings also had a strong effect on risk perception and speed.

Participants rated double yellow centre lines and wide centre lines as more risky than dashed white centre lines and drove more slowly when they saw them. This slowing effect was strongest in busy oncoming traffic, where the double yellow markings resulted in significantly lower speed choices.

Traffic volumes are linked to perception of risk

Participants generally rated risk higher when the road was busier with oncoming traffic, whatever the road conditions. The one exception was that wire rope barriers appeared to mitigate the effects of higher traffic volume.

Wire rope median barriers keep traffic flowing

Participants rated risk and chose speeds consistently near wire rope barriers, showing little change from low oncoming traffic to high oncoming traffic conditions. This suggests that drivers perceive a safety benefit from physical barriers from oncoming traffic.

Police cars had a major effect

Police cars were not part of the original research plan, but by chance a police car was visible at the roadside during filming. Seeing a police car made participants slow down and give higher risk ratings. This effect was much stronger than responses to a 'High Crash Area' sign. The effect suggests that a visible police presence on the roads is an effective way to reduce speeding.

Conclusion

Effectiveness and familiarity: which treatments work and endure?

Double yellow centre lines and wide centre lines have considerable potential as an indicator of high risk roads. Wide centre lines have two added benefits:

- they increase the physical separation of oncoming traffic
- they are often produced by decreasing the widths of the lanes in each direction (another road condition associated with increased risk and lower speeds).

'High Crash Area' signs had noticeable effects on reducing speed and increasing perceptions of risk, but they had less effect than a police car present on the side of the road.

The researchers suggest further work comparing how long-lasting the effects of different safety treatments are.

This document summarises research commissioned by the AA Research Foundation:

Charlton, S.G., Starkey, N.J., Perrone, J.A., and Isler, R.B. (2013). *Reading the Risk of New Zealand Roads: A Comparison of Actual and Perceived Driving Risk.* TARS Research Report. Hamilton: The University of Waikato.

Charlton, S.G. and Starkey, N.J. (2015). *Risk, Speed, and Countermeasures on Rural New Zealand Roads.* Research Report. Hamilton: The University of Waikato.

Peer-reviewed publications in international journals:

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. *TRF: Traffic Psychology and Behaviour, 25,* 50-64.

Charlton, S.G. and Starkey, N.J. (2016). Risk in our midst: Centrelines, perceived risk, and speed choice. *Accident Analysis and Prevention, 95,* 192-201.

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