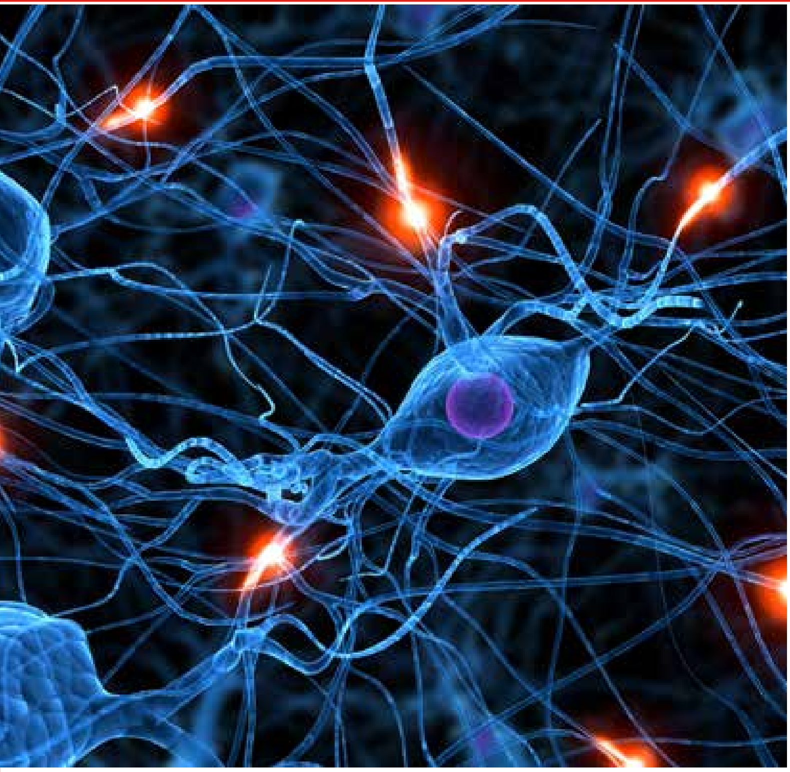
TRAFFIC AND ROAD SAFETY RESEARCH GROUP (TARS)

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Faculty of Arts & Social Sciences



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From the Dean

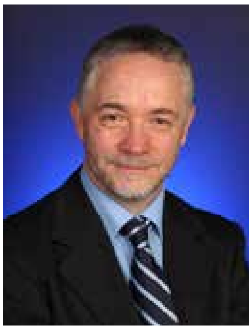
Internationally recognised research in Te Kura Kete Aronui, the Faculty of Arts & Social Sciences, is helping to foster social and cultural innovation and adaptation.

The research undertaken in the Faculty of Arts & Social Sciences is diverse in terms of both the topics and the types of outputs generated. Much of the research carried out in the Faculty plays an important role in assisting policy makers to meet the challenges posed by new technologies, new ideas, and changes in population and employment patterns.

The Applied Cognitive/Traffic and Road Safety (TARS) Research Group is an integral part of the Faculty's research capacity. Their dedication to conducting quality, cutting-edge research has rightfully earned them a reputation as New Zealand's pre-eminent centre for road safety research. Being an educational institute as well as a research provider, one of the group's key goals is the training of tomorrow's road safety researchers, and their students have gone on to make contributions in New Zealand and overseas.

In 2014 the Applied Cognitive/TARS Research Group began the process of consolidating their laboratory facilities into a single location in order to increase research capacity and collaboration. These research facilities (including New Zealand's most advanced driving simulation laboratory and sophisticated eye-tracking technology) were developed primarily from external research grants awarded over the past 20 years and were distributed across several on- and off-campus locations. The research group was successful in securing funding from the University's 2014 Strategic Investment Fund and the Facilities Management Division to consolidate the laboratory space in a purpose-built facility now handily located on campus (added to the HI tower block).

I strongly recommend the work of TARS to you. This booklet will give you more information about TARS and an insight into their wide range of research activities.



Professor Robert Hannah
Dean
Faculty of Arts & Social Sciences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TOYOTA | Believe
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Introducing the TARS Research Group

The University of Waikato's Applied Cognitive Psychology research team is made up of four researchers – Associate Professors Nicola Starkey, Robert Isler, Samuel Charlton and John Perrone.

Part of their work is devoted to using driver behaviour as a means to understanding attention, memory, decision-making, vision and other aspects of skilled human performance. They do this work as TARS, the Traffic and Road Safety Research Group.

TARS was founded in 1993 to be an independent research centre for issues related to drivers and road safety. Since then TARS has gone on to establish an international reputation for its research on driver behaviour, and has provided New Zealand-based research for the Ministry of Transport, the Automobile Association Research Foundation, the Road Safety Trust, the New Zealand Transport Agency, the New Zealand Police, the Accident Compensation Corporation, and many local and regional road controlling authorities.

Their research record and history of successful working relationships has made TARS New Zealand's pre-eminent centre for road safety research. In 2005 the New Zealand Automobile Association presented TARS with a Motoring Excellence Award for Road Safety Research, the first and only time it has made such an award.

The group has conducted leading-edge research into driver fatigue, distractions produced by cell phones, perceptions of risk, safety at intersections, the design of road workers' safety vests, the design of overtaking lanes, the effectiveness of road signs, urban threshold design, New Zealanders' driving habits, and many other topics.

This research has led directly to road design changes, including "signs and lines" and other innovative designs, rule changes for drivers such as lower alcohol limits and cell phone restrictions, and the development of a nationwide novice driver education and training programme. Each of these research projects has provided sound, fact-based support to policy makers and contributed to lowering the annual road toll. Quite simply, TARS research has led to changes that have saved the lives of New Zealand drivers.

The TARS Research Group comes under the School of Psychology, within the University's Faculty of Arts & Social Sciences. The School of Psychology is widely regarded as the centre of Applied Psychology in New Zealand.

Improving higher-order driving skills

It is common knowledge that young drivers are at considerable risk when they become solo drivers. They are eight times more likely to crash when they move from the learner phase to the restricted phase of driver licencing. Young, inexperienced drivers display less efficient visual search patterns and poorer complex perceptual and cognitive skills.

Failure to effectively scan the road is a frequent crash factor in young novice drivers and improvements in eye scanning is one of the changes that naturally occurs when drivers gain experience. However, gaining that experience involves exposure to risk.

The large scale study showed that young drivers' on-road driving performance was related to their executive functions, controlled by the frontal lobes of their brain which, on average, are still developing until the age of 25. The good news is that like any other brain function, frontal lobe functions can be enhanced by appropriate training.

The study of 36 young drivers from all over New Zealand, mostly on restricted licences, compared the effects of training in higher-order executive function related driving skills and vehicle handling in relation to driving performance, hazard perception, attitudes to risky driving and driver confidence levels. Driving assessors conducted on-road driving assessments of each participant before and after the training, while participants also carried out hazard perception tasks and completed questionnaires to assess attitudes to risky driving and driver confidence, before and after the training.

With on-road driving, those who had received higher-order driving skill training showed significant improvement in visual search and driving performance. The training also led to improved hazard perception, safer attitudes to risky driving, and more accurate self-evaluations of driving skills. Vehicle handling training also led to improvements in driving performance, but no improvements were evident in hazard perception, attitudes to risky driving or driving skill self-evaluation.

The study also showed that executive functions were related to on-road driving performance in regards to visual search, hazard perception and risk management. Furthermore, the findings suggest that 'insight'-based training may provide the crucial ingredient – to address the 'young driver' problem and other factors associated with the high crash rate in young drivers. The study emphasised the need for adapting a broader perspective to driver education and training and a more holistic and modern approach.

The results of this study were used by the New Zealand government to make a case for increasing the driver licencing age from 15 to 16 years. This licencing rule change came into effect in 2012.

Driving While Conversing

Cell phones that distract and passengers who react

New Zealand drivers were once free to use hand-held cell phones and other electronic devices while driving. However, by 2006 an increasing trend in casualties associated with cell phone use while driving was becoming apparent and TARS researchers began advising the New Zealand government on overseas research showing that the use of a cell phone while driving was a significant risk.

In response, the Labour Government's Road Safety Minister, Harry Duynhoven, issued a challenge to TARS – if talking on a cell phone while driving should be banned, why not ban conversing with passengers as well? TARS took up the minister's challenge and designed an experiment that researchers hoped would show just how and why talking on a cell phone was different to, and more hazardous than, talking to a passenger.

Using their state-of-the-art driving simulator they created faithful simulations of actual New Zealand roads, with representative driving hazards. They then went on to recruit pairs of people who knew each other to measure the risk of talking on a hands-free cell phone, with a passenger in the car, or with a remote passenger – someone who could see the road conditions, but wasn't in the car with the driver.

The results showed drivers driving with passengers or by themselves successfully slowed down and avoided all the hazards. Drivers using a cell phone didn't notice the hazards, didn't slow down, and had a very high number of crashes.

The experiment was also the first to reveal the reasons for the difference. One of the main reasons is that passengers slowed their rates of conversation as the car approached a hazard, and often warned the driver of approaching hazards, something we called 'conversation modulation', which doesn't happen in cell phone conversations.

In 2009 New Zealand went on to ban the use of hand-held cell phones while driving ('hands-free' phones are still permitted).

Three years after the law change, a subsequent project conducted in conjunction with medical students in Wellington was carried out to estimate how well drivers were complying with the new law.

The students observed drivers at intersections at several locations and found that about 2% of drivers at traffic signals were using their hand-held mobile phones. The majority of these drivers were young (under 25) and were using their phones in a "non-ear position" (i.e. texting rather than holding the phone next to their ear). This rate of use was approximately half of what was observed prior to the law change, but still remains too high.

Drinking and Driving

The effects of moderate alcohol consumption on driving

In 2011 The New Zealand Transport Agency and the Police were investigating the risks of alcohol for New Zealand drivers with a view to reducing the allowable Blood Alcohol Concentration (BAC) from 0.08 to the more widely-accepted international standard of 0.05.

The fact that alcohol increases the risk of serious injury and fatality crashes was already well-established, but there was an aspect of alcohol intoxication that made this research an intriguing project for TARS. Recent reports had suggested that alcohol's effects can be quite different depending on how long you have been drinking. The same amount of alcohol in the bloodstream can result in greater impairment if you have been at that level for a while; an effect called acute protracted error. This is the opposite of an earlier finding that alcohol can have its greatest effects when you have just started drinking; called acute tolerance, or the Mellanby Effect.

Which of these two effects was most commonplace for drivers? Would reducing BACs from 0.08 to 0.05 really make a difference for Kiwi drivers? Were Kiwi drivers even aware of their own levels of intoxication? These questions led TARS to perform a major study testing 61 drivers' responses to alcohol.

Participants were assigned to one of three alcohol conditions, one group was given enough alcohol mixed with orange juice to reach a BAC of 0.08 (the legal limit for driving at the time), another group was given enough to reach a BAC of 0.05 (the legal limit in Australia and most of Europe), and a placebo group that received a tiny dose of alcohol in their orange juice.

The results were clear, drivers with a BAC of 0.08 were significantly worse on a wide range of cognitive and driving tests. Furthermore, crossing the centreline of the simulated road and speeding became worse over time, even though the amount of alcohol in their bloodstream remained the same. Drivers' judgements of their own impairment and their willingness to get behind the wheel also changed, they thought they were getting sober quicker than they actually were.

The results of this study helped convince the decision makers, and the change to 0.05 BAC soon followed into law.

Road Design

Self-explaining roads for New Zealand

Whether the road is in suburban Auckland, downtown Invercargill, or rural Christchurch – New Zealand roads can all look very similar.

Problems arise when roads that look the same have different speed limits, as drivers can become confused as to what the correct speed is for a particular stretch of road which leads to speed heterogeneity, a situation that significantly increases the risks of crashes and injury.

Beginning in 2007, with funding from the then Foundation for Research Science and Technology and support from the Auckland City Council, which was keen to address problems in the established urban area of Glen Innes, TARS embarked on a project to make different types of roads look and feel different.

The self-explaining roads concept is about making roads safer and user-friendly for all users, including motorists, pedestrians, cyclists and residents, and the project began by turning to the community to find out how their roads were currently being used, and how they would prefer to use them.

TARS then turned this information into design principles that, when applied to the streets in Glen Innes, resulted in road categories that were clear and intuitive to road users. This included adding higher levels of delineation and defined pedestrian and cyclist facilities to through roads and increasing the landscaping and presence of "community islands" on access roads to provide a more residential atmosphere.

By mid-2009, the road works were complete, and it was time to see how the re-designed streets worked. The first thing noticed was that the different types of roads really felt different to one another, different in how the traffic moved and how pedestrians interacted with it. Residents' surveys showed that they felt the appearance of their roads had improved significantly.

Speed data collected three months later showed a significant reduction in vehicle speeds on the access roads making them feel much safer for walkers and cyclists. More importantly, different drivers were going the same speeds; on the access roads it just felt right to go about 30 km/h and on the through roads it felt right to go 50 km/h, so everyone did. The designs worked, without any changes to the speed limits or police enforcement.

Two years later and Glen Innes had seen a 30% reduction in crashes and an 85% reduction in crash costs. Furthermore, a visit to the area shows many more adults and children walking and cycling – feeling more at home using the streets they live on.

Risk Perception

Drivers' perceptions of risk

For many years researchers and road designers assumed that drivers' perceptions of risk played an important role in guiding their behaviour. But it wasn't known whether drivers could accurately perceive the risk of a particular road or driving situation.

This was the focus of an innovative and ground-breaking piece of TARS research conducted in 2013 with funding from the New Zealand Automobile Association Research Foundation. TARS wanted to compare drivers' feelings of risk as they drove on rural roads to the actual objective risk associated with those roads.

To find out the objective risk of the roads, they used road protection scores from the KiwiRAP database, which is part of the International Road Assessment Programme. These scores are based on the presence of road features such as intersections, curves, and roadside hazards that can increase the risk and severity of crashes.

Participants were recruited to take part in the research by driving on a wide range of rural roads, either in the simulator, or on the actual roads in an instrumented car. While they drove they rated how much risk they were feeling on scale of 1 (completely safe) to 10 (very unsafe).

The results showed that level of risk experienced by the drivers was, in general terms, in agreement with the objective risk for the roads, with some notable exceptions. Certain road situations were rated as riskier than the objective risk while the risk of other situations was significantly under-rated.

Curves and narrow lanes were associated with over-rated risk estimates, while intersections and roadside hazards such as power poles and ditches were significantly under-rated. The finding, that drivers under-rated the risk associated with roadside hazards such as power poles and ditches, had not been previously studied or reported and it appears drivers may be focussing more on things that they think could cause them to crash instead of risk factors that could magnify the severity of a crash when it happens.

Detailed analysis of the participants' ratings showed that drivers use curves, hills, road width, and the presence or absence of a divided median to judge the risk of a road, with these features alone making up about 80% of the variation in the participants' ratings of road risk.

How we did it

The TARS driving simulator, one of the most advanced in Australasia, was used to present high-definition videos of the roads to the participants. While participants drove the roads in the simulator they provided moment-to-moment risk ratings by moving an "apprehension meter" mounted on the steering wheel and displayed on the screen in front of them.

After driving the roads in the simulator, the participants were shown a series of photographs, some from the videos and some that were new. Participants told TARS whether they remembered having seen the roads in the videos, and also how they would rate the risk of those roads. This procedure allowed the researchers to compare different levels of risk people see in photographs and videos, the two most common research methods used to study driver perceptions. The results showed a very high degree of consistency and correlation across the two methods.

Another group of participants was recruited to rate the risk of the videos and the photographs while wearing sophisticated eye tracking equipment. The participants' data was analysed using software that compared where drivers looked, their eye movements, and their pupil size to their risk ratings. The results showed that the roadside hazards, which had been under-rated by participants, were not looked at by drivers. They had either not been noticed by drivers or they were not considered important enough to warrant attention.

A third group of participants was recruited to drive the actual roads contained in the videos, a procedure called naturalistic driving. Naturalistic driving, where unobtrusive observations are made of driver behaviour, allows researchers to observe and analyse the inter-relationship between the driver, the vehicle, the road and other traffic. The results from the naturalistic driving observations showed a very strong correlation to video-based ratings of perceived risk and added support to the portrait of how drivers' perceptions of risk are formed.

The use of multiple testing methods by the TARS team of researchers not only allowed them to assess the reliability of the data, it also provided a more complete picture of drivers' risk perception than had been previously possible.

Perceived train speeds

The prevalence of collisions between cars and trains at railway level crossings is a high-profile issue that has warranted close scrutiny over the past 10 years. However, the incident rate has not decreased. Recent research on the perceived speed of large moving objects, compared to smaller moving objects, has revealed the presence of a size-speed illusion. This illusion, where a large object seems to be moving more slowly than a small object travelling at the same speed, may account for these types of collisions.

TARS researchers set out to learn whether observers do underestimate a train's perceived travelling speed (relative to a smaller vehicle), and to determine whether or not our eye movements while tracking these vehicles could provide some insight into the illusion.

Results showed that observers significantly underestimated the relative speed of a train when compared to a car, and that this size-speed illusion was robust over a range of distances from the observer to the intersection/level crossing junction. The researchers also found that when looking at approaching vehicles, people tend to automatically fixate closer to the visual centre of the vehicle - which differs depending on its size and length – rather than the front of the vehicle.

This visual centre has a slower rate of image motion on the eye than the front of the object, so may affect the overall perceived speed of the object.

When research participants were forced to look at the front of the respective vehicles the size-speed bias was removed.

The results suggest that eye movement behaviour may be partly responsible for the illusion where a larger object appears to move slower than a smaller object travelling at the same speed.

The results of this research are consistent with earlier studies and have verified that the illusion occurs over a wide range of distances from the observer position relative to the road or train track. It is also possible that there may be a relationship between our eye movements and perceived judgement of a moving vehicle's speed.

The results of this research provide further avenues to investigate the effectiveness of interventions designed around minimising the size-speed illusion and reducing these types of collisions.

Automaticity

Driving without awareness

The "driving without awareness" experience is a relatively common one for drivers travelling on routes they use every day – the trip to work or the return home. Although it's an experience familiar to many, it had not been studied carefully to any degree until now. Part of the reason for this lack of research was the time commitment and difficulty involved in making a driving situation in the lab feel as familiar as the drive home.

However, there were important questions to be answered. How are we able to drive on "autopilot" on familiar routes and what triggers us back to a state of attention? Are there some things in the driving environment that drivers always pay attention to, and are there others they don't notice? How much practice does it take before we start to drive without awareness?

To uncover the answers to these questions, TARS began a multi-year research programme in which drivers were paid to come to the laboratory for several months to drive a simulated road twice a week, until they became so familiar with it they could do it without thinking.

The results showed that the more familiar we become with a route, the less attention we pay to the surrounding landscape. This "inattention blindness" grew increasingly common and drivers failed to notice even when prominent buildings were removed from the roadside and traffic signs were changed from English to German. In contrast, things the drivers were asked to react to over and over again during the drive, such as flashing their headlights whenever they saw a Volkswagen beetle, became automatic and fast. So automatic, in fact, that many of the participants found themselves flashing their headlights at Volkswagens when they drove their own cars around town.

This increased familiarity with the route led to a reduction in the mental demand of driving and, over time, people switched from active attention to monitoring, which requires less attention. Based on these results, TARS developed a Tandem Model of driver behaviour that includes both explicit (conscious) and implicit (automatic or unconscious) processes involved in driving performance.

The findings also presented new insights into the how and when of driving without awareness and the possible reasons drivers are most likely to crash at locations very near their homes. The research programme is ongoing, with investigations into what happens when drivers are asked to pay attention to things that have become automatic, and the kinds of things drivers think about when they let their minds wander as they drive.

Vision Science

Motion perception

The ability to drive a car depends a lot on vision; the information gathered by the eyes and brain about the road ahead and how fast the car is moving is critical for safe driving. But what is the actual visual information used when we drive? How does the brain process this information and how is it used to steer the car correctly along the road?

TARS researchers have been addressing these questions and have developed computer models of how the brain uses vision for vehicle control. In particular, the researchers have concentrated on the visual motion that is generated as we move through the world and have used physiological data from motion processing areas of the primate brain to guide the design of their computer models.

Once fully developed, these models will provide a powerful tool for understanding what the important visual cues used for driving are. This can help in the design of roads and to understand why particular road conditions lead to accidents. The computer models (based on the human visual system) can also be used to help design smart sensors for 'self-driving' cars.

In addition to generating computer models, the TARS researchers also try to understand the important visual information used for driving by gathering data on drivers as they control a car. To isolate the visual cues used for steering and control, the researchers run experiments where observers have to view computer displays depicting the view from a moving car. The researchers can also record the observer's eye movements in order to identify parts of the visual scene that are looked at during particular driving scenarios.

Future Areas of Research

Where do we go from here?

We hope you have enjoyed reading the stories that lie behind some of our recent research projects.

As effective as these projects have been, we don't yet have all the answers when it comes to driver behaviour. We don't even have all of the questions yet, but some, of particular interest to us, include:

» How does ageing affect our driving?

» How many people's driving is adversely affected by prescription drugs?

» Who has the greatest influence on young people's driving style?

» How do drivers respond to simulated and real risk?

» What will be the effect of increasing the level of automation in our cars?

Our new laboratory facilities are helping us to tackle some of these important questions. If you are interested in being part of this, we encourage you to contact us. We offer scholarships to students who want to learn more about driver behaviour research and we are very happy to discuss future research topics and projects with stakeholders, collaborators and potential research funders.

We will continue to recruit participants, collect data and teach students. So, if you are interested in being a part of our future, let us know and come along with us. You will find our contact details listed over the page.

TARS Research Group

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