The University of Waikato
Te Whare Wānanga o Waikato

THE 'FRONTAL LOBE' PROJECT

A double-blind, randomized controlled study of the effectiveness of higher level driving skills training to improve frontal lobe (executive) function related driving performance in young drivers

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ACC PREVENTION. CARE. RECOVERY. Te Kaporeihana Āwhina Hunga Whara

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Traffic and Road Safety Research Group
Psychology Department
University of Waikato
Private Bag 3105
Hamilton

Robert B. Isler, Ph.D. — Phone: (07) 838 4466 ext. 8401, e-mail: r.isler@waikato.ac.nz

Nicola J. Starkey, Ph.D. — Phone: (07) 838 44 66 ext. 6472. e-mail: n.starkey@waikato.ac.nz

Margaret Drew, Ph.D.
Research Assistant — email: madrew@xtra.co.nz

Peter Sheppard, Trustee
AA Driver Education Foundation
and Director of PCS Transport Consulting — Phone: 021 222 6964, e-mail: pcs.transport@xtra.co.nz

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Without our participants, this study would have never commenced. Their dedication and willingness to participate in a study of this type was most unique and hopefully the efforts of these people will have a serious impact in the future of adolescent drivers, both within New Zealand and perhaps world wide. Our sincere thanks and gratitude goes to these outstanding young individuals.

Important Note

This report has been peer reviewed. While the project received funding from the Accident Compensation Corporation, Road Safety Trust, Tranzqual ITO, AA Driver Education Foundation, and University of Waikato, the interpretation of the findings and the recommendations are those of the authors and do not necessarily represent the views of the funding agencies.

Abstract

The current study was undertaken in order to evaluate the effectiveness of higher level skills training on safe driving behaviour of 36 teenage drivers. The participants, who attended the Driver Training Research camp in Taupo (NZ) over a two week period, were 16 to 17 years old and had a valid restricted driver licence. The study focused on four main aims. Firstly, the behavioural characteristics of the sample and their attitudes to risk taking and driving were examined. Results showed that speeding was the most anticipated driving violation, and high levels of confidence were associated with a higher number of crashes and a greater propensity for risk taking. Many, often male participants, also rated their driving skills as superior to others and thought they would be less likely than others to be involved in an accident. Secondly, the relationship between driving performance and executive functioning, general ability and sustained attention was evaluated. Overall, better driving performance and more accurate self-evaluation of driving performance was related to higher levels of executive functions, in particular, working memory, and cognitive switching. In addition, higher general ability and greater ability to sustain attention were also linked to better performance on the driving related assessments. The third focus of this study was to compare the effects of both, higher level and vehicle handling skills training on driving performance, confidence levels and attitudes to risk. While both types of training improved direction control, speed choice and visual search, along with number of hazards detected and actions in relation to hazards, statistically significant improvement on visual search was seen only after higher level skills training. Vehicle handling skills training significantly improved direction control and speed choice. In addition, confidence levels in their driving skills were significantly lowered and attitudes to speeding, overtaking and close following had improved significantly in the participants after the higher level driving skills training. The final aspect to this study was to examine the effects of the training over the following 6 month period based on self-reported driving behaviour. The response rate of participants however, was not sufficient to reach any meaningful conclusion on any long-term training effects. A pilot study using GPS-based data trackers to assess post-training driving behaviour revealed some promising results for future driver training evaluation studies. The overall implications of the results are discussed in relation to improving the safety of young drivers in New Zealand.

Contents

1 EXECUTIVE SUMMARY

The over-arching aim of this study was to evaluate the effectiveness of higher level skills training to improve frontal lobe executive function related driving performance in young drivers (16-17 years). The study used a double-blind, randomized controlled, between-subjects design and involved a sample of 36 teenage drivers (23 males, 13 females) who attended a *Driver Training Research* camp over a two week period in the Taupo area, New Zealand. An additional 36 teenagers (26 males, 10 females), who did not attend the *Driver Training Research* camp, acted as a post-camp control group to evaluate long-term training effects.

The first specific aim was to assess the behavioural characteristics of the sample including their attitudes to driving and risks involved. Some factors were then examined which could have influenced these measures. They included level of anxiety, number of crashes and near misses they experienced in the last 12 months, confidence level in their driving skills and personality. Key findings included:

- The crash history of the participants showed that a minority of participants had most of the near misses and crashes and it also confirmed that young drivers experience a considerable risk of injury and death during the first months of solo driving on a restricted driving licence.
- The driver violations questionnaire revealed that the participants anticipated speeding violations to happen most frequently in the future (e.g., to exceed the 100km/h speed limit on average as often as 60% of the time). In comparison, non speed related driver violations (drink-driving) were predicted as less frequent.
- The results for the driver attitude questionnaire revealed that the responses reflected the safest attitudes in regard to drink-driving behaviour and close following and the least safe attitudes to the risk factors speeding and overtaking. There was a significantly less safe attitude in regard to speeding behaviour for the male participants compared to the female participants.
- The self-evaluation of driving skills questionnaire confirmed that many teenage drivers rated their driving skills as higher than the average driver, that they will be less likely involved in an accident than the average driver, often get a thrill from driving and often disagree with the statement that they sometime feel worried that they will be involved in an accident.
- A high level of confidence in their driving skills and a high number of crashes in the past related strongly to unsafe attitudes in many risk taking behaviours - particularly speeding. High levels of the personality factors agreeableness and openness and low

levels of impulsivity were associated with safer attitudes regarding driver violations anticipated for the future.

The second aim was to assess if the level of frontal lobe executive functioning, general ability and sustained attention of the participants in the sample related to their on-road driving performance regarding visual search, speed control and direction control - their road commentary scores and their driving self-assessment. Anxiety levels were also assessed as possible covariates of cognitive functioning. Key findings included:

- There were significant gender differences on some of the neuropsychological assessments. In particular, females performed significantly better than males on the sustained attention, complex information processing, verbal fluency and the inhibition tasks.
- There were no significant differences between the genders with regard to the driving related assessments. However, females tended to be more accurate in the self evaluation of their driving performance.

In terms of executive functions:

- More efficient working memory was associated with better performance in the on-road driving assessment.
- Better cognitive switching was also linked to better performance in the on-road driving assessments.
- Those with better complex information processing ability showed more accurate self-evaluation of their driving and reported fewer actions to hazards in the road commentary task.
- Higher general ability scores were related to better performance in the on-road driving assessment and more accurate driving self-evaluation.
- Those with higher verbal IQ detected more hazards in the road commentary task, whilst those with high performance IQ reported more actions to hazards.
- Higher levels of sustained attention were generally related to better scores on the on -road driving assessment and more accurate self-evaluations.

The third aim of the study was to determine what effects higher level and vehicle control skills training have on real driving performance, confidence levels, and attitudes to risk taking behaviour. The participants were trained (5 days) either on higher level skills (mostly off-road), vehicle control skills (mostly on-road) or received no training (control group). After the training, the on-road driving performance of the participants was re-assessed by the experimentally blind driver assessors. The participants were also required to respond again to the attitudes and risk-taking questionnaires and to self re-evaluate their driving confidence and skills. Key findings included:

- For the on-road driving behaviour assessment, the baseline scores for the participants were highest for direction control and lowest for visual search.
- Higher level and vehicle control driving skills training both improved the search behaviour of the participants but only the improvement after higher level driving skills training reached statistical significance.
- The scores for speed choice improved for both training groups (higher level and vehicle control) but the improvement only reached statistical significance for the vehicle control training. Direction control was improved by both types of training but more effectively with the vehicle control skills training. Overall, both training groups were able to significantly improve their composite score of the on-road driving assessment.
- The road commentary scores relating to the percentage of hazards detected and actions to hazards improved after higher level and vehicle control skills training, but the improvement was only significant for the higher level skills training. All three groups (including controls) were able to decrease the number of actions to non-hazards but the decreases were not significant except for the control group.
- Most importantly, higher level skills training significantly decreased driving confidence levels in driving skills, and improved attitudes towards speeding (at 110 and 120 km/h), close-following and overtaking. In comparison, training in vehicle control skills did not change significantly any of the confidence and attitude measures.

The fourth aim of the study was to determine if the training had any long-term effects on the participants' day to day driving behaviour. After the training and for a period of six months, the group of participants who received training (N=36) and a group of participants who did not attend the *Driver Training Research* camp and acted as post-camp controls (N=36) were required to complete fortnightly diaries recording their driving behaviour.

- The response rate of the participants was poor and therefore a comparison of the self-reported driver behaviour between the participants and the controls was not feasible.
- A pilot study that used a telemetric data tracking system, installed in the private cars of 8 participants, to assess long-effects training effects on real driving performance by recording objective and sensitive outcome measures, revealed some interesting results (see Appendix 8.1).

2 INTRODUCTION

This introduction will attempt to conceptualise the four aims of this study citing only studies in the road safety literature on young drivers that are directly relevant for this study. There are excellent and comprehensive literature reviews on young novice drivers and driver education and training in different countries (Engström, Gregersen, Hernetkoski, Keskinen, & Nyberg, 2003; Mayhew, 2007; Senserrick, 2007). The authors of this report assume that the reader is familiar with the content of these reviews.

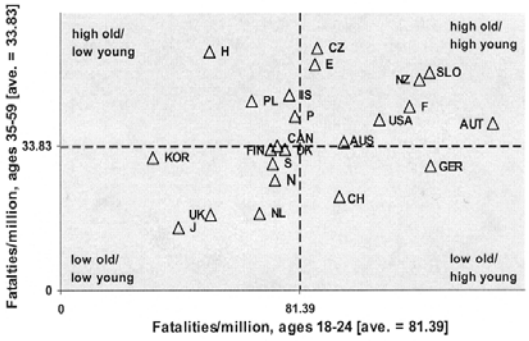
2.1 The young driver problem worldwide and in New Zealand

International road accident statistics clearly show that young novice drivers are at high risk of death or injury. A recent report from the OECD (ECMT, 2006) found that globally, 16-24 year old drivers are greatly over-represented in crash and fatality statistics. They pose a greater risk than any other drivers to themselves, their passengers and other road users. Young drivers represent about 27% of all drivers killed in OECD countries, although this age group only accounts for about 10% of the population. Death rates for 18-24 year old drivers are typically about double of older drivers (ECMT, 2006) and traffic crashes are the single greatest killer of 15-24 year old in the OECD countries. Interestingly, the report also found that those countries with lower average death rates for drivers aged 35-59 are also very often also those with lower rates for drivers aged 18-24 (see *Figure 2.1)*. This could mean that countries with overall higher safety standards also have a better safety record for young novice drivers.

In *Figure 2.1* New Zealand is situated in the top left corner, indicating that our overall driving safety standard is low and also revealing a high novice driver fatality rate (that does not include the young drivers below 18 years of age) which is larger than, for example, the United States of America (USA), Canada and the United Kingdom (UK). To support this, recent data from the New Zealand Ministry of Transport (MOT, 2007) show that

> "*In 2006, young drivers (those aged 15-24) were involved in 121 fatal traffic crashes (at fault in 92 crashes), 813 serious injury crashes (at fault 628 crashes) and 3768 minor injury crashes (at fault in 2894 of the crashes). The total social cost of crashes where 15-24 year old drivers were at fault, was nearly $1 billion. This is almost one third of the social cost associated with all injury crashes. Male drivers in the 15-19 year old group are approximately seven times more likely to crash (per 100 million kilometres driven) than male drivers in the 45 to 49 year old age group. Female drivers aged 15-19 have a lower crash risk than males of the same age but are approximately six times more likely*

to crash (per 100 million kilometres driven) than female drivers in the 45 to 49 year old age group.



Source: IRTAD.
Note: Data from year 2003, except for Australia (1999), Canada (2002), Hungary (2002), Japan (2002) Spain (2002) and average value of period 1999-2003 for Iceland.
Abbreviations used in Figure 4: H: Hungary, CZ: Czech Republic, E: Spain, SLO: Slovenia, NZ: New Zealand, IS: Iceland, PL: Poland, F: France, P: Portugal, USA: United States of America, AUT: Austria, AUS: Australia, CAN: Canada, FIN: Finland, DK: Denmark, KOR: Korea, S: Sweden, GER: Germany, N: Norway, CH: Switzerland, NL: Netherlands, UK: United Kingdom, and J: Japan.

Figure 2.1 Driver fatalities per million population for the 18-24 and 35-59 age group (reproduced from ECMT, 2006)

Male and female drivers in the 20 to 24- year old age groups are approximately three times more likely to crash than 45 to 49-year old drivers of the same gender. Recent figures show that 15 to 19 year old drivers make up just 7 percent of licensed car drivers, Yet between 2004 and 2006, 15 to 19 year old drivers accounted for 15 percent of all drivers involved in fatal crashes. Similarly, 20 to 24-year old drivers make up approximately 9 percent of licensed car drivers, but between 2004 and 2006 they accounted for 14 percent of drivers involved in minor injury crashes, 13 percent of serious injury crashes, and 12 percent of drivers involved in fatal crashes. Of all young drivers (15 to 24 years old) involved in fatal crashes between 2004 and 2006, 78 percent were male. Males accounted for 71 percent of young drivers involved in serious injury crashes and 63 percent of those involved in minor injury crashes over the same period. Alcohol/drugs and speed are the major contributing factors for young drivers involved in fatal crashes. These young drivers are more than two and a half times as likely to have speed as a factor as drivers over the age of 25. Crashes which involve drivers losing control of their vehicle are a major feature in crashes involving young drivers. Thirty-seven percent of 15 to 24-year-old drivers involved in fatal crashes were in single vehicle, loss of control or run off road crashes, compared to twenty percent for older drivers. In addition, many head on crashes also involve a driver losing control of their vehicle".

These statistics clearly highlight the high fatality and injury rate amongst young drivers. In addition to this, there is also a huge burden on the families and relatives related to these crash victims.

2.2 Age, gender and experience as risk factors

There is some evidence to support the idea that the high rate of road crashes among young people is attributable to a simple lack of experience; for example, the crash rate for novice drivers is highest during the first month, decreasing dramatically over the next seven months (Lewis-Evans & Lukkian, 2007; Mayhew, Simpson & Pak, 2003), and inexperienced drivers experience higher levels of anxiety than experienced drivers (Näätänen & Summala, 1974). However, there is also evidence indicating that age per se is an important factor in determining the risk of crashing as well as experience. Studies have found that the frequency of each type of traffic violation decreased with age (Harrington & McBride, 1970) and that during the first few months of driving, 16 year olds are involved in more crashes than recently licensed older drivers (Mayhew et al., 2003). While experience undoubtedly has some effect on crash rates, MacDonald (1994a) concluded that experience tended to have a greater effect on *older* drivers as well as female drivers, but for young males, age seems to be the main factor. In support of this, Lajunen and Parker (2001) found that driver anger and aggression in males was negatively correlated with age, while driver aggression in females was negatively correlated with annual mileage.

The characteristics of crashes involving young people are also different to the characteristics of crashes involving older people. For example, young people (particularly 15 year olds without a licence) are more likely to be involved in single-vehicle crashes, such as hitting a stationary obstacle or losing control on a bend (Ulmer, Williams, & Preusser 1997), while older driver are more likely to crash at intersections (Parsonson, Isler, & Hansson, 1996). Additionally, the incidence of rear end collisions has been found to be particularly high amongst younger drivers and only begins to decrease after the age of 26 (Yan, Radwan & Abdel-Aty, 2005).

In spite of these statistics, New Zealand is one of the few countries that currently allow teenagers to become solo drivers at 15 ½ years of age. The number of young drivers involved in casualty crashes increases from around 75 per month at the end of the Learner Licence to 425 per month during the first month of Restricted driving (Lewis-Evans & Lukkien, 2007). Accordingly, the behaviour of these adolescent drivers represents the single largest cause of fatalities in that age group, and is widely acknowledged as one of the most serious social issues facing New Zealand.

Obviously, it is not the case that *all* young drivers are guilty of exhibiting risky driving behaviour, in fact, some researchers suggest that a minority of young drivers account for the majority of risk taking (such as drinking, not wearing a seatbelt, and tailgating), and consequently account for the majority of crashes (Jonah, 1986).

Although young novice drivers do not consist of one homogeneous group, it is certainly *within* this group that most driver risk taking occurs, with young males being particularly

prominent in the group of risky drivers (for example, see Brown & Copeman, 1975; Evans & Wasielewski, 1983). In addition to gender, there are also lifestyle factors, which differ among young drivers, and which can influence crash risk. For example, such factors as car ownership, school grades and licensing age, having a part time job (which was generally more common among students with low grades and from low SES families) have all been shown to influence the propensity to be involved in accidents (Gregersen & Berg, 1994; MacDonald, 1994b; Murray, 1998). Those with lower school grades, lower SES background, car ownership and younger licensing age being more likely to be associated with a higher accident risk. It has also been suggested that those adolescents who frequently meet friends with no other purpose than to 'hang out' are more likely to drive for fun, and exhibit risky driving behaviour in order to show off and gain attention from their peers (Bina, Graziano & Bonino, 2006).

2.3 Attitudes and behavioural risk factors

Over the years there have been attempts to relate psychological characteristics to automobile crash frequency (Elander, West & French, 1993). In the last fifty years there has been a shift of focus from an emphasis on purely personality and psychopathology traits, to cognitive skills. More recently, there has been a shift from simply trying to identify high-risk drivers to trying to understand more generally the attitudes and behavioural factors which underlie the crashes. For example, it has been determined that drivers with particular attitudes (e.g. finding speeding acceptable and/or less considerate of other road users), are more likely to commit driving violations and/or be involved in accidents than other drivers (Assum, 1997).

There is evidence to suggest that over half of young drivers (60%) consider themselves to be better drivers than others (Delhomme, 1991). In particular, young male drivers are found to be more confident in their skills, compared with females (Job, 1990; McKenna, Stanier & Lewis, 1991). The type of bias that drivers have when comparing their ability with others has been considered both a 'positive-self' bias (McKenna et al., 1991), based on their evidence that drivers do not actually rate the average driver poorly but are over optimistic about the quality of their own driving ability, and a 'negative-other' bias (Walton & Bathurst, 1998), where people are confident because they perceive other drivers as being worse.

In much the same manner that young people overestimate their skill in relation to their peers, they also tend to rate their accident likelihood as being the same as older drivers but much less than people of their own age (Finn & Bragg, 1986; Matthews & Moran, 1986). Interestingly, drivers in general have the opinion that young drivers have the highest accident risk, but the individual young drivers themselves seem to feel they are an exception to this trend and rate their own accident likelihood as much lower (DeJoy, 1989, Finn & Bragg, 1986; Matthews & Moran, 1986). It has been suggested that this may be in part due to the limited experiential information they have to rely upon, resulting in an overestimation of their ability to manage dangerous situations (Matthews & Moran, 1986). This overestimation of their ability is

exemplified in a study by Evans and Wasielewski (1983) who found that drivers who follow too close to the car in front were more likely to be young males, driving alone, looking sideways rather than at the road ahead (at the time of the photograph), not wearing a seatbelt, driving relatively newer vehicles, and had more reported accidents and violations. Thus it would appear that young drivers in particular are characterized by an unwarranted level of confidence in their own ability, which is associated with less safe driving behaviours and this may well contribute to their high accident rate.

Adolescence has been described as a period in which individuals begin to show an increase in risk taking, novelty seeking, sensation seeking, and emotional intensity (Dahl & Spear, 2004). The need to experience reward becomes a priority, and unfortunately, some adolescents allow their decision making to be heavily influenced by the prospect of immediately gratifying rewards. Additionally, Parker, Manstead, Stradling and Reason (1992) suggested that young drivers, particularly males, are more likely than older drivers to view the positive aspects of committing violations. In addition, they show less awareness of the negative outcomes which is associated with a poorer ability to resist committing the violations. McKenna and Horswill (2006) found that drivers who exhibited the most risk taking (as evidenced in laboratory based tasks) were also those who had reported that they often allow their driving to be affected by their mood, and other studies have suggested that adolescents who are quite capable of wise decisions under 'normal' conditions, have a tendency to make poor decisions when experiencing intense emotional arousal (Dahl & Spear, 2004).

Senserrick (2006) differentiates between intentional and unintentional risk taking by describing intentional risk taking as deliberate "thrill seeking", and unintentional risk taking as simply a failure in skill or failure to actually recognise the inherent risk. A similar distinction is made between errors and violations, with errors involving a skill based failure in information processing, and violations being risk taking behaviour that involves a deliberate infringement of a regulation (McKenna, Horswill & Alexander, 2006). Unfortunately, adolescence 'predisposes' young drivers to engage in intentional, knowledge-based risk taking and is a reflection of the driving style that is in some ways inevitable during this developmental, exploratory period. This leads to subsequent deliberate violations of the driving environment and may partially explain why young drivers are involved in so many accidents.

2.4 Personality related risk factors

Because many factors, such as demographics, intelligence and information processing ability contribute to driving behaviour, personality traits in themselves are not likely to be major predictors of accident proneness. However, differences in driving behaviour do reflect individual choices, which in turn reflect individual differences in attitudes and beliefs. Thus differences in personality (reflected in driving style) must contribute, at least in part, to different propensities to accident involvement (Arthur & Grazanio, 1996). The 'big five' personality factors that can be

extracted from such instruments as the International Personality Item Pool are Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness. The Neuroticism domain reveals those that tend to lack emotional stability in that they are likely to experience a number of negative affects such as fear, sadness, embarrassment, anger, guilt or disgust and are also prone to irrational ideas and are less able to control impulses and cope with stress. The Extraversion scale reveals those who are more sociable, assertive, active and talkative, and who tend to have a more cheerful disposition and prefer large groups and gatherings. The Openness factor has often been labelled as the Intellect factor, and relates to openness to experience. Factors related to this domain include an active imagination, aesthetic sensitivity, preference for variety, intellectual curiosity and independence of judgement. This factor is related to such aspects of intelligence as divergent thinking which in turn contributes to creativity. The fourth domain is Agreeableness and like extraversion is a measure of interpersonal tendencies. The key characteristic examined in this factor is altruism, measured by the extent to which one is sympathetic to others and is prepared to help them. The final of the 'big five' characteristics is Conscientiousness which assesses such attributes as purposefulness, strong will and determination. This factor is often described as 'will to achieve' and on the positive side is associated with academic and occupational achievement, but negatively can be characterised by fastidiousness and workaholic behaviour.

Previous studies examining the link between personality factors and driving behaviour have shown mixed results which may have been due to both the variety of instruments used to assess personality and the different criteria used in defining the driving variables (see Dahlen & White 2006 and Lajunen, 2001 for a brief review). However, using traffic fatality data for 34 countries, Lajunen (2001), demonstrated a significant positive correlation (r= 0.58) between extraversion and traffic fatalities and a weaker non significant negative correlation (r= -0.28) between neuroticism and traffic fatalities (using the Eysenck Personality Questionnaire). A similar finding was demonstrated by Smith and Kirkham (1981) who found a statistically significant positive relationship between accidents and violations and extroversion in their sample of 20-23 year old males, along with no relationship between accident rate and neuroticism. Extraversion has also been related to traffic offences in young drivers (Renner & Anderle, 2000), and a willingness to drive after drinking (Martin & Boomsma, 1989). In addition this personality factor has been linked with a lesser 'dissociative' driving style and a less 'anxious' driving style (Taubman-Ben-Ari, Milkulincer & Gillath, 2004).

Conscientiousness has also been linked with risky driving in a virtual environment task, along with errors, lapses and violations on a Driving Behaviour Questionnaire, and speed and crashes on a Driving Habits Questionnaire (Schwebel, Severson, Ball & Rizzo, 2006). All of the 'big five' personality factors were examined by Arthur and Graziano (1996), when they assessed the links between traffic accidents and personality traits in a sample of college students. Using Goldberg's 100 Unipolar Markers (Goldberg, 1999) to measure the Big Five, significant

correlations were found between total accidents and extraversion (r= .15), at fault accidents and extraversion (r= .13) conscientiousness (r= -.14) and openness (r= .13), however only conscientiousness differentiated significantly between those who reported having had no accidents and those who had had at least one at- fault accident. In the same study, a non-student sample, were administered a slightly different Five Factor personality questionnaire (NEO-FFI; Costa & McCrea, 1985), which revealed significant correlations between total accidents and conscientiousness (r= -.16), at fault accidents and conscientiousness (r= -.19) and moving violation tickets and agreeableness (r= -.14) and conscientiousness (r= -.16). As with the students sample, only conscientiousness differed significantly between those who had / hadn't been involved in accidents and those who had / hadn't received tickets (Arthur & Graziano, 1996). Additionally, Dahlen and White (2006) reported that a combination of driving anger and sensation seeking measures, along with openness (in relation to risky driving (ß= -.17)) and agreeableness (in relation to loss of vehicular control (ß= -.16)) were good predictors of driving behaviour among college students.

2.5 Confidence, impulsivity and sensation seeking as risk factors

Linked somewhat to personality traits, are an individual's levels of confidence. In the context of driving, being over confident could result in an underestimation of the possible danger in a situation and an increased likelihood of crashing. However, when skid training (with the emphasis on anticipatory skills rather than vehicle manoeuvring) was added to the driving instruction in Finland, it increased driver confidence but did not alter the number of skid related accidents (Katila, Keskinen, Hatakka & Laapotti, 2004). Another study has shown that young males who indicated a greater confidence in driving with distracters such as cell phones, were also shown to be less affected by these than less confident male drivers, but the opposite appeared to be the case for females, as those who were the most confident showed the greatest decrease in driver performance in the presence of distracters (Lesch & Hancock, 2004). In addition, these authors suggest that it is not confidence per se which is important for driving safety, instead it is having an accurate awareness of the effects of being distracted and how well they can compensate for this (Lesch & Hancock, 2004). Among older drivers, higher levels of confidence have been related to fewer lapses and errors but a higher level of violations (Parker, MacDonald, Sutcliffe & Rabbitt, 2001). Thus, while changed levels of confidence had little impact on skid related accidents, generally greater confidence will impact driving ability or style in a way that seems to depend on the person and the situation.

Impulsivity is linked to risk taking but differs from sensation seeking in that impulsivity stems from an inability to control the risk taking behaviour while sensation seeking involves a preferred course of action (Dahlen, Martin, Ragan & Kuhlman, 2004). Higher impulsivity has been linked to both a reduced ability to recognise traffic signs and increased accident rates (Loo, 1979). In a sample of college students those with higher impulsivity ratings were more likely than those with

lower impulsivity ratings to engage in risk taking behaviours such as drunk driving and not wearing a seat belt (Stanford, Greve, Boudreaux, & Mathias, 1996). Additionally, when evaluating the efficacy of a Driving Anger Scale as a predictor of unsafe driving, Dahlen, Martin, Ragan and Kuhlman (2005) found that impulsivity added significantly to the prediction of risky driving (explained and additional 4% of the variance) and driver anger expression (additional 3% of the variance). In older drivers, impulsivity has also been shown to be related to an increased number of driver errors and violations (Owsley, McGwin & McNeal, 2003).

It seems evident then that factors such as attitudes to safe driving and risk taking, self assessments of crash likelihood and perceived risk, along with confidence levels, and general personality traits may differentiate between the different driving styles of young drivers. It was therefore the first aim of the study, to assess the behavioural and personality related characteristics of a sample of 36 teenage drivers, including their attitudes and confidence levels.

2.6 Cognitive abilities, including executive functions to minimise crash risk

The frontal lobes of the brain are the structures that enable us to i) engage in abstract thought, ii) plan and organize our behaviour in a logical and temporal manner and iii) inhibit inappropriate social and emotional responses. They specifically mediate things such as working memory, encoding and retrieving information, attention, intelligence, reasoning, emotional expression, theory of mind (being able to see things from another's perspective), motor movement and preparation, planning and executive functions. The frontal lobes are one of the most complex parts of the brain and as such affect all types of behaviour. They have been described as the 'orchestra leader' of the brain (Kolb & Wishaw, 2003; Lezak, Howieson & Loring, 2004; Martin, 2006). Of most relevance to driving behaviour is one part of the frontal lobes called the prefrontal cortex (PFC), which is located just behind the forehead. This area of the brain is essential for planning, regulating behaviour and making goals, all of which are classed as 'executive functions' (Luria, 1973). Other executive functions include divided attention, sustained attention, processing speed, initiation, sequencing, set shifting and cognitive flexibility (Martin, 2006; Weinberger et al., 2005). Clearly these functions have relevance to driving behaviour and various studies have examined the link between cognitive ability and driving.

The cognitive skills needed to drive have been studied most extensively in older drivers usually in an attempt to accurately evaluate their fitness to continue to drive. However, there is an ongoing debate regarding which skills are required be able to drive safely. Kurzthaler et al. (2005) suggest that important parameters for driving are reaction time, working memory, divided attention, psychomotor speed, and mental flexibility. Others argue that visuo-spatial difficulties, neglect, reduced psychomotor speed and executive dysfunction are impairments which are considered contrary to safe driving (Schanke & Sundet 2000). Studies in particular populations

(e.g., those with Parkinson's Disease, Alzheimer's Disease or Traumatic Brain Injury) have been conducted in an attempt to clarify this issue.

In Parkinson's Disease, some studies, but not all, have shown a relationship between impaired driving performance and low scores on the Mini Mental State Examination (MMSE; a brief screen of general cognitive abilities) (Stolwyk et al., 2007). However, the MMSE often only detects impairments when cognitive decline is quite advanced. Thus, more recent studies have examined the link between specific neuropsychological variables and driving behaviour. Various specific neuropsychological functions have been linked to faults or errors in a practical driving assessment in those with Parkinson's Disease (for example, poor vigilance, concentration, visual perception, choice reaction time, and information processing)(Heikkila, Turkka, Korpelainen, Kallanranta, & Summala, 1998); sustained attention, immediate recall and information processing (Radford, Lincoln, & Murray-Leslie, 2004); complex information processing, visuo-constructional/-perceptual abilities and set formation and shifting (Stolwyk et al., 2007). When performance is assessed in a driving simulator, complex information processing was most closely related to the number of collisions in Parkinson's Disease patients (Zesiewicz et al., 2002). This suggests that intact executive functions may be particularly important to be able to drive safely.

However, in Alzheimer's Disease patients the results were somewhat different. For example, a meta analysis conducted by Reger et al. (2004) suggests that visuo-spatial skills are important but the role of mental status was unclear. The effect of attention was generally small and executive functions did not appear to be a good predictor of driving behaviour in Alzheimer's Disease. However, the authors suggest that the cognitive domains which they categorised may have been too broad to provide useful information.

In contrast, following Traumatic Brain Injury, assessments of working memory were found to best separate patients from controls and most closely predicted driving skills (Lundqvist, 2001). However, others suggest that impaired driving was most closely associated with reduced awareness, distractibility, attention deficits and also (but less so) with visual perception, scanning and information processing (Haikonen et al., 1998; Schanke & Sundet 2000). More recent research also supports the notion that a range of neuropsychological functions contribute to safe driving performance. For example, research with the Traumatic Brain Injury population examined the utility of a battery of tests (visual perception, executive function, praxis skills, comprehension and premorbid IQ) in predicting performance (pass/fail) in an on road driving assessment. Results showed that the biggest differences between those who passed and failed the driving assessment were related to non-verbal planning and the ability to monitor a verbal rule (both executive functions) but those that failed the on road driving assessments performed poorly on most of the tasks (McKenna, Jefferies, Dobson & Frude, 2004).

Similar studies have also been carried out in 'non clinical' populations, again with varying results. In those with early stage cognitive decline, there was a significant relationship between complex information processing (r= .46), maze navigation (r= .52), visual attention (r= .61) and performance on a driving assessment, but in age matched 'normal' controls, none of these tasks were related to driving performance (Whelihan, DiCarlo, & Paul, 2005). This suggests that neuropsychological functions may only be linked to driving behaviour in cognitively impaired individuals.

One other approach to examining the link between cognitive function and driving behaviour has been to examine those with and without a history of driving accidents. In elderly drivers (>65 yrs), those with a history of accidents had poorer executive functions compared to those who were accident free (Daigneault, Joly, & Frigon, 2002). Furthermore, a prospective longitudinal study in young drivers suggests that accidents are more frequently associated with those with lower levels of education. In addition those with lower intelligence, worse hand eye co-ordination and perceptual motor performance were associated with more severe accidents (Sanchez Martin & Estevez, 2005). Unfortunately the latter study did not evaluate executive functions.

These studies are generally difficult to compare as most have used different patient groups, different samples sizes and a wide variety of neuropsychological tests. Overall though it appears that executive functions do have an important role to play in relation to driver performance. Whether this relationship is only apparent within cognitively impaired populations is not yet known as few studies have been conducted using a non-impaired group. The only study which evaluated 'normal' driver performance failed to support a link between neuropsychological function and driving (Whelihan, DiCarlo, & Paul, 2005). This suggests that perhaps there is critical level of neuropsychological functioning which has to be reached to enable safe driving. However, functioning beyond this critical level does not necessarily make one a better driver.

Executive functions tend to decline with age, and at the other end of the spectrum, they are one of the latest skills to develop. Thus, if a critical level of executive function is required to drive safely, this could also be evaluated in young people. Indeed, Daigneault et al. (2002) suggest that studies should be conducted to examine the relationship between "frontal lobe immaturity" and the accident rate of young drivers.

2.7 The development of executive functions during adolescence

Until recently it was thought that the brain was fully developed by 12-16 years of age. However, with the advent of improved imaging systems, this has been shown not to be the case. In particular, such studies have shown that the proportion of white matter in the brain increases between the ages of 4-21 years (Giedd, 2004), whilst grey matter continues to decrease at least up to the age of 30 years (Blakemore & Choudery, 2006; Sowell, Trauner,

Gamst, & Jernigan, 2002). The increase in white matter leads to faster and more efficient sharing of information both within and between brain areas, and this is particularly relevant for the frontal lobes (Paus, 2005). Studies focusing on the frontal lobes have shown that the Prefrontal Cortex (PFC) is one of the brain areas which is still developing well into our twenties (Lenroot & Giedd, 2006; Sowell et al., 2002) and its connections are extensively remodelled during adolescence (Giedd et al., 1999). *Figure* 2.2 shows a series of MRI scans of the developing brain and clearly shows the decrease in grey matter which occurs with increasing age.

As the brain is not yet fully developed neuroanatomically during adolescence, this could also suggest that cognitive processes in adolescents may not be as efficient as those in adults. Only a limited amount of research has examined executive function development during adolescence. However, generally studies suggest that performance on frontal lobe tasks, particularly those involving abstract reasoning, attentional set shifting and responses inhibition, continues to improve during and beyond adolescence (Blakemore & Choudery, 2006; Rosso, Young, Femia, & Yurgelun-Todd, 2004; Waber et al., 2007).

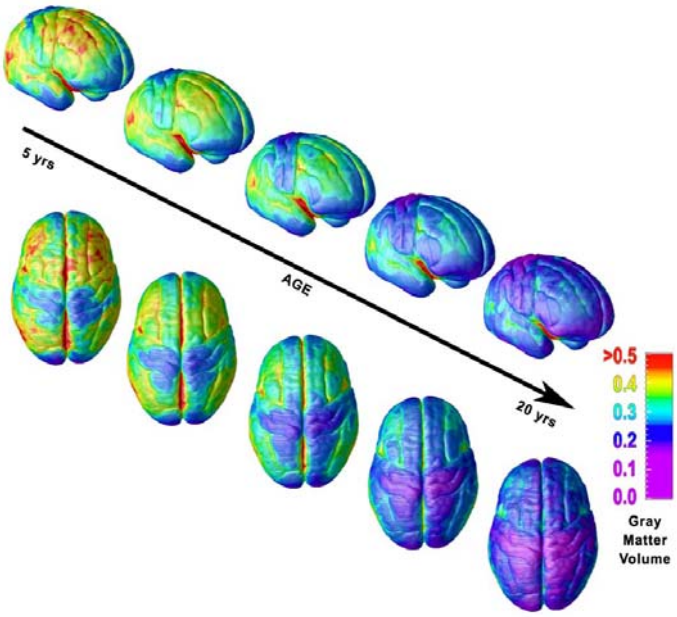


Figure 2.2 The developing brain
Right lateral and top views of the dynamic sequence of gray matter maturation over the cortical surface. The side bar shows a color representation in units of GM volume. Fifty-two scans from 13 subjects each scanned 4 times at approximately 2-year intervals. (Reproduced from Lenroot & Giedd, 2006)

More specifically, the adolescent brain does not perform inhibitory tasks very well and when it does it is generally very inefficient. For example, during working memory tasks, the teen brain does not fully engage the neural structures that are seen in adults completing the same task which has the consequence of making them more distractible (Casey et al., 1977). This is supported by more recent work which shows that when working memory was taxed in

adolescents, an increasing number of poor choices were made on a gambling risk task, and an increasing preference for short term rewards over greater long term rewards was demonstrated (Hinson, Jameson & Whitney, 2003). Similarly, the Prefrontal cortex (PFC), which plays an important role in inhibition tasks, shows alterations in activity with increasing age. As we age, PFC activity in relation to inhibition tasks such as the Stroop test, becomes more focal and specialized while irrelevant and diffuse activity in this region is reduced (Adleman et al., 2002; Yurgelun-Todd, 2007). In addition, research suggests that self guided attention does not mature until 18-25 years (Crone, Ridderinkhof, Worm, Somsen, & van der Molen, 2004).

Other studies also suggest that teenagers are not very good at assessing probabilities (e.g., gamblers fallacy) or making risky decisions and often take longer to make these decisions compared to adults. This could be explained by the activation of different brain areas when undertaking such tasks (see Blakemore & Choudery, 2006 for a review). Such findings may help to explain why young drivers underestimate the probability of specific risks of certain traffic situations and over estimating their ability to deal with it (Brown & Groeger, 1988; Deery, 1999). Furthermore adolescents may take part in more risk taking activities than adults as their motivation / reward pathways in the brain are not recruited to the same extent as in adults. Thus, they need to take a greater risk to feel the same level of reward / satisfaction. In fact, there is a link between poor executive function and increased risk for drug taking during adolescence (Rosser, Stevens, & Ruiz, 2005) and it is well known that “adolescents like intensity, excitement, and arousal” (Dahl & Spear, 2004, p.7).

Thus, while adolescents have developed improved general cognitive skills which underpin making logical and responsible choices, they behave erratically and recklessly, with periodic disregard for the risks and consequences of what they do. Reyna & Farley (2006) describe risk taking as something that is hardwired into the adolescent brain, and the delayed development of the frontal lobes goes a significant way to explaining the increase in risk taking, novelty seeking, sensation seeking, and emotional intensity which characterises adolescence. Thus, young drivers may find it hard to control or inhibit inappropriate behaviour and remain focused on the current task or situation, in addition to which they generally take higher risks, are poorer at decision making and recognizing the limits of their ability. These characteristics, in combination with a car may prove to be lethal.

Studies that have examined young driver behaviour are in keeping with the suggestion that their driving may partly be affected by the lack of fully developed frontal lobes. For example, at intersections, young drivers are poor at adjusting their driving to the conditions without clear, obvious signals. At an inconspicuous intersection, experienced drivers adjust their speed to anticipate the potential hazard, even though they have the right of way. Young drivers on the other hand will perceive their right of way as the only important factor and will make no such adjustments to their speed. While novice drivers are generally good at learning the give-way

rules, they lack the awareness that not all drivers will actually give way to them all the time (MacDonald, 1994b).

On a more general level, the driving process, especially for novice drivers, places significant demands on limited cognitive resources. As we become more skilled in handling the vehicle, subtasks such as changing gear become more automatic, thereby releasing cognitive capacity which can then be allocated to other tasks such as general surveillance. Increased skill is therefore associated with an increase in the capacity available to acquire information about the events around us, so that when we next encounter similar situations we have an increased awareness of what to expect and are thus able to anticipate the appropriate course of action (Underwood et al., 2002). In terms of the practical aspect of driving the car, most adolescents appear to master this skill in a relatively short period of time. However, Keating (2007) highlights findings from brain imaging studies which suggest that although the performance of adolescents on tasks may be similar to that of an adult, it requires much more brain power (or central processing capacity) for them to perform successfully (e.g., working memory as described above). In the driving domain, where there are multiple tasks to attend to, the cumulative load on the central processor may be excessive, leaving insufficient processing capacity for the young driver to be able to effectively scan the environment for hazards or anticipate the actions of others. In addition to this young drivers are often faced with multiple in car distractions such as cell phones, music devices and passengers, all of which absorb attention and place an added demand onto central processing capacity. Unsurprisingly, attentional distraction accounts for a large proportion of crashes, particularly with teen drivers (Keating, 2007). Recarte & Nunes, (2003) have formalized the concept relating to the difficulty of attempting to perform two tasks simultaneously, when both require evaluation and a response, as the ‘psychological refractory period’. In terms of driving, external distractions can often capture the gaze (e.g. looking at a cell phone), which means withdrawing it from the road ahead, while mental distraction (e.g. worrying about an upcoming meeting) can result in ‘looking but not seeing’. In young drivers these types of distraction may lead to less safe driving due to less available brain capacity. This type of multi tasking appears to be closely linked with working memory.

Together, the information presented in this summary is consistent with the proposal that frontal lobe functions have an important role to play in safe driving. In addition, interestingly, the age of 25 is about the time that age disappears as a risk factor for crashes even after driving experience is taken into account (Mayhew, Simpson & Pak, 2003), and it is also about the age at which the frontal lobes appear to become fully developed (Dahl & Spear, 2004). Thus, the second aim of this study was to determine if the executive functioning and cognitive ability of teenage participants related to their performance on driving assessments.

2.8 Driver training and education

New Zealand seems to be the only westernised developed country that currently allows teenagers to become solo drivers at 15 ½ years of age, and these young drivers contribute disproportionately to the crash statistics. As part of this problem, traditional methods of driver training have not delivered demonstrable safety benefits. Initial evaluations indicated that driver education was effective but due to methodological flaws, these studies need to be interpreted with caution (Haddon et al., 1964, quoted in Zhao et al., 2006). Studies conducted since then have had mixed results with few reporting beneficial effects of traditional driver education (e.g. Stock et al., 1983 in Zhao et al., 2006). More recent studies also have methodological problems, which make the results difficult to interpret, as often those who undertake driver education can obtain their full licence sooner compared to those who do not undergo training. Thus, it is difficult to separate the effects of education versus experience (Vernick et al., 1999; Zhao et al., 2006). A more recent study which attempted to control for this found that driver education decreased collisions during the learner licence phase but not during the restricted phase (Zhao et al., 2006). However, others suggest that training does improve driver skill and that both formal training and practice are both important components (Groeger & Banks, 2007). In contrast to this, some research has shown that improving driver skills can actually lead to less capable drivers. For example, skid training can lead to drivers overestimating their own driving ability, without actually improving the way they manoeuvre the car (Gregersen, 1996). Furthermore, studies suggest that crash involvement is more often the result of risk taking behaviour rather than poor driving ability (Clarke, Ward & Truman, 2005). Thus, driver training programs which concentrate on car handling skills may actually lead to increased risk taking due to learners' inflated self confidence and self rated skills.

A growing consensus among driver training and road safety researchers is that greater emphasis should be placed on higher level cognitive functions underlying driving skills (e.g., Mayhew, 2007). Elander et al. (1993) suggested that accident risk is related to two concepts, driving skill and driving style. Skill is related to controlling the vehicle and responding appropriately in different traffic situations and can be influenced by training and education, whilst style refers to the way drivers choose to drive (habit). Driving style is thought to be influenced by attitudes and beliefs regarding driving and this aspect of driving is another area that we can target with education & training (Elander et al., 1993).

Some researchers have argued further that there is an urgent need for a holistic and structured plan of education and training that addresses all goals of driver education, as outlined in the "Goals for Driver Education" (GDE) model (see Engström, Gregersen, Hernetkostki, Keskinen, & Nyberg (2003) for a comprehensive review on young drivers, driver education and training).

Key components of the GDE model seem to involve executive functions. For example, "self evaluation" refers to insight processes allowing the driver to become aware of their short comings in their driving skills. As with any skills, meta-cognitive skills (and executive functions)

such as reflective thinking can be trained and indeed these skills have been strongly recommended to be enhanced in any formal driver training (Engström et al., 2003). However, as yet, the effectiveness of this type of training in decreasing accident rates is unclear.

Novice drivers learn the basic vehicle handling skills and traffic laws quickly, often after only 15 hours of driving (Deery, 1999). However, the higher order perceptual and cognitive skills required to safely interact with the driving environment (Deery, 1999) need much more time to develop and novice drivers don't seem to realise that they are lacking these skills. For example, and as previously mentioned, hazard perception and risk management skills are functions of the pre-frontal cortex that may be under developed in young drivers. They seem to be critical driving skills, which if trained may assist adolescents to successfully and safely manage the demands of driving. Deery (1999) suggests that the hazard detection of novice drivers involves:

> *"assessing traffic hazards on the basis of a single characteristic, so that all situations that share a certain characteristic, such as wet roads, are perceived equally dangerous*".

In contrast, experienced drivers:

> *"perceive situations on the basis of multiple characteristics, which they then use to differentiate their degree of potential risk"* (Deery, 1999, p. 229).

This indicates that with experience, people are better able to integrate information quickly and on the basis of their experience assess each situation in a more holistic way, that is, in the context of the entire driving environment. Being able to quickly and realistically assess the potential danger in a situation is vitally important in a driving context, and not surprisingly longer hazard perception latency has been associated with a higher crash rate (Quimby, Maycock, Carter, Dixon & Wall, 1984 cited in Deery, 1999). While research shows that drivers who display long hazard perception latency may not necessarily show slow reactions in other contexts, young drivers are more likely to fail to detect hazards and take longer to detect the hazards that they do see (McKenna & Crick, 1991 cited in Deery, 1999).

McKenna, Horswill and Alexander (2006) reported that anticipation in driving can be significantly improved by training in the laboratory using video simulation techniques, and that novice drivers could be improved to the level of experienced drivers within only 4 hours of such training. They showed that after hazard perception training there was a significant reduction in risk taking behaviour with no evidence of an associated increase in confidence. They also showed that the decrease in risk taking was not a result of general sensitisation to risk - illustrated by the fact that choice of speed reduction was particular to only hazardous situations- not in non-hazardous situations. In addition, when they compared the results of this computer based task to real world examples, they found that police officers who had undergone an advanced driver training showed similar results to those observed in novice drivers after the anticipation training. Although it is difficult to translate these results to real life driving, the effects of anticipation training look promising and worth evaluating with regard to actual driving behaviour.

Other researchers have also stressed the importance of anticipation, particularly in the context of hazard perception ability. Anticipation of the road ahead and the behaviour of other traffic is critical to successful scanning, in that anticipation influences the selection of appropriate areas of the visual field on which to fixate (Chapman, Underwood, & Roberts, 2002). While only a small fraction of hazards represents any real danger for a driver in any given situation, a more experienced driver will be better able to quantify the degree of a given danger and respond appropriately (Ferguson, 2003).

These studies therefore indicate that skill training in the form of hazard perception/ anticipation training may be a beneficial addition to the training of young drivers. This type of training may improve hazard perception, without exposing them to the dangers of driving and is therefore well worth evaluating.

Keating (2007, p. 153) has suggested that:

> *"the difference between having and avoiding a crash is measured in milliseconds, as is the difference between severe and more moderate crashes. This is an interesting paradox: skill acquisition in the driving domain takes a substantial investment of time in order to preserve a few milliseconds in an emergent situation, but it is those few milliseconds gained through more effective hazard detection etc. that are critical."*

This paradox is central to the young driver problem, as novices are often oblivious to the potential dangers, therefore learning to become aware of these possibilities should be an important part of driver training. It has also been pointed out however, that unsafe habits can be automated just as readily as safe ones suggesting that there can be significant risks associated with unstructured acquisition of expertise (Keating, 2007). Thus, each time a driver speeds successfully without mishap or each time they follow closely without an adverse event, this increases the likelihood that this type of behaviour will become automated. Clearly we want to avoid this happening and our aim is must be to automate safe driving habits as rapidly as possible, before dangerous habits, which have not yet led to crashes become automated (Keating, 2007). In spite of the possibility that new drivers acquire poor driving habits, under the current GDLS in New Zealand, there is no compulsory set formal driving training.

2.9 The rise and fall of driver training/education

In a recent paper, Mayhew (2007) reviewed driver education and graduated licensing in North America and historically followed the rise and fall of driver education and training. Briefly, the growth in driver education changed dramatically in the eighties when a single study 'DeKalb' revealed in a technical report (Stock, Weaver, Ray, Brink & Sadoff, 1983) that their 'improved driver education programme' (30 hours in-class education and 6 hours in-vehicle instruction) had:

> *"at best had only small, short-term, benefit, and, at worst, it was not associated with reliable or significant decrease in crash involvement"*.

Recent reviews, as reported by Clinton and Lonera (2006) found, that

"although it seems reasonable to expect that driver education would make our novice drivers safer, most scientific evidence to date does not support this."

On the other hand, Crick and McKenna (1991) maintained that the

"lack of evidence for the benefits of road safety education/training may be ascribed to the lack of methodological soundness in previous evaluations and the content of the courses".

Indeed, many follow-up driver training evaluations were methodologically seriously flawed without proper control conditions or they were operating with very little statistical power to find a training effect.

One of the biggest problems identified was the fact that increased availability of driver education in high schools seems to stimulate earlier licensing in teenagers that leads to more crashes as they become exposed to risks at an earlier and less mature state of their lives (Mayhew, 2007). In addition, it has been realised that "time discounts" (e.g., reducing the length of time they must hold a learner's licence) as an incentive for driver education had clear negative effects and can seriously compromise the overall safety impact of the GDLS. These problems, however, are only 'by products' of driver education and can be addressed separately, therefore they should not be used to argue against the value of driver education/training.

The results of the DeKalb study nevertheless, had a profound impact in New Zealand in the eighties as the attention of road safety authorities shifted from driver training to the issue of driver licensing. The idea was that if they were not able to train /educate young drivers to become safer drivers, at a time when increasing the driver licensing age was politically a 'no go area', they would need to make the licence test harder and put restrictions on young drivers. As a result, New Zealand was the first country to introduce a graduated licensing system (GDLS) in 1987, which was designed to allow novice drivers to gain driving experience under conditions of reduced risk. It still serves as 'model of success' for many countries that are in search of an evidence based intervention that will lower the crash rate of young drivers. In New Zealand, the introduction of the GDLS showed a net reduction in serious traffic related injury among 15-19 years old of 8% from 1987-1992. Furthermore, over the time – period 1987-1998, the motor vehicle traffic crash fatality and hospital admission rate per 100,000 population and per 100,000 licenced drivers for 15-19 and 20-24 year olds reduced by 50% (Begg & Stephenson, 2003). It would be interesting to know if these effects of the GDLS continued over the last ten years (1998-2007). Some states in the USA claim that after the introduction of the GDLS, young driver related crashes decreased by 20-25 percent (Ferguson, Teoh & McCartt, 2007).

A recent study on the crash profile of novice drivers in New Zealand (Lewis, Evans & Lukkien, 2007) made it quite clear that the initial learner phase of the GDLS is relatively safe for the novice driver but as soon as they become solo drivers in the restricted phase they experience the highest crash risk they will ever face. It seems that the learner phase is providing safe driving practice opportunities for young drivers but may do very little to prepare the novice

driver to keep themselves safe in the restricted phase. As mentioned previously, young people can learn vehicle control skills very quickly which could give them a great sense of achievement and may lead to an inflated confidence in their driving skills without being aware of the lack of higher level driving skills. This may lead to unsafe driving behaviour such as speeding, unsafe overtaking and close following as soon as they become solo drivers in the restricted phase.

Furthermore, the report by Lewis Evans and Lukkien (2007) found that allowing a restricted licence holder to complete an approved time-reducing educational course in order to shorten the restricted phase form 18 months to 12 months might seriously undermine the safety benefit of the GDLS. Such time discounts as an incentive to complete driver education courses have been generally recognised as counter productive for the safety of young drivers for many reasons (see Mayhew, 2007). The report by Lewis, Evans and Lukkien has also clearly confirmed that young male drivers are more at risk than young female drivers at any stage of the GDLS after the learner's phase and that age is a risk factor regardless of driving experience.

Mayhew (2007) offers comprehensive recommendations for future directions and maintains that' *it is important not to abandon driver education*' despite its disappointing safety record to date. Today, there is much better appreciation of the strengths and shortcomings of driver training programmes and new technologies are available to deliver training programmes more effectively. As Mayhew points out, the content of the training needs to be improved by focusing on those factors that contribute most to the high crash risk of solo drivers in the first few months. This could be done by motivating teens to drive safely and provide them with the hazard perception, risk management skills and insights to counteract overconfidence. Driver education needs to use the best teaching practices, psychological learning principals, computer based instructions and simulations so that the novice drivers can learn important higher level skills such as eye scanning, without exposing them to hazardous driving situations. Hazard anticipation skills using road commentary techniques and in-car technologies to measure progress and allow instant feedback should also be considered.

The third aim of this study was therefore to use some of these recommended techniques and technologies and focus on best teaching practices to train young people on higher level driving skills and compare the effects of such training with the effects of traditional vehicle control skills training on the participants' on-road driving performance, confidence level and attitudes to risk taking.

2.10 Driver education/training evaluations

The DeKalb study had an impact on future research and evaluations for driver training, as for many people, there was no need for further research. The 'fact' that driver education/training does not make young drivers any safer - had been widely accepted - and the methodological standard set by the DeKalb study would be very difficult to replicate (Mayhew, 2007).

It would be interesting to examine, why road safety authorities accepted so willingly the far reaching and over generalised conclusion that driver education/training has no safety benefit. After all, the De Kalb conclusion was only based on one particular driver education programme (30 hours in - class education and 6 hours in vehicle instructions) that was delivered in high schools. Additionally, failing to find a driver education/training effect does not necessarily mean that it does not exist. In fact, many post DeKalb driver education evaluations did not use appropriate control groups and used hypothesis testing inappropriately, with very little statistical power to detect any effects.

One of the main issues with driver training programme evaluations was the fact that the success of driver training/education intervention programmes was often measured against the number of crashes the participants experienced after the intervention. This is certainly a crude outcome measure for statistical purposes as crashes are relatively rare occurrences. In this study, for the third aim we used experimentally blind professional assessors who re-tested the participants in relation to their on-road driving performance after the training, without knowing which training group (higher level, vehicle control or control) the participants had been assigned to. This will show if our driver training can improve important driving behaviour such as search and speed choice as well as attitudes on a short-term basis. Improving these measures, is important because if education improves speed choice (for example), it is likely that this will also decrease crash risk, given that speed is one of the major contributing factors (involved in 43%) in fatal crashes involving young drivers (MOT, 2007).

The fourth aim of the study was to assess any long-term effects of the training by using a wide range of self-reported driving behaviour (in form of diaries) as outcome measures. Additionally, as an extra pilot study, more objective telemetric data were also gathered on unsafe post-training driving behaviour using GPS based data trackers that were installed in the cars of some of the participants. However, from the outset, we knew that the number of data trackers (8) we were able to use would be too small for making conclusive claims about any potential long-term effects of our driver training in our study. The idea was to test this new and promising evaluation technology and report on our findings. Further discussion regarding evaluating the effectiveness of driver education programmes can be found in the introduction of the paper presented in Appendix 8.1.

3 AIMS OF THE STUDY

1) To assess the behavioural characteristics of thirty-six teenage drivers, including their attitudes and confidence levels with regards to their driving behaviour and the associated risks involved

2) To determine if frontal lobe executive functions of the participants are associated with their performance on the driving related assessments

3) To assess the effects of training of higher level and vehicle control skills on participants' on-road driving performance, confidence levels and attitudes to risk taking behaviour

4) To evaluate any long-term effects of training on participants' every-day driving behaviour

4 METHOD

4.1 Overview

The study used a double-blind, randomized controlled, between-subjects research design (as recommended by Clinton & Lonero, 2006) with the overall aim to evaluate the effectiveness of higher level skills training in enhancing frontal lobe (executive) functioning in young drivers. Most of the data were gathered during the *Driver Training Research* camp involving 36 teenage drivers as participants. The camp took place in the Taupo - Turangi area over the 2006 third term school holiday period (two weeks, Saturday, 16 September, 2006 – Sunday, 1 October, 2006), with support from a range of selected expert driver trainers/facilitators/examiners and administrative support staff (see Appendix 8.2 for a photographic impression of the camp).

In order to assess the behavioural characteristics of the sample the participants were first required to complete questionnaires on their attitudes to driving and associated risks involved, and on their level of driving confidence and skill (see Aim one).

They were then psychometrically assessed on frontal lobe executive functions, general ability, sustained attention and also on anxiety levels and depressive tendencies as possible covariates for cognitive functioning. These measures were then compared with participants' baseline driving related assessments, which included a comprehensive on-road driving assessment, a road commentary test and a driving self-assessment (see Aim two).

The participants were then trained for 5 days either on higher level skills, vehicle handling skills or received no training (see Aim three). The participants were not given any information about the aims of the study and were therefore considered as experimentally 'blind'. After the training, the on-road driving assessment of the participants was repeated by the experimentally 'blind' driver assessors and all participants did another road commentary test (post training data). Each assessor re-tested the same participants. It was ensured that the assessors did not receive any information about the type of training the participants received and also that they did not know to which training group the participants were assigned. The participants were also required to respond again to the attitudes and risk-taking questionnaires and had to re-evaluate their driving confidence and skills.

In the second week of the *Driver Training Research* camp, the group who received higher level skills training in the first week received vehicle handling skills training and the group who received vehicle handling skills training in the first week received higher level skills training. We decided that the control group who did not receive any training in the first week would receive higher level skills training in the second week as it was important that all participants received at

least some training and there is some evidence in the literature that higher level skills training (e.g., hazard anticipation training, McKenna et al., 2006) improved attitudes to risky driving behaviour. Also in contrast to vehicle control skills, there is evidence that links hazard perception skills to crash risk (Horswill, Waylen and Tofield, 2004).

The on-road driving performance of the participants was assessed a third time by the driver assessors (each assessor re-tested again the same participants) after the second week and the participants again responded to the same questionnaires as after week 1. These extra data could help assess any order effects of the two types of training. However, the gathered data have not been linked to a specific aim in this report and will therefore not be documented here.

After the *Driver Training Research* camp, for a period of six months, all participants who attended the camp and received training (N=36) and a new group of participants who did not attend the camp and acted as 'post camp controls' (N=36) were required to complete fortnightly written diaries recording their driving behaviour over a time period of six months (Aim four).

As an extra pilot study after the training camp, GPS-based data trackers were installed in the private cars of 8 participants at the final day of the *Driver Training Research* camp in order to record more objective and sensitive training outcome measures than self reported driving behaviour via fortnightly diaries. The idea of this pilot study was to test this new and promising evaluation technology and report on our findings. The GPS-based data trackers recorded distance travelled and unsafe driving behaviour relating to speeding over 100km/h and large g-forces possibly indicating unsafe driving (see Appendix 8.1 for a full report of this study).

4.2 Demographics of the Participants

The completed demographics questionnaire of the thirty-six participants who attended the *Driver Training Research* camp revealed that 23 participants were male and 13 participants were female. Two were 15 years of age, the majority, (26) were 16 years of age, 7 were 17 years and 1 was 18 years of age. Thirty one of these participants classified themselves as NZ European, 2 as NZ Maori, 1 as Asian and 2 as 'Other'. Thirty four participants held a New Zealand restricted driving licence and 2 held a New Zealand full driving licence.

Of the thirty–six participants who acted as 'post training controls' (Aim 4) and did not attend the *Driver Training Research* camp, 26 were males and 10 were female. The majority, (30) were 16 years of age, 4 were 17 years and 2 were 18 years old. Twenty eight of these participants classified themselves as NZ European, 4 as Maori, and 4 as 'Other'. All of them held a New Zealand restricted driving licence.

4.3 Questionnaires, Psychometrics and Driving Related Assessments

4.3.1 Driving history

The *Driving History* questionnaire (see Appendix 8.3) asked participants how long they had held their restricted driver licence, and how many kilometres per week they would estimate they would be driving. The participants also had to indicate how many crashes and near misses they had in the last 12 months and also how many driving convictions, offences or warnings they had over the same time period.

4.3.2 Driver behaviour related questionnaires

With regard to their driving behaviour, participants were asked to complete a *Driver Violations* Questionnaire which was an abbreviated Driver Behaviour questionnaire (internal reliability Cronbach's α >0.7; Reason et al., 1990). This questionnaire asked the participants how likely they were in the future to engage in each of eleven types of undesirable driving behaviour. The behaviours addressed by the questionnaire, included impatient and aggressive actions and exceeding the speed limit. Each question was rated on a scale of 0 (never or hardly ever) to 4 (nearly all of the time). The wording on the original scale asked participants to '*rate how often these things had happened to you over the last three months*'. As we wanted to examine the effects of a brief intervention, we changed the wording to ask them '*how often would you engage in this type of behaviour in the future'*. This enabled us to examine differences in responses to the questionnaires before and after training and this type of adaptation has been used with other driving related questionnaires (Parker, Stradling & Manstead, 1996). Although this questionnaire had not been validated with the revised wording, we were unable to use it with the wording in the original form. As it turned out, internal reliability remained high, see results section.

Participants also completed the *Driver Attitude* questionnaire (internal reliability α>0.75; Parker et al., 1996), the *Driver Risk Taking* questionnaire (internal reliability α>0.77, Parker, Stradling & Manstead, 1996) and a *Self Evaluation* questionnaire of their driving ability (Horswill, Waylen & Tofield, 2004). The self-evaluation questions each address a different area and are used individually so no internal reliability data are available.

The *Driver Attitude* questionnaire *(DAQ)* is a 20 item questionnaire which asks about attitude to rules and regulations on the road. Scoring was on a 5 point Likert scale ranging from 1= strongly disagree to 5= strongly disagree). For the analysis, scales for some of the items had to be reversed so that higher scores consistently meant a less safe attitude. The DAQ is made up of four factors which relate to speeding, drink driving, close following and overtaking. The internal reliability of the questionnaire overall was good (Cronbach's α=0.78) but the reliability of two of the subscales was somewhat low (speeding α=0.65, drink driving α=0.47, close following α=0.81, overtaking α=0.48). As the overall reliability of the scale was high, this questionnaire

was still administered and reliability estimates were calculated for our sample (see results section for further information).

For the *Driver Risk Taking* questionnaire, participants were required to indicate to what extent they agreed or disagreed (1=strongly disagree to 5=strongly agree) with a 24 statements relating to the laws that address unsafe or risky driving behaviour. For the analysis, the scales of some of the items had to be reversed so that higher scores consistently meant less safe attitudes.

The *Self Evaluation* questionnaire of their driving skills was assessed by means of 4 statements or questions. The first statement relating to accident concern (item1) was "I sometimes feel worried that I will be involved in an accident" and the responses were rated from 1 (strongly disagree) to 9 (strongly agree). The same rating scale was also applied to the second statement (item 2) which related to participants' thrill seeking from driving and was "I often get a thrill from driving". The third item, which addressed driving ability was "How likely are you to be involved in accidents in the future compared with the average driver?" and the response ratings ranged from 1 (much less likely) to 11 (much more likely). The same response scale was also applied to the second driving ability evaluation (item 4) which was "How skilful do you think you are compared with the average driver?"

Driver confidence was assessed using two questionnaires; the first (*Driving Confidence 1*) asked participants how safe (from 1, very safe to 5, very unsafe) they felt driving in various situations such as at night and in an unfamiliar area (Bergdahl, 2005; no reliability data available in the original study). The second questionnaire, the *Driver Confidence Rating Scale* (*Driving Confidence 2*) assessed participants' level of confidence (from 0, not at all confident to 10, completely confident) when driving in various different situations such as in rush hour or pulling into traffic from a stop (Marottoli & Richardson, 1998; no reliability data is available). Copies of these questionnaires can be found in Appendix 8.3.

4.3.3 General attitudes to risk

As well as assessing risk taking in relation to driving behaviour, we also assessed general attitudes towards risk to determine if those who show high levels of risk taking in their driving also do so in other areas of their life. The *Attitudes Towards Risk* questionnaire (internal consistency 0.91; Franken, Gibson, & Rowland, 1992) required the participant to use a 5 point Likert scale, ranging from A (Like me) to E (Not like me) to indicate how well each of 10 statements described themselves. The alpha ratings were converted to numeric scores and 5 of the items were summed (e.g., I often think about doing things that are illegal), to give a total Psychological Risks factor score, and the remaining 5 items summed (e.g., the greater the risk the more fun the activity), to provide a total Physical Risks factor score. Linked to this, there was also the possibility that individuals perceive risk in different ways for example some may view skiing as risky whilst others may not. Thus, we also assessed individual's perception of the

physical risk of certain activities (*Physical Risk Assessment Inventory* (PRAI); internal consistency 0.9; Llewellyn & Clarke, 2003). To complete the PRAI each participant was required to assess the level of risk to an average person of each of 27 activities. The level of risk was ranked on a seven point Likert scale, ranging from 0 (no physical risk) to 6 (extreme physical risk). Thirteen items were summed (e.g., smoking marijuana) to provide a total Health Risk subscale score, and the remaining 14 items (e.g., water skiing) were summed to provide a total Sports Risk subscale score. Please see Appendix 8.3 for a copy of the questionnaire.

4.3.4 Balloon Analogue Risk Task

Participants were also asked to take part in a computerised risk taking task, *Balloon Analogue Risk Task* (BART) which has been shown to relate to real world risk taking behaviours, as well as novelty seeking behaviours (Lejuez et al., 2003). For this task the participants had to click a mouse button which gave one pump of air to a simulated balloon. Each mouse click earned money, but if the participant clicked too many times, the balloon burst and the money was lost. The amount of money accruing on any one balloon was not known by the participant, but a reset button labelled “Collect $$$” could be pressed at any time to collect whatever money had accrued. The accumulated total amount of money was, however, displayed on the screen and was up dated after each balloon. After either the balloon had exploded or the money had been collected, another balloon appeared, until 30 balloons in all had been used. All balloons have different explosion points, ranging from one pump to 128 pumps, and the aim of the task is to make as much money as possible. The *BART* produced three measures of interest, the total number of dollars earned, the number of trials where the balloon exploded, and the average number of pumps in those trials where the balloon did not explode. The higher the score on any of these measures, the greater the tendency for risk taking

4.3.5 Personality

The Big Five personality factors were assessed using items from the *International Personality Item Pool* (Goldberg et al., 2006). Of particular relevance here were items related to impulsivity and extraversion as both have been linked to risky driver behaviour (e.g., Dahlen et al., 2005). For this assessment the participants were required to indicate how well each of 50 items described themselves. Scoring was on a Likert scale of 1 (very inaccurate) to 5 (very accurate), with the items each contributing to one of five factors, namely, Extraversion (Cronbach’s α=.86), Agreeableness (α=.77), Conscientiousness (α =.81), Neuroticism (α =.86) and Openness (α=.82). Twenty-six of the items were worded in a positive manner, for example “Am the life of the party”, and were scored as rated, but the remaining twenty-four items were worded negatively, for example “Feel little concern for others”, and the given ratings were transposed. For example a given rating of 5 was transposed to a score of 1, and a total score for each factor was thus obtained. This questionnaire is in Appendix 8.3.

To measure impulsivity more specifically we also included the *Barrett Impulsiveness Scale (BIS),* which has reported internal consistency between from 0.80 to 0.82 and is highly associated with risk taking (Patton, Stanford, & Barratt, 1995; Stanford et al., 1996). This is a 28 item questionnaire where the participant was required to rank how well the descriptions of ways of acting or thinking related to them. The BIS was also scored by way of a Likert scale with values ranging from 1 (rarely/never) to 4 (almost always) (see Appendix 8.3 for a copy of the questionnaire).

Socially desirable responding was assessed using the *Marlowe Crowne Scale* (internal consistency of 0.88; Crowne & Marlowe, 1960). The Marlowe Crowne Scale consisted of 13 statements concerning personal attitudes and traits, each of which the participant rated as either true or false depending on whether or not they considered it pertained to themselves. Five items were scored 0 when answered 'true' and 1 when answered 'false' (e.g., no matter who I'm talking to I'm always a good listener), and 8 items were scored 0 when answered "false' and 1 when answered 'True' (e.g., I sometimes feel resentful when I don't get my own way). A total score was obtained from the sum of the 13 items giving a score ranging from 0 to 13 for each participant. Scores were examined for each participant to ascertain their level of socially desirable responding

4.3.6 Levels of Anxiety and Depression

Levels of anxiety and depression were assessed in order to screen for psychological illness, and because they may also interfere with cognitive performance. The *Beck Anxiety Inventory (BAI,* Beck & Steer, 1993*)* consisted of twenty one common symptoms of anxiety and the participant indicated how much they have been bothered by each symptom in the last week by ticking in either the 'not at all', 'mildly' 'moderately' or the 'severely' column. Scoring ranged from zero for the 'not at all' column to three for the 'severely' column, and this then provided a total anxiety score which was the measure of interest (Cronbach's α=.92). The *Beck Depression Inventory (BDI,* Beck, Steer & Brown, 1996*)* had twenty one groups of statements, with each group consisting of various levels of a 'symptom', and with the associated scores increasing from zero for no symptoms to three for the most severe symptom (α=.81). For this questionnaire the participant was required to pick out the one statement in each group that best described the way they have been feeling over the past two weeks. Again the total score was the measure of interest.

4.3.7 Psychometrics

Executive functions were assessed by a variety of tests including three subtests from the Delis Kaplan Executive Function System (DKEFS), Verbal Fluency, Colour Word Interference, and Tower of California. The DKEFs is a relatively new set of tests designed specifically to assess executive function. It has a large and representative normative sample and can be used

to assess both children and adults. Each of these tests have split half reliabilities α>0.6 (Delis, Kaplin & Kramer, 2001).

- *Working memory* was assessed using the well known Digits Backwards test (Lezak, Howieson, Loring, Hannay, & Fischer, 2004). This test has been shown to have good external validity as it correlates highly with other tests of executive function such as the Wisconsin Card Sorting Task, but also has demonstrated a lack of correlation with tests which assess other abilities (Homack, Lee & Riccio, 2005).

- *Spontaneous production/ generation of words* was assessed using the Verbal Fluency assessment (Delis, Kaplin & Kramer, 2001). This test required the participant to generate as many words as possible beginning with the letters F, A and then S, followed by a category fluency assessment where the participants are required to produce animal names and then boy's names. The final part of this assessment requires the participant to alternate (switching) between the names of fruit and the names of furniture and assessed *cognitive switching*. Each condition has a time limit of sixty seconds and age adjusted scaled scores were obtained for letter fluency, category fluency, category switching and switching accuracy.

- *Inhibition* and *cognitive switching/ flexibility* were assessed using the Colour Word Interference test (Delis, Kaplin & Kramer, 2001). This test had four parts; the first consisted of a page with five rows of ten randomly sequenced patches of blue, green or red colour. The participant was required to name the colours in order along the rows as quickly as possible. The second part consisted of rows of randomly sequenced colour names printed in black type which the participant was required to read. The items in part three were colour names printed in incongruent colours and the participant was required to name the colour of the ink, thereby ignoring the word. The final part also had colour names printed in incongruent colours but half of these words are contained in rectangles and the participant was required to name the colour of the ink for those words not in a rectangle, but read the word if it was enclosed in a rectangle. There is a scaled score for each part as well as contrast scores which compare the time taken for each of the first two conditions with the time taken for the latter two conditions.

- *Forward planning* and *problem solving* was assessed using the Tower of California test (Delis, Kaplin & Kramer, 2001). This test consisted of nine items of increasing difficulty and the participants were required to construct 'towers' on a board with three pegs of equal height using a maximum of five circular blocks each with a central hole

so they may be placed on the pegs. For each item a number of blocks were arranged on the pegs in a 'start position' and the participant was shown a picture of the 'end position' and was instructed to create the arrangement in the picture by moving one block at a time between the pegs and not placing a larger block on a smaller block. The participants were also instructed to complete the arrangement as quickly as possible using as few moves as possible.

- *Complex information processing:* The Trail Making Test part B was used to assess complex information processing and is comprised of attention, sequencing, mental flexibility and visual search behaviour (Lezak et al., 2004). This required the participants to connect consecutively, in alternating order, encircled numbers and letters which are presented randomly over an A4 page. For this assessment the time taken was the measure of interest.

General ability was tested using the *Wechsler Abbreviated Scale of Intelligence* (WASI). It consists of the Vocabulary, Similarities, Block Design and Matrix Reasoning sub-tests of the Wechsler Adult Intelligence Scale and provided standardised age appropriate scaled scores, which in turn provided a rapid and reliable measure of Verbal (VIQ), Performance (PIQ) and Full Scale (FSIQ, PsychCorp, 1999).

Sustained attention was assessed using the *Letter Cancellation Task* (Diller, Ben Yishay et al., 1974). The task consisted of six rows of randomly generated letters and the participant is required to put a line through all the C's and E's as quickly as possible. Time taken and the number of cancellations were the measures of interest.

4.3.8 Driving related assessments

The Driving related assessments used three different tests.

- The *On-Road Driving* assessment was specifically designed for this research by a senior Driver Licensing Auditor from Land Transport New Zealand. He 'hand picked' and briefed four experienced professional driver assessors. Before any assessments, the LTNZ compliance officer spent two hours teaching the assessors how to conduct the assessments. This included 'on road' training where the assessors were taken out around a specified route and carried out a 'mock' driving assessment, until all assessors were consistent in their ratings. Unfortunately, the data obtained from this was not recorded so we cannot report inter rater reliabilities.

  The assessment borrowed elements from the so-called Michigan Test (Test B) [no longer in use], the New Zealand Full License Test and the Advanced Driving Assessment as described in the Learning System for Driving Instructors. The format of the 'Michigan Test'

was suitable for this project as it involved the use of set test routes which helped increase the level of reliability. The emphasis was on the driver's ability to search and manage road hazards, both fixed and potential. The assumption was that a hazard will be managed by either altering speed and/or changing position. For most hazards this means braking and/or steering away from the hazard.

For the purposes of this study, this enabled assessment of hazard identification and response without drawing the hazard to the attention of the driver as would happen in the Full License Test where a verbal response is used. For ease of assessment the test route was structured as follows. A warm up zone in which no assessment took place, observation zones where the driver's behaviour was closely observed, and marking zones where the driver's behaviour was recorded. This structure eased the burden on the assessor and created a standard test which did not indicate to the person being assessed where the assessment occurred. The 25 situations assessed, for example turning right at a stop sign, were the observation zones, and were of a predetermined number, based on accident producing sites in Taupo. Some of the situations assessed were purely car handling skills such as parallel parking. In each observation zone the performance of the applicant was assessed (using 'yes' or 'no' responses - indicating that the assessed specific driving behaviour was either displayed or not displayed) under the following three criteria (see Appendix 8.5 for a copy of the on road assessment form):

1. *Search* – this included the visual scanning of the road to the front, back and sides. Criteria descriptors were 2 seconds, 4 seconds ahead, 12 seconds which equated to the driver scanning either immediate, intermediate, or distant areas in front of the vehicle. In addition, 360 degrees chacks (i.e., using the mirrors) and head checks (i.e. checking blind spots) were also assessed.
2. *Speed Control* – this included the suitability of the speed of the vehicle, braking and acceleration. Criteria descriptors were: legal, safe headway, reduces speed, accelerates. Under Speed Control, the 'reduces speed' category was marked in relation to responding to a hazard, and 'accelerates' refers to moving positively into a gap or onto a new road.
3. *Direction Control* – this included steering, positioning of the vehicle and driver signals. Criteria descriptors were: legal, indicates, steers away.
4. The *Composite* score was the average taken over the marks for the three variables search, speed choice and direction control.

- The *Road Commentary* assessment was based on a videoed real traffic simulation, presented on a lap top computer screen. The participant was required to conduct a running commentary of potential hazards and driving behaviour required in relation to the

unfolding conditions. Each trial ran for 90 seconds and an audio tape recorder was used to record the commentary. This procedure was carried out three times in all. The first was prior to the commencement of any training (Baseline), the second was at the end of the training in the first week (Post Training) and the third and final time was at the conclusion of the second week (Post Training 2 – data will not be reported). The traffic scenarios were different on each trial. For each of the commentaries, the numbers of immediate detected and reported hazards, actions in response to the hazards and actions in response to non-hazards were obtained for each participant. They were then expressed as percentages of either the total number of hazards, actions to hazards, or actions to non hazards (the total number of actions to non hazards was taken from the participant with the highest number of such reported actions).

- The *Driving Self Assessment* procedure consisted of the participants driving a predetermined route with a driver instructor. After they returned from their drive, each participant rated their own driving performance on several parameters using a S*elf-Assessment* questionnaire. The instructor also rated the performance of each participant using the same form, which required ratings of five driving characteristics on a scale with options of No, Sometimes, Most of the Time, or Yes. An example of one of these five questions is: “Do you think your speed was appropriate at all times?” Two questions were worded in the form “How do you rate your confidence as a driver?” and the rating options were Very low, Low, Average, High or Very high. For a further two questions which were worded in the form “How do you rate your reactions to driving situations?” the rating scale was Bad, Below Average, Average, Above Average and Excellent. Overall a total of nine questions were rated. Because the number of rating options was not consistent for each question, any difference between the instructor’s assessment and the participant’s assessment of themselves was calculated as a percentage of the total number of rating options for each question. These percentages were then averaged over the nine questions to provide an overall measure of under rating or over rating. Where the participant more often under rated their own performance the overall average was negative. Conversely, when the participant more often over rated their performance the overall average was positive.

  Participants also drove an instrumented car which provided objective data with regard to their steering and G-force changes. We were hoping to compare the self evaluation data with the data received from the instrumented car, but due to technical difficulties were not able to carry out this analysis.

4.4 The Post-Camp Measures

After the *Driver Training Research* camp, the 36 participants who received training (Group A, B and C) were requested to complete a driving diary every fortnight over a period of six months (total of 12 diaries). They were asked to record their number of successes, problems, issues, near misses, fines, crashes, driving errors and lapses (see Appendix 8.6 for a copy of a diary). They were also asked the number of kilometres they had driven that particular fortnight and how many times they had driven more than 10 km/h over the speed limit, followed at an unsafe distance, been involved in unsafe overtaking, texted while driving and/or used a cell phone while driving. These last five questions were answered on a five point Likert scale with options of zero, 1 to 5, 6 to 10, 11 to 15 or >15 with regard to the frequency of their occurrence.

In addition, as an extra pilot study, 8 GPS-based data trackers were installed in the cars of 8 participants (4 males and 4 females) who received training (see full report in Appendix 8.1).

4.5 Procedure

4.5.1 Ethical approval

Ethical approval for the research was received from the Psychology Department Ethics Committee of the University of Waikato. Receiving a completed application from the participants was considered as preliminary consent to attend the two week *Driving Research Training* camp at the Wairakei Village in Taupo, New Zealand. The rights of the participants (e.g., right to withdraw from the research at any time, right to anonymity etc.) were clearly stated on the application form. It was also stated that they would attend the camp at their own risk. Also an information sheet informed the participants about the *Driving Research Training* camp and the assessments. Formal consent was received from the participants before they were required to complete the first assessment.

4.5.2 Recruitment and selection of participants

Posters were displayed in more than 50 secondary schools all over New Zealand requesting participants. Applicants were selected on a ‘first come first served basis’. This resulted in the recruitment of seventy-two participants were from throughout New Zealand, with representation across many ethnic and social backgrounds. A minimum requirement was holding a restricted driving licence. Thirty-six of the participants attended the *Driver Training Research* camp (Aim 1-3) and an additional thirty-six participants were recruited to act as a post-camp control group for the 6-month post-camp period (Aim 4).

4.5.3 The Driver Research Training camp

The *Driver Research Training* camp took place in the Taupo - Turangi area in New Zealand over the 2006 third-term school holiday period over two weeks and included three weekends, Saturday,16 September, 2006 – Sunday, 1 October, 2006.

During the first weekend, all 36 participants completed questionnaires and assessments that were administrated only once. They included the questionnaire on their Driving History and the questionnaires regarding Personality, General Attitudes to Risk, Impulsivity, and Socially Desirable Responding. Each participant was then psychometrically assessed once on executive functions, general ability, sustained attention, and anxiety and depression levels. The psychometric tests were conducted by four graduate clinical psychology students who had appropriate training in psychometric testing. They were supervised by the second author. The Driving Self Assessment from the Driving Related Assessments was also only conducted once during the first weekend.

Other questionnaires and assessments were administrated as Baseline on the first weekend and re-administrated after the training in week 1 on the second weekend (Post Training) and again after the training in week 2 on the third weekend (Post Training 2). They included the Balloon Analogue Risk Task (BART), the questionnaires on Driver Behaviour, i.e., Driving Violations, Driver Attitude, Driver Risk Taking, Self Evaluation of their driving ability, and the Confidence questionnaires. The Driver Attitude Questionnaire (DAQ) was available in a parallel form which made it particularly suitable for repeated testing over a short time period. The remaining questionnaires were administered in their original form.

Two Driving Related Assessments, including the On-Road Driving assessment and the Road Commentary test were conducted as Baseline on the first weekend and repeated after the training in week 1 on the second weekend (Post Training) and the training in week 2 on the third weekend (Post Training 2).

After the first weekend, all participants were randomly assigned to one of the three training groups. Each participant was given a number from 1-36. Each of the 36 numbers were then randomly drawn and assigned to one of the three training groups for the first week (5 days): ‘higher level’ skills (Group A), ‘vehicle handling’ skills (Group B) or ‘control’ (Group C).

- The first group A (N=12) practiced higher level driving skills such as eye scanning, hazard anticipation, risk management, emotion regulation, and impulse control. For this group, a variety of teaching methods were used that included video based real traffic simulations, road commentary, driving self evaluation, focus groups, coaching and peer teaching (as recommended by Engström et al., 2003). The road commentary training (approx. 2 hours per participant) was either conducted by an expert road commentary instructor in groups of three in a vehicle on the road or via video based traffic simulations. For the video based traffic simulations, each participant was required to video record one self-selected traffic scenario (5 minutes) using a car with a video

camera installed ,filming from the perspective of the driver. Using that scenario they then performed a road commentary in front of their peers in the training group as well as to a panel of expert judges who gave them extensive feedback on their commentary performance. The three participants who received the highest marks (given by the judges and their peers) were invited to perform live at the Civic Reception (sponsored by the mayor of Taupo) in front of an audience of about 160 people. The winner received a 20 minute helicopter scenic-flight around Taupo as a prize, sponsored by the Taupo community.

- A second group B (N=12) was trained on traditional vehicle handling skills such as manoeuvring, parallel parking, emergency braking, cornering, and economic driving. Each participant received at least 6 hours of practical in-car driving tuition that involved a lot of practical on-road driving.
- The third group C (N=12) engaged in non driving related activities (mostly sight-seeing activities) and acted as the 'control' group in the first week.

After the second weekend that included the Post Training Assessments (see above), for the second week (5 days), group A who received higher level skills training in the first week received vehicle handling skills training and group B who received vehicle handling skills training in the first week received higher level skills training. The control group C who did not receive any training in the first week received higher level skills training in the second week.

The third and last weekend of the camp was used to perform the Post Training 2 Assessments (see above)

4.5.4 The Post-Camp period

Following the two week *Driver Training Research* camp, the 36 participants who received training (Group A, B and C) and 36 participants who applied for the camp but were not selected and acted as post-camp control group were requested to complete a driving diary (see Appendix 8.6) every fortnight for a period of six months (total of 24 diaries). The diary was sent to them as a hardcopy via mail including free postage and a self addressed envelope for them to return the completed form.

In addition, for the extra pilot study, 8 GPS-based data trackers from SmartTrak (www.SmartTrak.co.nz) were installed in the cars of 8 participants (4 males and 4 females) who had received training and brought their private cars to the *Driver Training Research* camp. The trackers continuously recorded on-line any speeding behaviour (over 100km/h) and G-force changes that indicated unsafe driving over a time period of six months after the training (see Appendix 8.1).

4.6 Methodological Issues

4.6.1 Sample size

Our approach in determining the sample size was driven by a decision on how big a training effect would need to be in order to have some practical significance. The study was not about finding small effects that would have needed the statistical power of a very large sample size. Our reasoning was that if 5 days of intense training would not generate a statistically significant change in the driving behaviour of 12 novice drivers (compared to a control group who did not receive any training) then this kind of training would probably not be worth or practical pursuing.

Unfortunately, no similar studies have been conducted that reported effect sizes which would have allowed us to perform power analysis. However, we knew from research evidence, that novice drivers seem to be poor in hazard perception, eye scanning and risk management skills and that video based hazard perception and road commentary training has been shown to be very effective in improving these skills in laboratory based tasks in novice drivers. But how well such training will transfer to on road driving performance has not yet been shown.

We were aware right from the outset that our relatively small sample size will not be powerful enough to reveal all significant effects and relationships and that this study was therefore much more at risk of committing type II errors (reporting that there was no effect when in fact there was an effect) than type I errors . We made provisions for this in the data analysis, including reporting near significant effects and 95% confidence intervals on the graphs.

4.6.2 Double blinding

The term 'demand characteristics' is used in psychology experiments to describe a cue that makes participants aware of what the experimenter expects to find or how participants are expected to behave. Demand characteristics can change the outcome of an experiment because participants will often change their behavior to conform to the experimenters expectations. In this study, much care was taken to ensure that the driver assessors and the participants did not know the expectations, aims and goals for this study ('double blind'). We made sure that the driver assessors were not informed in which training group the participants were assigned to, what training activities they were required to perform and what the aims and hypotheses of the study were. The assessors only came to the camp on the training free weekends in order to conduct the assessments and had no contact with participants except for the time of the assessment. The participants were randomly assigned to the two training groups and one control group. It was very likely that the participants in the control group knew that they were in the control group as they were engaged in sight seeing activities. However, as the study had no expectations on any behavioural change in that group, no demand characteristics issue could have influenced their data. The other two groups both received training and were

expected to perform to the best of their ability in the on-road driving assessment. Again, no information was given to the participants on the aims and goals for particular driver training in this study.

4.6.3 Approach to statistical analysis

Psychology is relatively unique in that we have to measure most psychological constructs indirectly, for example we use IQ tests to infer intelligence and questionnaires to assess various aspects of personality. These types of assessments / tests give rise to data at the ordinal level of measurement, which strictly speaking is not appropriate for parametric data analysis. However, most psychological researchers treat these data as reaching the interval level of measurement in order to carry out parametric analyses, which allows us to answer more complex research questions (Fife-Shaw, 2006). The suitability of this approach is a topic of much debate in psychology and for the purposes of this study we have assumed that the data derived from the questionnaires and neuropsychological assessments was of an interval level of measurement and used parametric analyses. This decision was based on an examination of the methods used in previously published articles and a desire to be able to compare our result with those obtained from other studies (Fife-Shaw, 2006). For this reason, using more recent techniques such as item analysis were not appropriate for these analyses. Thus, all questionnaires were scored according to instructions provided by the authors and the total or mean values were used as appropriate. The neuropsychological tests were scored following the instructions in the respective manuals. The availability and relevance of the normative data for the psychological tests were evaluated when the test were selected and were felt appropriate for comparison purposes.

Overall, various types of analyses were performed. Firstly, all data were checked for normality (i.e., skewness and kurtosis was assessed, in addition to stem-and-leaf plots for visual inspection). Where data failed to meet the requirements for parametric analysis, non parametric tests were conducted using either the Mann Whitney U test (for independent samples) or the Wilcoxon test (for related samples) as appropriate. For data that met the requirements for parametric data analysis, we used individual ANOVAs with post hoc tests (normally Scheffe's tests), or t tests where appropriate. This approach to analysis was taken as many of the dependent variables recorded in our study were correlated, which diminishes the power of multivariate analysis of variance (Tabachnick & Fidell, 2001).

For some of the variables arising from the questionnaires and neuropsychological assessments, we wanted to compare the performance of participants who scored / performed particularly well with those who performed poorly on these measures. Thus, we compared the performance of those in the highest and lowest quartiles. By removing those obtaining scores

around the population mean, it ensured that the scores from the high and low scoring groups were as far apart as possible, but still provided a large enough sample for parametric statistics. This type of approach is relatively common in the neuropsychological area. To ensure that the results from the comparisons of the upper and lower quartiles reflected the whole population, correlational analyses were also conducted which included the entire sample.

We have used APA (American Psychological Association) conventions in reporting significant results, i.e., we considered $p< 0.05$ as statistically significant (*) and $p<0.01$ as statistically highly significant (**). However in order to alert the reader to possible type II errors (not enough statistical power to reveal a significant statistical effect) we reported p values >0.05 and <0.1 as 'approaching significance', where appropriate.

5 RESULTS

The results are structured in four parts, each addressing one of the four aims. After each part, there will be a short discussion of the results. A General Discussion (Section 6) can be found after the Results section.

5.1 RESULTS PART 1

Aim 1: To assess the behavioural characteristics of thirty-six teenage drivers, including their attitudes and confidence levels with regard to their driving behaviour and the associated risks involved

The first aim of the study will be addressed by reporting the results from the demographics questionnaires regarding participants' self reported driving history and driver violations, along with the results from the questionnaires regarding their attitudes to driving and risk taking, and how confident they feel about their driving and driving skills (self evaluation). Also the results from the Balloon Analogue Risk Task (BART), the personality questionnaires and the anxiety and depression measures will be reported.

The second part of this results section will focus on some factors that may have influenced the responses of the participants to the driver violations, attitudes to driving and self evaluation of their driving skills questionnaires. The factors examined were: number of near misses and crashes they had in the last 6 months (taken from the Driving History questionnaire), driving confidence, risk taking tendency as assessed by the BART, anxiety and depression, and personality related factors.

5.1.1 Driving History

The majority of participants had held their restricted driver licence between 6 - 8 months. The lengths of time participants held their restricted or full licences are summarized in *Figure 5.1.1* (left). The shortest period of time a participant had their licence was less than 2 months, the longest was 20 months.

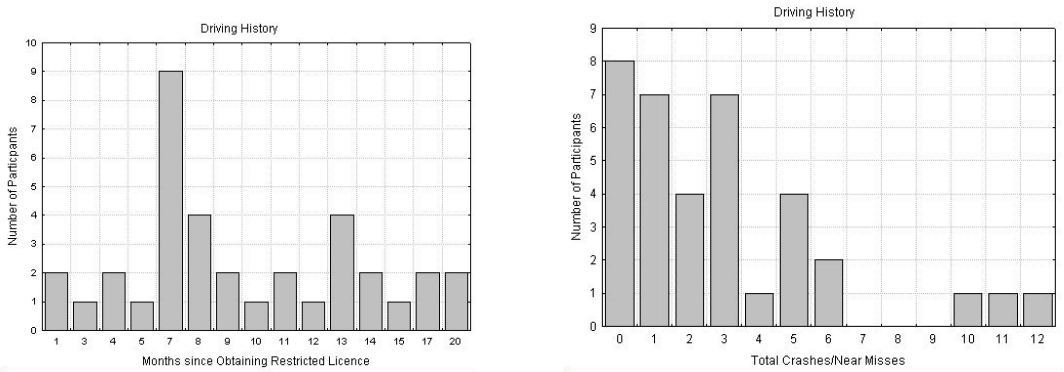


Figure 5.1.1 Length of time (months) that each participant of the sample (N=36) has held their driver licence (left) and their total number of crashes/near misses within the last 12 months (right)

Most participants (20) reported driving between 0 and 50 km per week on average, 6 drove between 50–100 km, 2 drove 150–200 km per week and one participant reported driving between 350 and 400 km per week. Information regarding the crash history of the participants over the previous 12 months revealed that 27 participants had not had any crashes, 7 participants had one crash, 1 had four crashes and 1 participant had six crashes. The 'near misses' over the previous 12 months were, however, more widely distributed. The number of participants involved in crashes and near misses are presented in *Figure 5.1.1* (right). Only 8 participants had not been involved in either a crash or a near miss within the last 12 months. Three of the participants had been involved in more than 10 crashes/near misses.

With regard to driving convictions or offences, 24 participants reported no offences. Of the remainder, the most common offence was driving in breach of their licence (5 participants), 3 had speeding convictions, 1 had taken a vehicle without consent and 1 had been convicted of another driving offence. Warnings were most commonly issued for driver licence offences and driving without legal certification (nine participants), speeding (two participants), reckless driving (one participant), failure to stop (one participant).

5.1.2 Driver Violations

The Driver Violations questionnaire (Cronbach's internal reliability α =0.87) required the participants to indicate how often, in the future, they would engage in certain undesirable risky driving behaviours. The scoring range was from 0 (hardly ever) to 4 (nearly 100% of the time).

Figure 5.1.2 shows the mean score for each of the statements. The items 1, 4 and 7 related to showing annoyance to other road users and our participants indicated that they were not particularly likely to do this. Item 6 asked participants about driving when they think they might be over the alcohol limit, the score suggested that on average they would anticipate doing this only around 10% of the time. In contrast to this, for items 9, 10 and 11 relating to speeding, participants anticipated driving over the 100km/h speed limit around 60% of the time, driving fast around 50% of the time and driving over 50km/h in built up areas around 40% of the time.

A significant gender difference was apparent only in response to item 2, with males being significantly more likely to become impatient and overtake on the inside than females (mean score males=1.61 (N=23) vs. mean score females=0.64 (N=13), t(33)=2.56, p<.05).

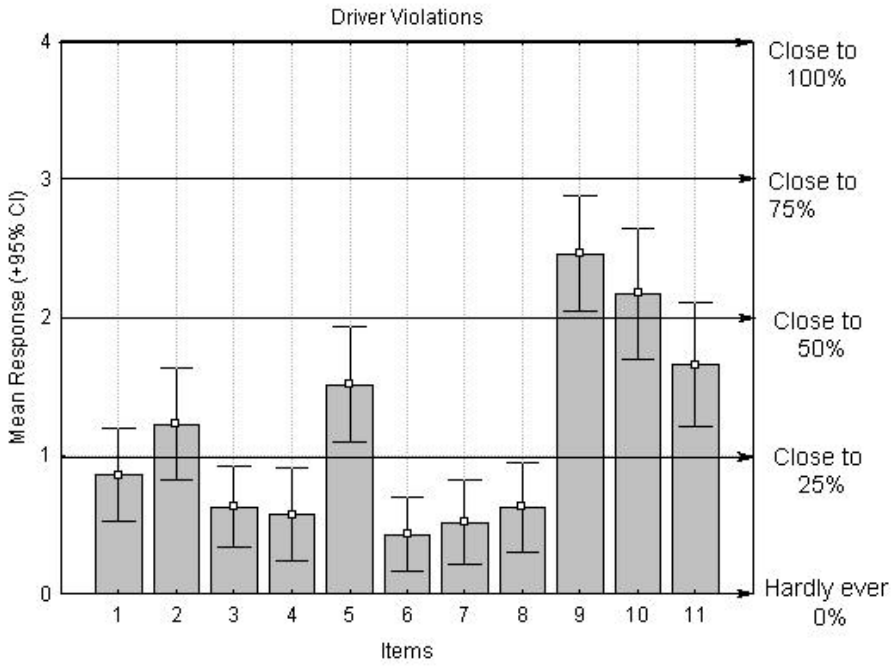


Figure 5.1.2 Mean responses of the participants (N=36) to the 11 items of the Driver Violations questionnaire: In the future, how often would you expect to do each of the following? (CI=Confidence Interval)

1. Drive close to car in front to get driver to move
2. Become impatient and overtake on the inside
3. Cross a junction with the lights against you
4. Chase another driver
5. Disregard speed limits early in the morning or late at night
6. Drive even though you may be over the limit
7. Have an aversion to a particular class of road user
8. Get involved in unofficial 'races'
9. Exceed the 100km/h speed limit on the open road
10. Drive fast
11. Exceed the 50 km/h speed limit in built up areas

5.1.3 Driver Attitude

Figure 5.1.3 shows the mean responses to the 20 items of the Driver Attitude Questionnaire (DAQ, see Method). The responses (1=strongly agree to 5=strongly disagree) were recoded so that they fitted on an attitude scale (1=very safe (attitude) to 5=very unsafe). The DAQ has four factors relating to speeding, drink driving, close following and overtaking. The figure indicates that the participants responded on average to most of the questions between the scale value of 2 'safe' and 3 'neither safe or unsafe'. They had responses that reflected the safest attitudes to the items that were related to drink/driving and close following and had the least safe attitudes to the risk factors speeding and overtaking.

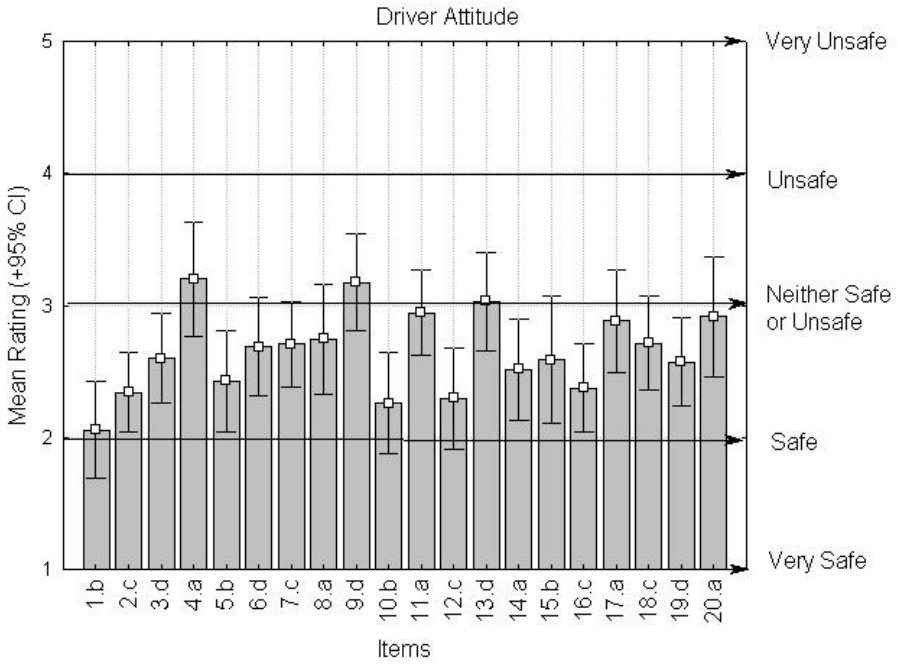


Figure 5.1.3 Mean ratings of the participants for the 20 items in the Driver Attitude questionnaire relating to the risk factors speeding (a), drink/driving (b), close following (c) and overtaking (d): To what extent do you agree or disagree with the following statements?

1. Some people can drive perfectly safely after drinking three or four pints of beer (b)
2. People stopped by the police for close following are unlucky because lots of people do it (c)
3. I would welcome further use of double yellow lines to let me know when it is unsafe to Overtake (d)
4. Speed limits are often set too low, with the result that many drivers ignore them (a)
5. I think the police should start breath analysing a lot more drivers around pub closing times (b)
6. It is quite acceptable to take a slight risk when overtaking (d)
7. Close following isn't really a serious problem at the moment (c)
8. I know exactly how fast I can drive and still drive safely (a)
9. Some drivers can be perfectly safe overtaking in situations which would be risky for others (d)
10. Even one drink makes you drive less safely (b)
11. I would favour stricter enforcement of the speed limit on 50 km per hour roads (a)
12. Some people can drive perfectly safely even when they only leave a small gap behind the vehicle in front (c)
13. The aim of the police should be to stop as many people as possible overtaking in risky circumstances (d)
14. Even driving slightly faster than the speed limit makes you less safe as a driver (a)
15. It's hard to have a good time if everyone else is drinking but you have to limit yourself because you're driving (b)
16. I would be happier if close following regulations were more strictly applied (c)
17. Stricter enforcement of speed limits on 50kmp roads would be effective in reducing the occurrence of road accidents (a)
18. Even driving slightly too close to the car in front makes you less safe as a driver (c)
19. I think it is O.K. to overtake in risky circumstances as long as you drive within your own capabilities (d)
20. The law should be changed so that drivers aren't allowed to drink any alcohol (a)

The internal reliability of the questionnaire overall was good (alpha (Cronbach's)=0.78) but the reliability of two of the four subscales was somewhat low (alpha for speeding=0.65, alpha for drink/driving=0.47, alpha for close following=0.81, alpha for overtaking=0.48). The low alpha values for these two subscales are similar to that reported by others (Parker et al., 1996). Thus data from these two scales should be interpreted with some degree of caution. *Figure 5.1.4*

shows the composite scores of the four risk factors (subscales), graphed separately for the male and female participants.

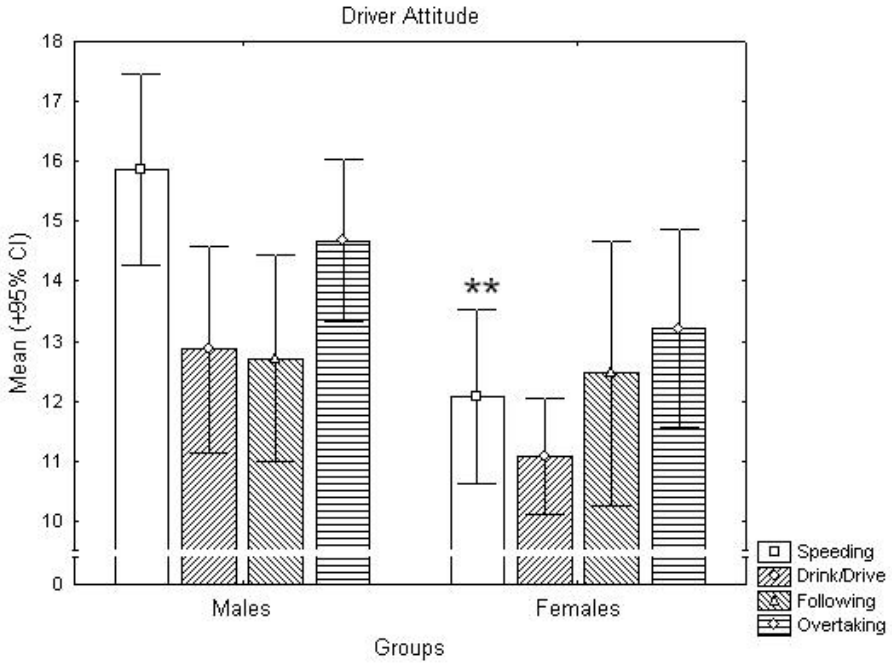


Figure 5.1.4 Mean composite scores (larger values mean less safe attitudes) for the four risk factors (speeding, drink/driving, close following and overtaking) in the Driver Attitude questionnaire (DAQ) for the male (N=23) and female (N=13) participants (** p<.01)

Visual inspection of *Figure 5.1.4* clearly confirmed that the participants were most accepting of taking risks when overtaking and speeding. The possible range of total scores for each factor was 5 -25, with the midpoint being 12.5. When analyses were conducted to examine differences between the genders, it was found that the males were significantly more accepting of speeding than the females, $t(34)=2.82$, $p<.01$. In addition, the difference between the genders on the overall DAQ composite score also approached significance, $t(34)=1.74$, $p=0.09$, with the males scores being higher (less safe overall attitude) than the females.

5.1.4 Driver Risk Taking

For the Driver Risk Taking Questionnaire, participants were required to indicate to what extent they agreed or disagreed (1=strongly disagree to 5=strongly agree) with a number of statements relating to the laws which address unsafe or risky driving behaviour. The responses were recoded so that they fitted on an attitude scale (1=very safe (attitude) to 5=very unsafe). 22 participants had a total score greater than 75; (72 would be an overall neutral response), whilst only 4 participants obtained a total score below this (within the unsafe range). When scores were split on the basis of gender, there were no significant differences between males and females. The mean response to each question is presented in *Figure 5.1.5.* From this, it is

interesting to note that these young drivers acknowledge that speeding is a main cause of accidents (item16) but disagreed (unsafe attitude) that speed limits should be more strictly enforced (item 6). They also think that random breath testing is a good idea (item 12) and acknowledge that using mobile phones whilst driving is dangerous (item 24) but on the other hand think that it is quite ok to text message while driving (item 18).

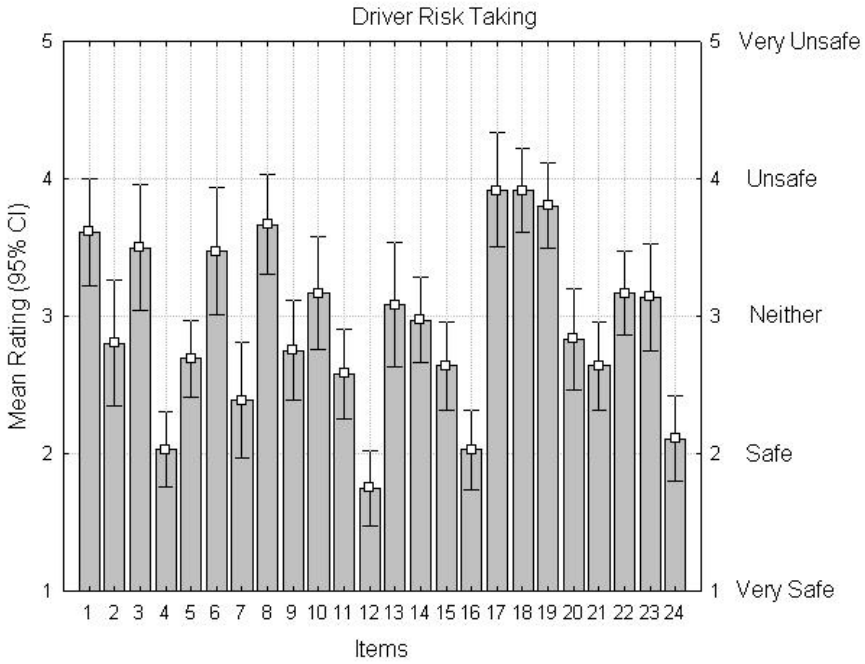


Figure 5.1.5 Mean ratings of the participants for the 24 items in the Driver Risk Taking questionnaire:

1. I think it is ok to overtake in risky circumstances as long as you drive within your own capabilities
2. The law should be changed so that drivers aren't allowed to drink any alcohol
3. It is quite acceptable to drive after only one or two drinks
4. On the whole people aren't aware of the dangers involved in close following
5. Even overtaking in a slightly risky situation makes you less safe as a driver
6. I would be happier if the speed limits were more strictly enforced
7. The aim of the police should be to stop as many drink drivers as possible
8. People stopped by the police for risky overtaking are unlucky because lots of people do it.
9. Harsher penalties should be introduced for drivers who drive too close to the car in front
10. It's OK to drive faster than the speed limit as long as you drive carefully
11. I know exactly what risks I can take when I overtake
12. Random breath testing of drivers is a good idea
13. People stopped by the police for speeding are unlucky because lots of people do it
14. I think the stopping distances in the road code are too great for people to take notice of them
15. I would be happier if there was a clamp down on dangerous overtaking
16. Speeding is one of the main causes of road accidents
17. I think I know exactly how much I can drink and still be under the limit
18. I think its OK to send text messages while driving
19. It is quite acceptable to drive closer to the car in front than is recommended
20. Sometimes you have to drive in excess of the speed limit in order to keep up with the flow of traffic
21. I would favour a clamp down on drivers who drive too close to the vehicle in front
22. Risky overtaking isn't really a serious problem at the moment
23. The amount of alcohol you're allowed to drink before driving is too high
24. Its dangerous to talk on your mobile phone while driving

5.1.5 The Balloon Analogue Risk Task (BART)

The *Balloon Analogue Risk Task (BART)* produced three measures of interest, the total number of dollars earned, the number of trials where the balloon exploded, and the average number of pumps in those trials where the balloon did not explode. The higher the score on any

of these measures, the greater the tendency for risk taking (see Method section for more details). *Table 5.1.1* shows the mean scores (and standard deviations) for males and females at baseline.

Table 5.1.1 Scores obtained for the whole sample (overall) and the males and females for the BART task at Baseline

Measure		Males	Females	Overall
$ Earned	Mean	6.4	5.7	6.0
	SD	1.9	2.5	2.3
Explosions	Mean	4.6	3.6	4.0
	SD	1.4	1.4	1.5
Pumps per Bank	Mean	25.7	19.6	22.9
	SD	11.6	10.8	11.9

Note: SD=Standard Deviation

The table shows that males tended to score more highly than females. However, analysis (independent t tests) revealed no significant differences in these BART measures between males and females.

5.1.6 Self-Evaluation of Driving Skills

Self evaluation of their driving skills was assessed by means of 4 statements or questions. The first statement relating to accident concern (item 1) was “I sometimes feel worried that I will be involved in an accident” and the responses were rated from 1 (strongly disagree) to 9 (strongly agree). The same rating scale was also applied to the second statement (item 2) which related to participants’ tendency for thrill seeking and was “I often get a thrill from driving”. The third item, which addressed driving ability was “How likely are you to be involved in accidents in the future compared with the average driver?” and the response ratings ranged from 1 (much less likely) to 11 (much more likely). The same response scale was also applied to the second driving ability evaluation (item 4) which was “How skilful do you think you are compared with the average driver?”

From *Figure 5.1.*6, it can be seen that for item 1, over half of the participants reported being worried that they might be involved in an accident (20), whilst 6 felt ambivalent about their accident involvement. For item 2, most participants agreed that they get a thrill from driving, with only 3 disagreeing with the statement.

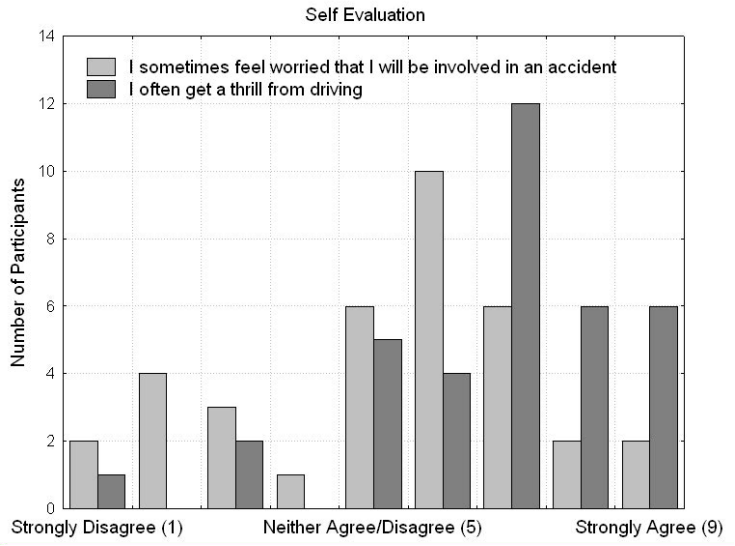


Figure 5.1.6 Distribution of the responses of the participants to the Self Evaluation questionnaire, item 1 and 2.

Figure 5.1.7 shows that nearly half (15) of the participants reported being equally as likely to be involved in an accident compared to the average driver, 15 believed they were less likely to be involved in an accident than average and 6, more likely.

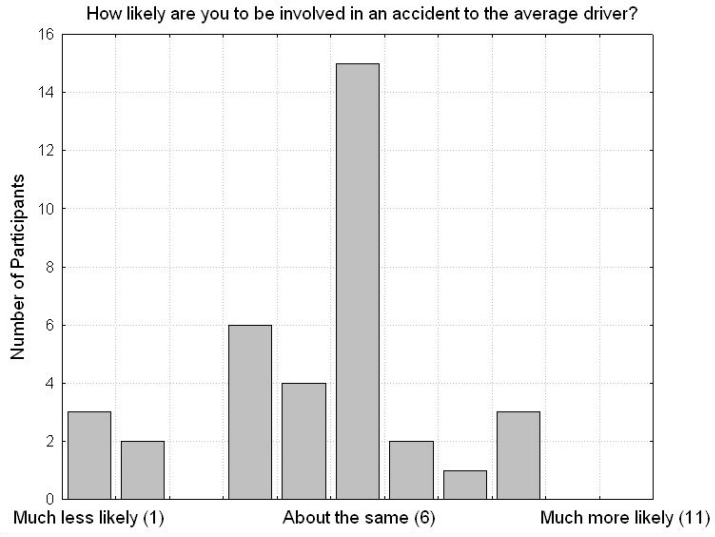


Figure 5.1.7 Distribution of the responses of the participants to the Accident Concern and Driving Skills questionnaire, item 3.

With regard to skill (see *Figure 5.1.8*), 12 rated themselves as the same as the average driver, whilst 14 rated themselves as more skilful than average (one as much more skilful).

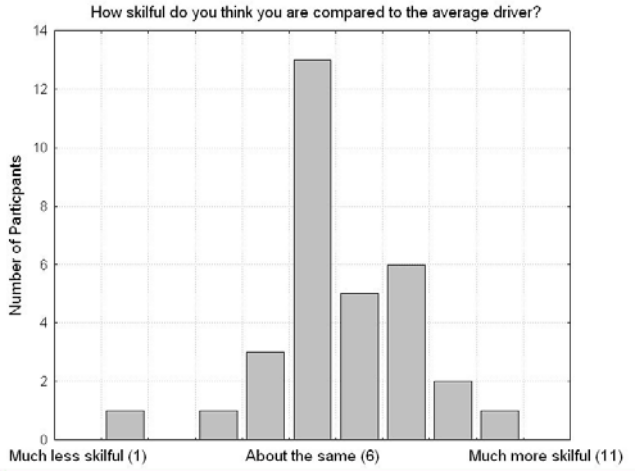


Figure 5.1.8 Distribution of responses of the participants to the Accident Concern and Driving Skills questionnaire, item 4.

T test revealed no statistically significant differences between the response of males and females on any of the four items. Females, however, tended to rate themselves as being more likely to be involved in accidents than males, and less skilful as a driver.

5.1.7 Attitudes to Risk

The assessment of the participant's attitude toward risk was divided into two factors, each with five contributing questions and a range of possible scores from 5 to 25. The internal reliability of this questionnaire was good (overall scale Cronbach's α=0.89, physical scale α=0.82, psychological scale α=0.81). The Psychological Risk factor (N=34) had a mean score of 13.9 (SD=4.6) and the Physical Risk factor (N=35) had a mean score of 16.17 (SD=4.5). This indicates that these participants, on average, are more likely to be involved in activities which have some level of physical risk, (lower score indicated 'not like me') and less likely to partake in activities which involve a level of psychological risk (higher score indicated 'like me'). The exception to this was that on average, people did not think that 'liking doing things that paralyse them with fear' was like them (mean score=2.7). Some evidence for truthful responding is also shown in this questionnaire as almost all of the participants rated the statement 'I often do things I know my parents would disapprove of' as being 'Like Me'.

5.1.8 Physical Risk Assessment Inventory

The *Physical Risk Assessment (PRAI)* measured the individual's perception of risk involved in certain activities. Again two separate factors were assessed, the Health Risk (Cronbach's alpha=0.93) and the Sports Risk (alpha=0.84), and a Total Risk score (alpha=0.91) was also obtained which was a combination of the two separate factors.

The Health risk factor consisted of 13 items and a possible score range of 0 (no risk) to 78 (extreme risk), the mean score for the group (N=34) was 57.1 (SD=10.1). The Sport Risk factor

was made up of 14 items and therefore the possible range of scores was 0 to 84, with the group mean (N=36) being 46.3 (SD=15.7) indicating that this group perceived that there was less risk attached to sporting activities than to activities which carried a health risk. The Total Risk score range was 0 to 162 and the group (N=34) mean was 102.5 indicating that overall these participants perceived the level of risk involved in both health related and sports related activities combined to be greater than average.

For this assessment a small non-significant difference was also seen between males and females. For males (N=21 & 22) the means for the health factor and the sports factor were 56.6 and 46.7 respectively, while the means for the females (N=13 & 14) were 57.8 and 45.5 respectively. This suggests that females are more likely to see risk in health related activities and less likely to perceive a high level of risk in sports related activities. When the two factors were combined however, the mean total perceived level of risk for males was 101.9, while for the females it was 103.5, indicating that overall females are more likely to perceive a higher level of risk in relation to a range of activities than males. However, statistical analysis revealed no significant differences between males and females.

Participants rated both of the driving related activities, driving recklessly (mean approx 4.9) and driving after drinking (mean approx 5.2) as between moderate (3) and extreme physical risk (6).

5.1.9 Driving Confidence

The first of the two driving confidence measures *(Confidence 1)* required the participants to rate how safe they felt in 13 different driving situations. The internal reliability of this scale was high (Cronbach's α =0.87). The ratings they could give ranged from 1 (very safe) to 5 (very unsafe), resulting in total possible scores between 13 and 65, with a mean of 39. The majority of the participants scored close to the mean. When the scores for males and females were examined separately at baseline, the mean confidence ratings for the males were 35.7 (SD=7.9) and 41.2 (SD=4.7) for females, indicating that males generally felt safer. Independent t test revealed that this difference was statistically significant, $t(34)=2.24$, $p<0.05$. The mean rating for each of the 13 scenarios are presented in *Figure 5.1.9.*

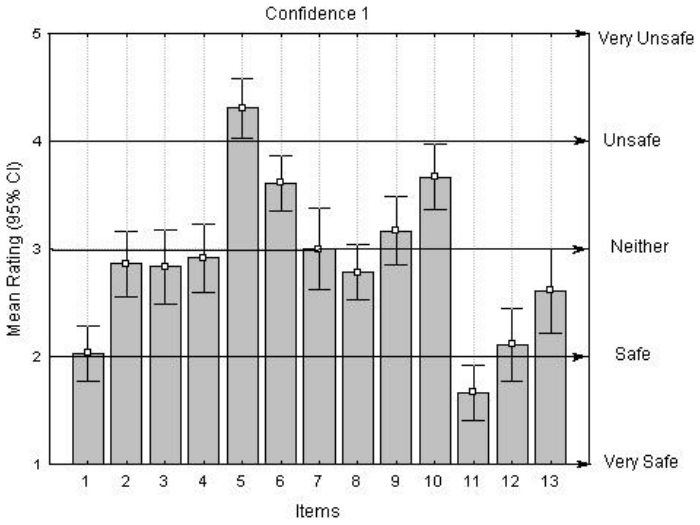


Figure 5.1.9 Mean ratings of the participants how safe they felt in certain driving conditions (Confidence 1 questionnaire)

1. At night
2. In unfamiliar area
3. In the city
4. In bad weather
5. After drinking
6. Sleepy or tired
7. Towing a trailer
8. An unfamiliar car
9. When angry
10. Being Tailgated
11. At 100 km/ph
12. At 110 km/ph
13. At 120 km/ph

To investigate this gender difference further, the response of the males and females to each of the questions were examined. Females scored higher than males in all cases – indicating they felt generally less safe in all traffic scenarios. For some of the questions this difference was significant including responses to question 4 (bad weather; $t(34)=2.9$, $p<.01$), question 5 (after drinking; $t(34)=3.77$, $p<.01$), question 8 (unfamiliar car; $t(1.92$, $p=0.06$, only approaching significance), question 12 (at 110km/h; $t(34)=2.32$, $p<.05$) and question 13 (at 120km/h; $t(34)=3.58$, $p<.01$). In some case, these gender differences shifted the response from 'safe' to 'unsafe' (questions 4 & 13). Both groups reported feeling unsafe when driving after drinking, but felt safe when driving at 100 km/h, 110 km/h and for the males at 120 km/h. At 120 km/h average score for the girls was in the unsafe range (3.58).

The second confidence measure *(Confidence 2)* required participants to rate their levels of confidence in various driving conditions from 0 (not at all confident) to 10 (completely confident). The internal reliability was high (Cronbach's $\alpha=0.90$). The mean ratings for the group over the first two weeks were 7.0, & 7.0 respectively, indicating that there was, overall, an above average feeling of confidence amongst the participants in a variety of driving situations. When confidence levels of males and females were examined separately, the mean confidence ratings of males at baseline was 7.3 (SD=1.7), and 6.6 for females (SD=1.3). Although males

demonstrated a tendency to be more confident, the difference between these scores was not statistically significant (p>05).

The means scores for each of the questions are presented in *Figure 5.1.10.* From this it can be seen that participants felt somewhat / very confident driving at night, in bad weather, on the high way, on long trips, pulling into traffic from a stop and making a right turn across traffic. They scored between neither confident/unconfident to somewhat confident when driving in rush hour or heavy traffic, changing lanes on a busy street and reacting quickly. The only situation in which they did not report feeling confident was parallel parking. In addition, there were gender differences evident in the responses to this question, with males being significantly more confident than females, t (34)=2.31, p<05).

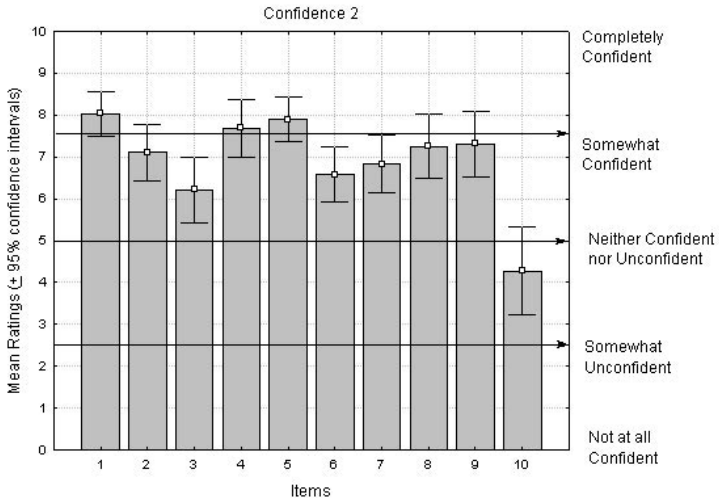


Figure 5.1.10 Mean ratings of the participants how confident they felt in certain driving conditions (Confidence 2 questionnaire)

1. At night
2. In bad weather
3. In rush hour or heavy traffic
4. On the highway
5. On long trips
6. Changing lanes on a busy road
7. Reacting quickly
8. Pulling into traffic from a stop
9. Making a right turn across traffic
10. Parallel parking or backing into a space between cars

5.1.10 Personality

This personality assessment used items from the *International Personality Item Pool (IPIP),* producing scores for five different personality factors (the 'Big Five': extraversion, agreeableness, conscientiousness, neuroticism and openness) each of which was made up of ten contributing items (total score minimum 10, maximum 50). These data are summarized in *Table 5.1.2.* below.

Table 5.1.2 Scores for each of the 'Big Five' personality variables

IPIP Factor	N	Mean	(SD)	(Cronbach's α)
Extraversion	33	32.7	(8.3)	0.87
Agreeableness	34	35.9	(6.1)	0.84
Conscientiousness	32	29.8	(6.2)	0.74
Neuroticism	35	32.9	(6.7)	0.82
Openness	36	34.2	(6.5)	0.82

Note: Standardised mean midpoint = 33

Participants' ratings indicated that as a group they were slightly more 'agreeable' and 'open' than 'extravert', conscientious' or 'neurotic'. What is interesting in the context of this driving research is that the mean score for the 'extraversion' factor was also above the midpoint of 30, and the 'conscientiousness' factor, which would be the inverse of impulsivity, was lower than the other factors, and below the midpoint. Analysis indicated that the internal reliability of the entire scale and each of the subscales was good (Cronbach's α for full scale=0.84; see *Table 5.1.2* for other values).

When comparing males and females, females scored significantly higher on extraversion, $t(30)=3.15$, $p<.01$) and near significantly higher on agreeableness, $t(31)=1.97$, $p=0.06$) than males.

The other measure of personality, the *Barrett Impulsivity Scale***,** had a possible range of scores of 28 to 112. For this sample, (N=36) the mean score was 67.26 (SD=10.7), which is just below the mid-point between the minimum and maximum scores. This suggests that overall these participants have slightly lower than average impulsivity tendencies. However, when a comparison was made between males and females, a significant difference was found between the lower scoring (less impulsive) males (N=23, Mean=64.2, SD=8.3) and the higher scoring (more impulsive) females (N=13, Mean=72.6, SD=12.5), $t(34)=-2.4$, $p<.05$. This difference may however be questionable as the overall reliability of this scale was rather low and subsequent results need to be interpreted with caution (Cronbach's α =0.56). An examination of how these personality factors relate to driving behaviour is presented in later sections.

Socially desirable responding as assessed by the *Marlowe Crowne Scale* produced a range of possible total scores from 0 to 13, and the mean score (N=32) was 6.1 (SD=2.1). The reliability of this scale was somewhat low (Cronbach's α =0.53).The minimum score obtained for this assessment was 1 and the maximum was 10. Given the low reliability of this scale, responses from this were not included as a covariate in subsequent analyses.

5.1.11 Anxiety and Depression

The scores from the measures of Anxiety and Depression indicated that on the whole these participants had no significant mood disorders. The *Beck Anxiety Inventory* mean score was

10.3 (SD=8.1, Minimum score=0, Maximum score=35), with scores between 16 and 25 representing moderate anxiety, and scores above 25 indicating severe anxiety. Most participants scores were within the 'non anxious' range, apart from 5 participants who had scores between 16 and 25 (moderate anxiety, 4 female) and 2 who had scores above 25 (severe anxiety, both female). In keeping with this an independent groups t – test revealed that females scored significantly higher than males, $t(34)=2.34$, $p<.05$, on this measure.

The mean score for the *Beck Depression Inventory* was 8.2 (SD=7.55, Minimum score=0, Maximum score=35). Thus, for the BDI, most scores were in the normal range. However, two female participants scored as being moderately / severely depressed (over 26). As was the case with the BAI, females scored significantly higher than males on this measure, $t(34)=2.64$, $p<.05$.

5.1.12 Influencing Factors

This result section will focus on some factors that may have influenced the responses of the participants to the driver violations, attitudes and self evaluation of their driving skills questionnaires. The factors examined were: number of near misses/crashes they had in the last 6 months (driving history questionnaire), driving confidence, risk taking tendency as assessed with the BART, anxiety and depression, and personality related factors. These were chosen on the basis of previous findings in the literature.

First, correlations were performed between the influencing factors and the questionnaire measures. Then t-tests were performed on the questionnaire measures comparing the nine participants who were scoring in the highest quartiles of the influencing factors and the nine participants who were scoring in lowest quartiles of the influencing factors.

The BART measures did not correlate with any of the questionnaire measures and the two groups (nine each) with the highest and lowest BART scores did not significantly differentiate between any of the questionnaire measures. The confidence measure 1 highly correlated with the confidence 2 measure, therefore only the measure for confidence 1 was examined as influencing factor.

Measures that influenced some responses of the participants to the questionnaires are shown in *Table 5.1.3*.

The number of crashes/ near misses correlated significantly with the measure for driver risk taking (i.e., the higher the number of crashes/nears misses the less safe their attitudes regarding risk taking). The group who had the highest number of crashes (5 males, 4 females), had an average number of crashes/near misses of 7.2 (SD=2.9), while none of the participants who had the smallest number of crashes had any crashes/near misses. The two groups were not different in relation to the time period they had their restricted licence or in relation to the number of kilometres they estimated they drive per week.

The group with the highest number of crashes had a significantly less safe attitude to risk taking and road rules compared to the group with the lowest number of crashes/near misses.

From the *Table 5.1.3,* it can be seen that there were significant correlations between the confidence in their driving and driver risk taking, driver attitude, accident concern, driving attitudes and self assessed driving ability. The nine participants (lower quartile) who were less confident in their driving (Mean=28.2, SD=3.5) compared to the nine participants (upper quartile) who were more confident (Mean=46.3, SD=4.3) had higher scores on the driver risk taking questionnaire (which assesses to what degree the participants agree with the laws of the road). Thus, those low in confidence agreed more often with laws which addressed risky driving behaviour, and they were also more concerned about being in an accident (SE1). They also had a safer overall attitude to driving (DA), and more specifically to speeding (DA1), and they were less likely to get a thrill from driving (SE2) and were more likely to feel their driving skills were not as good as others (SE4).

The level of anxiety factor did not correlate significantly with any of the questionnaire measures.

The scores for the Impulsivity measure significantly correlated with both driver violations (DV) and the tendency to get a thrill from driving (SE2). The nine participants who scored in the highest quartile regarding impulsivity (Mean=81.4, SD=5.5) admitted to more driving violations and suggested they get more of a thrill from driving than the nine (lower quartile) who were less impulsive (Mean=54.4, SD=3.5). The more impulsive group also tended to be less worried about being involved in an accident (SE1).

The personality factor agreeableness was significantly correlated to Driver Risk Taking and Attitudes to close following (DA3), such that those in the upper quartile who were more agreeable (Mean=43.7, SD=3.2) were more likely to endorse the laws of the road and had a safer attitude to close following than those who were less agreeable (lower quartile, mean= 28.7, SD=2.8). There was also a tendency for the more agreeable group to feel they were less likely to be involved in an accident than did those who did not score so highly on this factor.

The personality factor openness correlated significantly with Driver Risk Taking and Attitudes to close following. For this personality factor however, there were also significant differences on the overall driver attitude scores along with the drink-driving and overtaking factors more specifically, between those who were more open (upper quartile, mean=42.2, SD=2.3) and had safer attitudes, and those who were less open (lower quartile, mean=26.0, SD=2.3) and had less safe attitudes.

Table 5.1.3 Influencing factors examined

	Number of Crashes and Near Misses			Confidence Level in their Driving		
	r(N=36)	High Mean (SD)	Low Mean (SD)	r(N=36)	Low Mean (SD)	High Mean (SD)
DV	.28	15.8(8.5)	10.1(4.2)	-.21	9.9(6.9)	14.0(6.5)
DRT	-.43*	86.8(12.4)	74.8(7.5)*	-.49*	86.1(7.4)	75.8(13.8)
DA	-.23	49.6(10.5)	56.4(5.2)	-.33*	49.0(8.4)	56.0(10.0)
DA 1	-.09	13.6(4.3)	15.1(3.6)	-.41*	11.9(2.3)	15.6(4.1)*
DA 2	-.08	11.8(1.9)	12.2(2.2)	-.24	10.8(2.7)	12.3(2.4)
DA 3	-.11	11.9(4.0)	13.7(1.9)	-.27	11.9(2.5)	14.0(3.2)
DA 4	-.17	12.7(2.6)	14.1(2.0)	-.24	12.8(2.9)	14.4(2.4)
SE1	.14	5.4(2.8)	4.6(1.8)	.43*	7.2(1.3)	4.2(2.5)*
SE2	.19	7.1(2.1)	6.3(1.8)	-.41*	5.6(2.2)	7.6(1.5)*
SE3	.10	5.9(2.8)	5.3(1.9)	.05	5.9(1.5)	5.2(2.5)
SE4	-.06	5.4(2.6)	7.1(1.1)	-.45*	4.3(2.1)	7.0(1.3)*
	Anxiety			Impulsivity		
	r(N=36)	High Mean (SD)	Low Mean (SD)	R(N=36)	High Mean (SD)	Low Mean (SD)
DV	.24	15.9(7.4)	10.4(9.1)	.41*	16.56(8.3)	7.33(4.8)*
DRT	-.0098	79.2(6.4)	80.2(12.9)	-.19	82.33(14.4)	82.44(9.7)
DA	.08	56.7(9.6)	52.1(10.1)	.04	53.11(10.9)	50.67(9.7)
DA 1	.02	14.6(3.9)	14.2(3.7)	.06	13.22(3.8)	12.33(3.8)
DA 2	.22	13.9(4.9)	11.4(3.2)	.16	12.56(4.04)	11.11(3.02)
DA 3	-.18	11.0(4.3)	12.9(2.3)	.02	12.11(5.1)	11.56(2.3)
DA 4	.10	15.6(4.1)	13.9(2.4)	.09	15.00(4.1)	12.89(2.7)
SE1	.26	6.6(1.5)	5.3(2.1)	-.30	4.33(2.6)	6.22(1.8)
SE2	.02	6.7(1.5)	6.8(2.7))	.35*	7.56(1.2)	5.38(2.3)
SE3	.-.05	4.9(2.6)	6.3(1.5)	.23	5.33(2.4)	5.22(2.0)
SE4	-.22	5.4(2.2)	5.7(2.1)	-.07	6.22(1.9)	6.11(2.5)
	Agreeableness			Openness		
	r(N=33)	High Mean (SD)	Low Mean (SD)	R(N=36)	High Mean (SD)	Low Mean (SD)
DV	-.19	14.33(9.2)	16.3(7.8)	-.12	10.1(7.6)	14.3(4.1)
DRT	.52*	87.0(11.1)	75.7(7.7)*	.35*	88.3(9.3)	77.7(6.8)*
DA	-.34	52.0(11.9)	57.3(3.9)	-.29	47.8(6.7)	57.1(8.1)*
DA 1	-.23	14.1(4.4)	15.2(2.2)	-.11	13.0(3.6)	14.9(3.4)
DA 2	-.01	13.8(4.9)	12.4(1.9)	-.07	10.7(1.4)	12.6(2.2)*
DA 3	-.47*	9.6(4.0)	14.7(2.3)*	-.45*	10.6(3.0)	14.8(3.1)*
DA 4	-.21	14.6(4.6)	15.0(2.3)	-.20	11.9(2.0)	15.2(2.5)*
SE1	.10	5.8(2.3)	4.9(2.6)	.06	5.4(2.9)	5.1(2.3)
SE2	.10	7.4(1.3)	7.0(1.3)	.28	7.3(1.2)	6.2(1.6)
SE3	-.21	4.6(2.7)	6.2(1.5)	.05	5.6(2.4)	5.4(1.7)
SE4	.00	6.2(2.0)	6.1(2.1)	-.01	5.8(2.4)	5.7(1.2)

Note: DV=Driver Violations, DRT=Driver Risk Taking, DA=Driver Attitude (1=Speeding, 2=drink /driving, close following, and overtaking. SE=Self Evaluation (1=I sometimes feel worried that I will be involved in an accident, 2=I often get a thrill from driving, 3=How likely are you to be involved in accidents in the future compared with the average driver? 4=How skilful do you think you are compared with the average driver" (* =p< 0.5, ** =p< 0.01)

A hierarchical linear regression analysis was conducted using Confidence, Anxiety and Total Accidents and Near Misses as the three possible predictors (in that order), to determine their level of influence on the dependent variables. Confidence alone was the best predictor of Driver Attitudes overall (R^2=.11, adjusted R^2 =.08, F(1,34)=4.2, p<.05) and more specifically to attitudes to Speeding (R^2=.17, adjusted R^2=.14, F(1,34)=6.9, p<.01), accounting for 11% and 17% of the variance respectively. The Confidence only model was also the best predictor of SE1 (R^2=.19, adjusted R^2 =.16, F(1,34)=7.7, p<.01), SE2 (R^2=.17, adjusted R^2 =.15, F(1,34)=7.0, p<.01), and SE4 (R^2=.20, adjusted R^2=.18, F(1,34)=8.7, p<.01), predicting 19%, 17% and 20% of the variance in those scores respectively. The second model which included both Confidence and Anxiety significantly predicted Attitudes to Drink Driving (R^2=.17, adjusted R^2 =.12, F(2,33)=3.3, p<.05), with both variables together predicting 17% of the total variance. The third model was the best predictor of Driving Violations (R^2=.24, adjusted R^2 =.17, F(3,32)=3.3, p<.05), predicting 24% of the variance in scores, although only Confidence (t=-2.1, p<.05) and Anxiety (t=2.2, p<.05) made significant contributions to the model such that those who felt more safe were more likely to commit driving violations than were those who were more anxious. For Driver Risk Taking, model three was also the best predictor, R^2=.43, adjusted R^2 =.37, F(3,32)=7.9, p<.01, accounting for 43% of the variance in Driver Risk Taking scores, but in this instance it was Confidence, t=3.4, p<.01, and total Accidents and Near Misses, t=3.5, p<.01 that contributed significantly to the model.

5.2 SUMMARY PART 1

The first part of the results examined the self reported characteristics of the sample of thirty six teenage drivers on a restricted driver licence who attended the *Driver Training Research* camp in Taupo. The aim was to assess their attitudes to driving and risks involved and some factors were examined which may have influenced their responses to the attitude questionnaires. The crash history of the participants indicated that the majority of drivers (27) had no crashes, seven participants had one crash and only two participants had many crashes, namely one participant had four crashes and another had six crashes. Two-thirds of participants (24) had at least one near miss. The length of time the participants had their restricted driver licence varied substantially (2-20 months), but nevertheless, these data reflect the road safety statistics that show that young drivers experience a considerable risk of injury and death during the first months of solo driving on a restricted driving licence.

The questionnaire on driver violations revealed that in the future the participants would choose to exceed the 100km/h speed limit on average as often as 60% of the time, and exceed the 50 km/h speed limit about 40% of the time. They indicated that they would disregard speed limits early in the morning and late at night around 40% of the time. In comparison, non speed related driver violations were predicted for the future much less frequently. For example, ‘drive even though you may be over the limit’, on average the participants would anticipate doing this

only 10% of the time. However, the opportunity to drink and drive occurs much less frequently than speeding and this may partly explain this discrepancy. Becoming impatient and overtaking on the inside was something males would anticipate doing significantly more frequently than females. It is interesting to compare these results with the road toll statistics of young drivers in New Zealand. Speeding violation is the most frequent cause of crashes for young drivers, a statistic which is consistent with the high number of speeding violations the participants anticipated in this study.

The results for the driver attitude questionnaire revealed that the responses reflected the safest attitudes to drink/driving behaviour and close following and the least safe attitudes to the risk factors speeding and overtaking. There was a significantly less safe attitude to speeding for the male participants compared to the female participants. The drink / driving findings need to be interpreted with caution as alcohol effects the decision making process. Thus, those who report they do not agree with drinking and driving, may drive after drinking.

A very similar picture emerged for the risk taking questionnaire. It was interesting to note that the participants acknowledged that speeding is the main cause of crashes but disagreed that speed limits should be more strictly enforced. Similarly, text messaging was acknowledged to be dangerous, but on the other hand they feel that it is quite ok to text while driving. Overall, it is interesting that the young drivers seem *to know* about the danger of some risky behaviours but are still willing to engage in them quite frequently.

The Balloon Analogue Risk Task (BART) was performed by the participants in an attempt to receive a more objective measure of their risk taking tendency, however, unlike previous research, the BART measure related to none of the attitude or risk taking questionnaires and there was no significant gender effect visible in any of the BART measures, a result which is surprising considering the clearly demonstrated gender effect of risk taking behaviour in teenagers in the research literature.

The self-evaluation of driving skills questionnaire confirmed that many teenage drivers rated their driving skills as higher than the average driver, and thought that they would be less likely to be involved in a crash than the average driver. They indicated that they often get a thrill from driving and disagreed often with the statement that they sometime feel worried that they will be involved in an accident.

The participants' often reported inflated confidence in their driving skills was also clearly visible in the responses of the two driving confidence questionnaires. Particularly alarming is the fact that participants seem to feel quite safe speeding - even at 120 km/h. They also seem to feel safe at night, which is the time when many novice driver crashes occur.

The personality assessments showed that as a group, the participants were more agreeable and open than extravert or neurotic, but the differences were perhaps too small to be relevant for this study. Regarding impulsivity, the participants as a group scored in the range you would expect. The results from the Marlowe Crowne Scale were unreliable and thus, we have no

measure of socially desirable responding. The truthfulness of responses is an issue for all questionnaire studies, and hopefully, as participants were aware that data were anonymous, relatively accurate responses were received.

Some factors were found that influenced the responding of the participants in the attitude - and self evaluation of driving skills questionnaires. Confidence level was the strongest predicting factor (accounted for between 17 and 20 % of the variances in the three attitude questionnaires). A high level of confidence in driving skills related to unsafe attitudes for many risk taking behaviours, but particularly regarding speeding behaviour. The number of crashes/near misses also related significantly to less safe attitudes to risk taking, but the level of anxiety did not significantly influence any of the responses. Interestingly, a high level of impulsivity related to unsafe attitudes regarding driver violations anticipated for the future while higher values of the personality factors agreeableness and openness lead to safer attitudes regarding driver violations anticipated for the future.

5.3 RESULTS PART 2

Aim 2: To determine if frontal lobe executive functions of the participants are associated with their performance on the driving related assessments

Firstly, the sample results from the executive function, general ability and sustained attention assessments are reported. This is followed by the sample results of the baseline driving related assessments for the whole group (on-road driving assessment, road commentary assessment and driving self assessment). Where appropriate the performance of our participants was compared to the normative data using one sample t-tests.

The second section examines the association between executive function, general ability, sustained attention and the driving related assessments. In order to do this, firstly scores on each of the tests were correlated with each part of the driving related assessments. Subsequently, comparisons of the driving related assessments were made between participants scoring in the highest and lowest quartiles on each of the neuropsychological tests. As the data from the On-Road Driving Assessment did not meet the requirements for parametric analyses, the data were analysed using the Friedman / Mann Whitney U test as appropriate. The remaining data were analysed using independent t tests / ANOVAs.

5.3.1 Executive Functions

The scores obtained from all of the neuropsychological assessment on executive functions are presented in *Table 5.3.1.*

As a sample, their *working memory* scores were significantly below that expected, $t(35)=2.79$, $p<0.01$, however there were no significant gender differences on this measure. The participants *verbal fluency* skills were significantly better than that of the normative sample, $t(35)=2.10$, $p<0.05$, whilst their *cognitive switching* was not significantly different from the standardized mean. With regard to gender differences, females produced more correct words on the letter fluency task than males, this was largely due to females generating significantly more words during the first quarter of the task compared to males, $t(34)=2.7$, $p<0.01$.

With regard to *inhibition* of automatic responding, the participants in this study performed similarly to the standardized average for their age group. In addition, as a group, they performed in the normative range for the *combined inhibition and cognitive flexibility* measures. However, on this more complex task females performed significantly better than males, $t(34)=2.91$, $p<0.01$. Similarly, *forward planning and problem solving* ability were similar to the normative group, however no gender differences were apparent on this measure. In contrast, the participants *complex information* processing was significantly poorer than the normative group, $t(35)=5.5$, $p<0.01$, and males took significantly longer than females, to complete the task $t(34)=2.6$, $p<0.05$.

5.3.2 General Ability

Assessments of general ability produced three scores relating to *Verbal Intelligence Quotient* (VIQ), *Performance Intelligence Quotient* (PIQ) and the *Full Scale Intelligence Quotient* (FSIQ). The overall general ability (FSIQ) and PIQ scores of our sample were both significantly higher than the standardised mean (FSIQ: $t(35)=2.79$, $p<0.01$, PIQ: $t(35)=3.56$, $p<0.01$), however VIQ was similar to the normative data. There were no statistically significant differences between the genders in relation to general ability.

5.3.3 Sustained Attention

On the whole, the sustained attention of this sample was similar to that reported elsewhere (Lezak et al, 2004). However, they made a significantly greater number of omissions than expected, $t(35)=3.11$, $p<0.01$. Gender differences were also apparent on this task with females performing significantly better than males, $t(34)=2.08$, $p<0.05$.

Table 5.3.1 Means, standard deviations and range of scores obtained on the executive function, general ability and sustained attention tasks. * $p<0.05$, ** $p<0.01$ indicates significant difference from the normative sample score.

Executive function	Measure	Normative Score	Mean Score	Std Dev	Range
Working Memory	Digits Backwards	10 (SD = 3)	8.1**	4.0	2-18
Fluency & Switching	Letter Fluency	10 (SD = 3)	11.3*	3.6	3-19
	Fluency Switching	10 (SD = 3)	10.3	2.8	4-17
Inhibition & Cognitive Flexibility	CW Inhibition	10 (SD = 3)	9.8	2.7	3-17
	CW Switching	10 (SD = 3)	10.0	2.1	5-15
Planning and Problem Solving	Tower Overall achievement	10 (SD = 3)	10.4	1.8	7-15
Complex Information Processing	Trails Part B Total Time	49.8 (SD = 15.2)	73.4**	25.7	30-138
General Ability	VIQ	100 (SD = 15)	104.0	13.9	78-135
	PIQ	100 (SD = 15)	106.2**	10.0	84-127
	FSIQ	100 (SD = 15)	105.7**	11.5	85-129
Sustained Attention	Cancellation Time	100 (median)	104.3 (median =103.5)	19.4	69-151
	Omissions	1 (median)	3.1* (median =2)	4.1	0-17

5.3.4 Driving Related Assessments

As explained previously, participants took part in three different driving assessments. For the *On-Road Driving* assessment, each participant received an overall mark (between 0 and 1) for the dependent variables *Search, Speed Choice*, *Direction Control* and a c*omposite* score for their driving performance (a higher score indicated a better driving performance). As can be seen in *Table 5.3.2,* at baseline, for the sample as a whole, participants performed most poorly at *Search* behaviour, followed by *Speed choice* and *Directional Control*. There were significant differences between these scores, χ^2 (2)=21.01, N= 36, p<0.01 and post hoc tests indicated that participants obtained significantly higher scores on *Direction Control* compared to *Speed Choice*, Z=-2.51, N=36, p<0.05, or *Search*, Z=-4.65, N=36, p<0.01. In addition the scores obtained for *Speed Choice* were significantly greater than that for *Search,* Z=-4.30, N=36, p<0.01. However, there were no significant differences between the scores obtained by males and females on this task.

Table 5.3.2 Performance for the *On-Road Driving* assessment at baseline

	Overall (N=36) Mean (SD)	Males (N=23) Mean (SD)	Females (N=13) Mean (SD)
Search	.71 (.2)	.71 (.1)	.71 (.2)
Speed Choice	.79 (.2)	.78 (.2)	.81(.2)
Direction Control	.85 (.1)	.85 (.1)	.86 (.1)
Composite	.78 (.1)	.78 (.1)	.79(.2)

As explained in the Method section, the *Driving Self Assessment* provided an average of the difference between the participants and instructors driving assessment scores. Where the participant more often under rated their own performance the overall average was negative. Conversely, when the participant more often over rated their performance the overall average was positive.

Analysis revealed that overall, participants were more likely to over rate their driving abilities, with 20 of the 36 (55%) participants having an average percentage difference of between zero and plus 35. There was no statistically significant difference between males and females in relation to their overall rating differences (Mean % difference for males=6.4, females 0.7).

When examined on a question by question basis only Question 6 revealed a significant difference between males and females (Did your hands remain in the correct position throughout the drive?) revealed a statistically significant difference, t(34)=2.5, p<0.05. *Table 5.3.3* presents the Mean percentage difference scores (and Standard Deviations) for each question for all participants and for males and females separately.

Table 5.3.3 Average agreement in scores between participants and instructors in the *Driving Self Assessment* (*=p<.05)

Question	Overall Mean %Diff. (SD)	Males Mean % Diff. (SD)	Females Mean % Diff.(SD)
Q. 1	0 (16.9)	2.17 (16.7)	-3.8 (17.2)
Q. 2	2.8 (19.6)	2.17 (18.3)	3.8 (22.5)
Q. 3	4.2 (22.0)	8.7 (17.8)	-3.8 (26.7)
Q. 4	6.1 (11.6)	6.9 (11.5)	4.6 (12.0)
Q. 5	2.1 (22.7)	7.6 (19.1)	-7.7 (25.8)
Q. 6	-7.6 (18.7)	-2.7* (18.3)	-17.3* (15.8)
Q. 7	6.7 (15.9)	8.7 (16.9)	3.1 (13.8)
Q. 8	7.3 (14.5)	8.8 (16.9)	4.6 (8.8)
Q. 9	5.6 (12.3)	6.1 (14.1)	4.6 (8.8)
Overall	4.3 (10.8)	6.4 (11.5)	0.7 (8.5)

Note: Q1=Do you think your speed was appropriate at all time? Q2=Did you indicate correctly and when required at all times? Q3=Were you scanning constantly throughout your drive? Q4=Did you think your management (road position, cornering braking) of the car was? Q5=Was your following distance appropriate throughout your drive? Q6=Did your hands remain in the correct position throughout your drive? Q7=How do you rate your reactions to driving situations? Q8=How do you rate your confidence as a driver? Q9=Overall how would you rate your driving skills? (1=Poor, 2=Below Average, 3=Average, 4= Above Average, 5=Excellent)

The *Road Commentary* assessment required the participants to conduct a running commentary of immediate hazards and driving behaviour required in relation to unfolding conditions shown on the video. Scores obtained for each participant included the number of immediate hazards observed, safety action taken in relation to the hazards and safety actions taken not related to hazards. From *Table 5.3.4* it can be seen that more hazards were identified compared to actions in relation to hazards or non hazards. There were no significant differences in the number of hazards detected between males and females.

Table 5.3.4 Performance in the road commentary assessment at baseline

Number of	Overall Mean (SD)	Males Mean (SD)	Females Mean (SD)
Hazards detected	9.21 (5.0)	9.67 (5.0)	8.46 (5.0)
Actions to hazards	5.09 (3.8)	5.70 (4.6)	4.15 (2.1)
Action to Non Hazard	6.26 (3.4)	6.32 (3.0)	6.15 (4.1)

5.3.5 The association between executive function, general ability, sustained attention and the driving related assessments

For all analyses, correlation coefficients are presented in the Tables, not in the text. All analyses were initially conducted with anxiety scores as a covariate, but this was found not to have a statistically significant influence on the results. Thus, the analyses that are presented do not include anxiety as a covariate. However, *anxiety* alone was found to have a significant influence on the driving related results (see *Figure 5.3.1* below and *Table 8.5.2 in Appendix* 8.5 for means and correlation coefficients). In the on road driving assessment, anxiety correlated significantly and positively with speed choice, suggesting that those with higher levels of anxiety drove at more appropriate speeds. Furthermore, the differences between those in the upper and lower quartiles of scores on the BAI approached significance with regard to appropriate Speed choice, Z=-1.90, N=18, p<0.1, and Search, Z= -1.90, N=18, p<0.1, and the Composite score , Z = -1.68, N=18, p<0.1. Thus, those with high levels of anxiety were tended to be better at both the speed choice and search components of the practical driving task compared to those with lower anxiety scores (see *Figure 5.3.1*). For the driver self assessment, scores on the BAI were negatively correlated with the average difference between the participant and instructors rating on the self assessment task. This suggests that higher BAI scores were associated with participants rating their performance more similar to that of the instructor, whilst those with lower anxiety scores over estimated their driving performance. There were no statistically significant relationships between anxiety and the participants' performance on the road commentary at baseline. The correlation coefficients are summarised in *Table 8.5.2 in Appendix* 8.5.

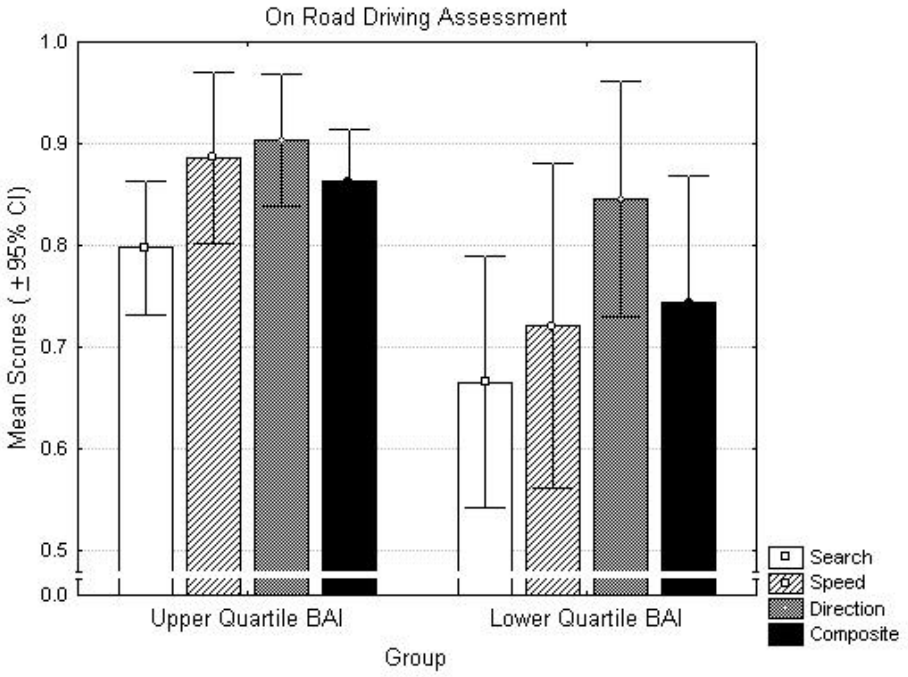


Figure 5.3.1 The effect of Anxiety on performance in the On-Road Driving assessment

With regard to executive functions, *working memory*, (digits backwards), correlated significantly with search behaviour on the driving assessment (see *Table 5.3.5a* for the correlation coefficients and descriptive statistics). In addition, those in the upper quartile of scores on working memory obtained significantly higher scores for search, Z = -2.57, N=18, p<0.01, compared to those with the lower quartile scores. Also, the difference between the upper quartile and lower quartile working memory groups approached significance for the composite score Z=-1.90, N=18, p<0.1 (see *Table 5.3.5.a and Figure 5.3.*2). The correlations between working memory, speed choice and the composite score on the driving assessment were consistent with these results.

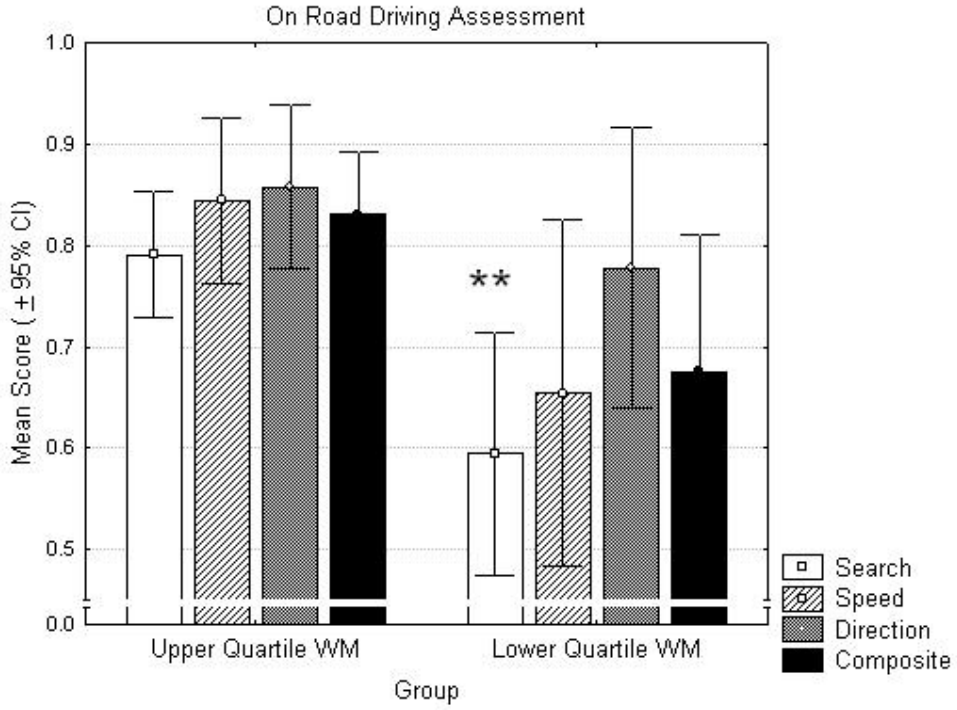


Figure 5.3.2 The effect of Working Memory on performance in the On-Road Driving Assessment (* = p<0.01 from upper quartile working memory group)

Verbal fluency scores showed no significant relationship with any of the driving related measures. As can be seen in Table 5.3.5a, all correlations involving verbal fluency were low (<.2). In contrast, with regard to *cognitive switching* (between categories) there were significant differences between those in the upper and lower quartiles for speed choice, Z= -1.95, N=18, p= 0.50, and direction control, Z= -2.17, N=18, p<0.05, whilst the difference between the composite driving assessment score approached significance, Z= -1.77, N=18, p<0.1. In keeping with this there were significant positive correlations between cognitive switching with both the speed choice and the composite score from the driving assessment (see *Table 5.3.5a*). In addition, there was a significant difference between those obtaining scores in the upper and lower quartiles of the cognitive switching task with regard to the number of action related to non

hazards in the road commentary, t(10.8)=2.18, p<0.05; those in the upper quartile reported a significantly greater number of actions to non hazards. However, the correlations between cognitive switching and the other driving related measures (self assessment, actions to hazards) were not statistically significant.

Inhibition (measured by the Colour Word Interference Task, see *Table 5.3.5b*) correlated significantly and positively with actions to hazards in the road commentary. Furthermore, those obtaining scores in the upper quartile reported a significantly greater number of actions to hazards compared to those in the lower quartile, t(9.74)=2.43, p<0.05. The other driving related measures showed little relationship with inhibition as evidence by the correlations which were generally low. The more complex assessment of *inhibition and switching* (Colour Word Switching) showed no statistically significant relationship with the driving assessments.

Similar results were obtained for *forward planning* and *problem solving* (Tower Test), that is, there were no statistically significant relationships between this measure and the driving assessments (see *Table 5.3.9.c*). Indeed, all the correlations were low. However, those scoring in the upper quartile on the *complex information processing* (Trails) over rated their driving ability significantly more than those in the lowest quartile, t(16)=2.14, p<0.05. In addition, poorer performance on this task was associated with increased reporting of actions to hazards in the road commentary. Furthermore, those obtaining scores in the upper quartile of this task stated significantly fewer action to hazards compared to those in the lower quartile, t(13)=2.32, p<0.05.

General ability (FSIQ) showed significant positive correlations with visual search, speed choice and the composite score on the practical driving task (see *Table 5.3.5d)*. In addition, those in the upper quartile of *FSIQ* performed better (approaches significance) on the search, Z = -1.68, N=18, p<0.1, and speed choice, Z=-1.72, N=18, p<0.1, components of the practical driving assessment compared to those obtaining FSIQ scores in the lowest quartile. These effects appeared to be partly due to the contribution of the *verbal component* of the general ability score, as this also correlated significantly with speed choice and the composite score of the driving assessment, and high VIQ scorers obtained significantly better scores on the speed choice component of this task compared to those with in the lower VIQ quartile, Z= -2.12, N=18, p<0.05, whilst the differences between the scores for search Z=-1.77, N=18, p<0.1, and the composite score, Z=1.90, N=18, p<0.1 approached significance (see *Figure 5.3.3*).

The overall general ability measure and the two subscales showed significant positive correlations with the average difference score in the driver self assessment. In addition, those in the upper quartile of general ability, t(16)=3.13, p<0.01, and the verbal, t(16)=2.38, p<0.05 and performance subscales, t(16)=3.13, p<0.01, rated their driving performance significantly less well compared to those in the lowest quartiles. In fact they were more accurate in their self evaluations.

For the road commentary, the verbal aspect of general ability correlated significantly and positively with the number of hazards detected, whilst the performance aspects correlated significantly with actions to hazards. In addition, those in the upper quartile of PIQ reported significantly more actions in relation to hazards compared to those in the lowest quartile, $t(16)=3.00$, $p<0.01$. However, FSIQ was not significantly related to the hazard detection measures.

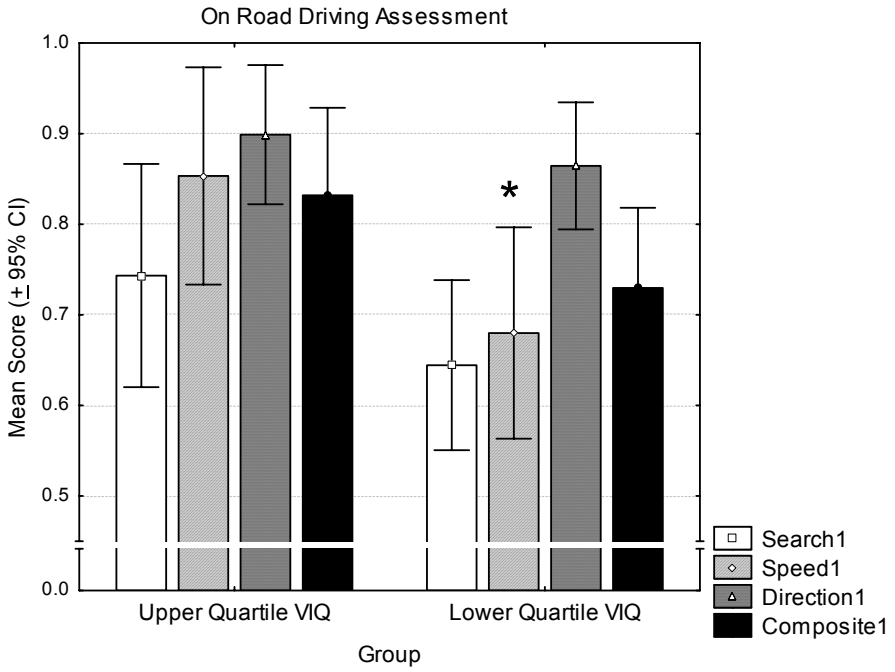


Figure 5.3.3 The effect of VIQ on performance in the On-Road Driving assessment.
* $p<0.05$ compared to upper quartile VIQ

Sustained attention also appeared to be an important factor in the driving assessments. More specifically, omissions on the Letter Cancellation task correlated significantly and negatively with performance on the speed choice, direction control and composite score for the driving assessment (see *Table 5.3.5e*). Also, those making the highest number of omissions obtained a significantly lower score on the direction control aspect of the driving assessment compared to those in the lowest quartile, $Z=-2.39$, $N=18$, $p<0.05$. Omissions also correlated significantly and positively with the average difference on the driver self assessment, suggesting that higher omissions (poorer sustained attention) were related to greater over estimation of driving behaviour.

Table 5.3.5a The relationship between Executive Functions (*working memory* and *verbal fluency*) and the Driving Related Assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$)

	Digits Backwards			Verbal Fluency			Verbal Fluency Switching		
	R (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On Road Driving									
Search	.33*	.79(.08)	.59(.2)*	.15	.70(.2)	.71(.2)	.23	.76(.2)	.66(.2)
Speed Choice	.25	.84(.1)	.65(.2)*	.18	.80(.2)	.79(.2)	.36*	.87(.2)	.71(.2)
Direction Control	.10	.86(.1)	.78(.2)	-.10	.84(.1)	.87(.1)	.30	.91(.1)	.81(.1)
Composite	.25	.83(.1)	.68(.2)*	.10	.78(.1)	.79(.2)	.33*	.85(.1)	.73(.2)
Driver Self Assessment									
Average Difference	-.31	1.22(12.2)	9.12(13.3)	-.11	8.12(9.1)	8.4(11.2)	-.27	.60(7.4)	7.15(8.1)
Road Commentary									
Hazards detected	.05	9.5(4.2)	7.88(5.1)	-.03	9.38(2.3)	9.22(5.8)	.30	10.22(5.2)	7.33(4.1)
Action to Hazard	.28	7.88(5.4)	4.50(4.0)	.15	4.63(2.8)	4.71(4.3)	.21	5.00(3.0)	3.14(2.0)
Action to Non Hazard	.01	5.78(1.6)	6.44(3.0)	.13	7.44(4.1)	7.38(4.3)	.29	7.33(4.1)	4.13(1.6)*

Table 5.3.5b The relationship between Executive Functions (*Inhibition* and *Inhibition / switching)*) and the Driving Related Assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$)

	Colour Word Interference			Colour Word Switching		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On Road Driving						
Search	-.01	.70(.1)	.68(.2)	.08	.69(.2)	.69(.2)
Speed Choice	.01	.78(.1)	.79(.2)	.15	.82(.2)	.77(.2)
Direction Control	-.05	.78(.08)	.86(.2)	-.11	.84(.1)	.87(.1)
Composite	-0.02	.75(.1)	.78(.2)	.06	.78(.1)	.78(.2)
Driver Self Assessment						
Average Difference	.15	8.54(11.1)	.51(9.2)	-.11	4.03(6.6)	4.79(9.4)
Road Commentary						
Hazards detected	-.13	9.11(3.9)	11.11(5.6)	.05	7.89(3.6)	8.50(6.5)
Action to Hazard	.34*	8.11(5.5)	3.44(1.8)*	.12	4.75(2.32)	4.57(2.7)
Action to Non Hazard	-.08	6.67(3.2)	7.44(3.8)	-.27	6.00(4.0)	8.89(4.2)

Table 5.3.5c The relationship between Executive Functions (f*orward planning* and *complex information processing)*) and the Driving Related Assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles (*=p<0.05)

	Tower Test			Trails		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On-Road Driving						
Search	-.13	.71(.2)	.72(.1)	-.16	.66(.2)	.72(.2)
Speed Choice	-.09	.80(.2)	.78(.2)	-.24	.72(.2)	.83(.2)
Direction Control	-.06	.86(.2)	.83(.1)	.02	.83(.2)	.81(.1)
Composite	-.10	.79(.1)	.78(.1)	-.15	.74(.2)	.79(.1)
Driver Self Assessment						
Average Difference	.07	.67(9.9)	4.38(11.5)	.24	9.54 (9.1)	0.00 (9.8)*
Road Commentary						
Hazards detected	.01	9.75(5.3)	9.38(5.5)	-.15	7.38(5.2)	9.33(4.4)
Action to Hazard	-.14	4.00(1.8)	5.67(3.0)	-.37*	3.00(1.7)	7.44(4.4)*
Action to Non Hazard	-.24	4.22(1.7)	6.63(3.5)	.05	6.8(3.0)	6.78(3.3)

Table 5.3.5d The relationship between General Ability and the Baseline Driving Related Assessments. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$)

	FSIQ			VIQ			PIQ		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On Road Driving									
Search	.38*	.76(.2)	.63(.2)	.31	.74(.2)	.64(.1)	.30	.76(.2)	.65(.1)
Speed Choice	.45*	.85(.1)	.66(.2)*	.42*	.85(.2)	.68(.2)*	.30	.82(.2)	.71(.2)
Direction Control	.16	.88(.1)	.82(.2)	.08	.90(.1)	.86(.1)	.18	.84(.1)	.81(.2)
Composite	.38*	.83(.1)	.71(.2)	.32*	.83(.1)	.73(.1)	.29	.81(.1)	.72(.2)
Driver Self Assessment									
Average Difference	-.44*	-2.39 (8.0)	11.41 (10.6)*	-.40*	-.72 (10.4)	11.73 (11.8)*	-.35*	-3.50 (7.1)	8.29 (8.8)*
Road Commentary									
Hazards detected	.31	11.11(4.4)	8.6(6.9)	.37*	10.44(5.1)	6.86(7.2)	.09	10.22(3.6)	7.25(4.1)
Action to Hazard	.27	6.89(5.0)	4.88(3.9)	.15	4.33(1.9)	4.86(4.3)	.39*	8.11(4.7)	3.11(1.8)*
Action to Non Hazard	-.09	6.00(3.2)	6.00(3.3)	-.02	5.67(3.2)	7.22(4.4)	-.13	5.78(3.5)	6.89(4.70)

Table 5.3.5e The relationship between Sustained Attention and the Baseline Driving Related Assessments. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. *= p<0.05, indicates a significant correlation, or a significant difference between the upper and lower quartiles

	Letter Cancellation			Letter Cancellation Omissions		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On Road Driving						
Search	-.11	.71(.2)	.71(.1)	.21	.65(.2)	.65(.1)
Speed Choice	-.07	.79(.2)	.79(.2)	-.36*	.69(.2)	374(.1)
Direction Control	.10	.89(.2)	.83(.1)	-.47*	.74(.1)	.89(.1)*
Composite	-.04	.79(.2)	.78(.1)	-.38*	.70(.2)	.76(.1)
Driving Self Assessment						
Average Difference	-.01	6.90(8.6)	8.34(10.8)	.39*	9.96(9.2)	5.62(9.3)
Road Commentary						
Hazards detected	.03	10.50(6.6)	8.38(4.5)	.05	9.25(5.7)	8.75(5.5)
Action to Hazard	-.07	4.43(2.6)	4.38(1.7)	-.01	6.29(5.8)	4.00(2.4)
Action to Non Hazard	.19	8.13(3.7)	6.11(3.3)	.07	6.67(3.3)	7.25(4.8)

5.4 SUMMARY PART 2

The aim of this section was to examine the relationship between executive functions, general ability and sustained attention with the driving related assessments.

On the most part, our participants performed on executive functions at a level similar to those described in other studies except they performed more poorly on the tasks which assessed working memory and complex information processing. There were significant gender differences on a number of measures including males performing more poorly on verbal fluency, inhibition, complex information processing and both parts of the sustained attention task. With regard to the driving related assessments, there were no significant differences between the performance of males and females.

With regard to the relationship between executive functions and the driving related assessments, higher working memory scores were related to better scores on search behaviour on road driving assessment. Better cognitive switching was related to better speed choice and direction control in the on road driving assessment and greater hazard detection. Higher inhibition scores were related to a higher number of actions to hazards, whilst the combined

inhibition and switching score only linked to actions to non hazards. Higher complex information processing ability was linked to more accurate self evaluations and fewer actions to hazards.

General ability (in particular VIQ) was positively related to several of the driving related assessments including search, speed choice and the composite scores from the on road driving assessment and more accurate self evaluations. Higher VIQ was linked to hazards detected in the road commentary, whilst higher PIQ related to actions to hazards.

Sustained attention also linked to the on road assessment and the self evaluations. Higher levels of sustained attention were generally related to better scores on the on road driving assessment and more accurate self evaluations.

Together, this suggests that general ability (particularly VIQ) and cognitive switching were most closely linked to practical driving performance. However, some executive functions, in particular working memory, inhibition and complex information processing, also appeared to show some relationship with driving performance. This exploratory study suggests there is promise in looking at this further with a larger sample size.

As there were no specific questions in our Aims regarding the relationship between questionnaire responses and performance on the driving assessment, these data are presented in Appendix 8.4.

5.5 RESULTS PART 3

Aim 3: To assess the effects of higher level and vehicle handling skills training on participants' driving performance, confidence levels, and attitudes to risk taking behaviour

The third aim of the study will be addressed by comparing the baseline data from the driving related performance (on-road driving and road commentary), confidence and attitudinal questionnaires from each of the three training groups (higher level, vehicle control and control group), with the corresponding data after the training in week 1 (post training). One participant was sick in the first week and his data was not included in the higher level training group.

5.5.1 On-Road Driving Performance

The effect of the training on the *on-road driving* performance can be seen in the figures below for the three dependent variables *Search* (Figure 5.5.1), *Speed Choice (Figure 5.5.2) Direction Control (Figure 5.5.3 and the Composite* score (Figure 5.5.4). Visual inspection of these figures shows considerable improvements in all dependent variables for both types of training (higher level and car control) and only a small increase in the score in *Search* for the control group. The mean baseline values for all variables were slightly larger for the vehicle control group compared to the higher level and control group, but this difference was not significant. All groups obtained the highest mean baseline values for *Direction Control* and the smallest mean baseline score for *Search*.

As previously mentioned, the variables of the *On-Road Driving* performance *(Search, Speed Choice, Direction Control* and *Composite* score) were not normally distributed and therefore separate, non parametric Wilcoxon signed ranks paired tests were used to test for any statistically significant training effects.

These tests revealed that higher level driving training significantly improved *Search* ($Z=-2.139$, $N=11$, $p<0.05$) and the *Composite* score ($Z= -2.046$, $N=11$, $p<0.05$) while vehicle handling skills training led to significant improvements in *Speed Choice*, $Z=-2.432$, $N=12$, $p<0.05$), *Direction Control* ($Z=-1.989$, $N=12$, $p<0.05$) and the *Composite* score ($Z= -2.708$, $N=12$, $p<0.05$). There were no significant improvements for the control group in any of the variables.

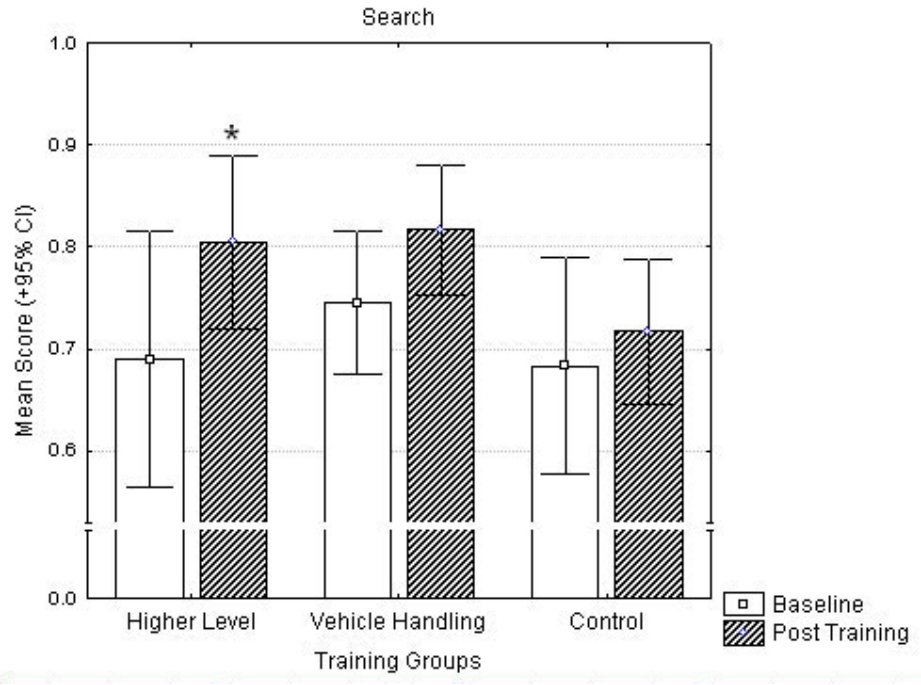


Figure 5.5.1 Effect of training on *Search* (CI=Confidence Interval, *=p<0.5)

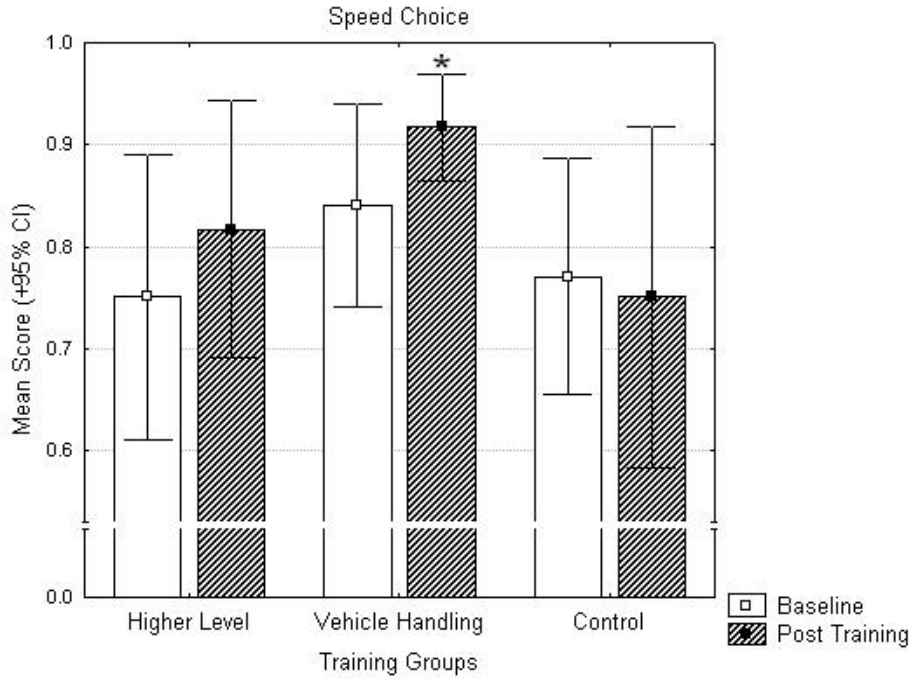


Figure 5.5.2 Effect of training on *Speed Choice* (*=p<0.5)

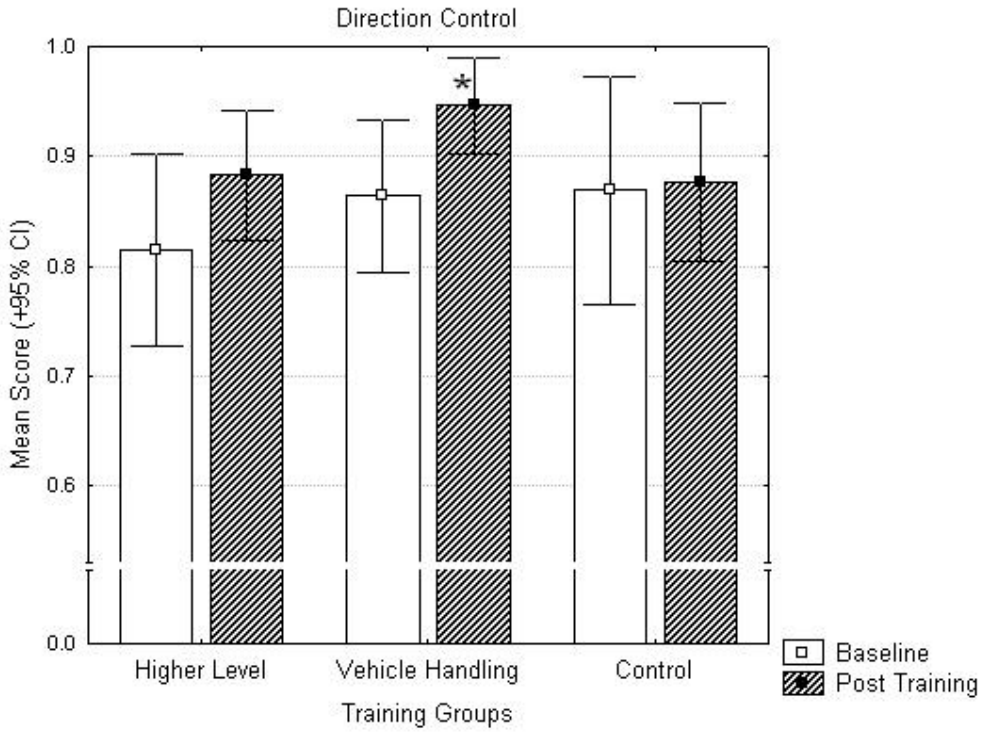


Figure 5.5.3 Effect of training on *Direction Control* (*=p<0.05)

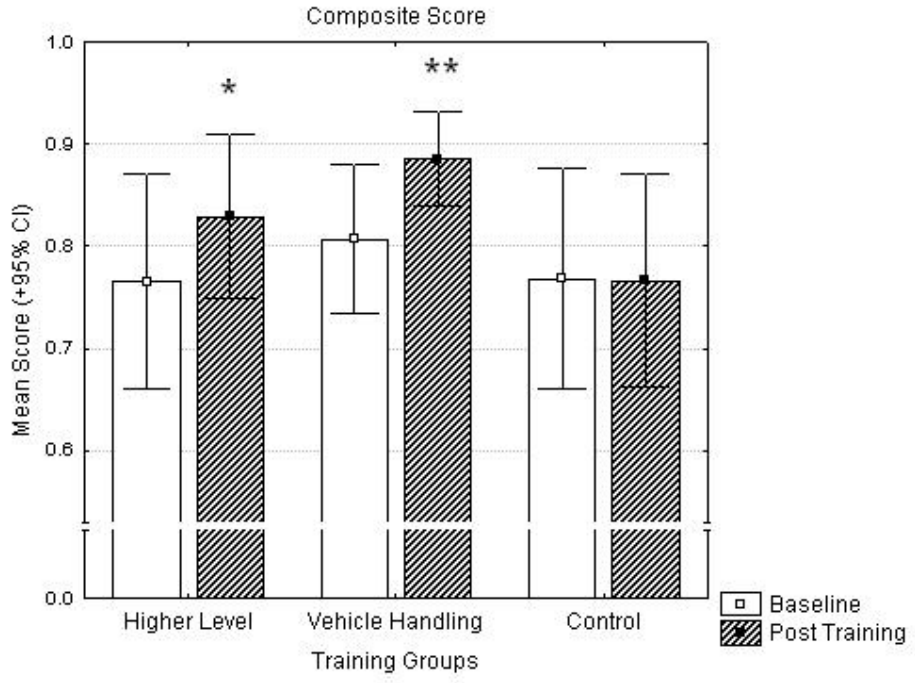


Figure 5.5.4 Effect of training on the *Composite* score (*=p<0.05, **=p<0.01)

5.5.2 Road Commentary

The video based *road commentary* assessment was conducted before the training (Baseline and after the training (Post Training) for the participants in all three groups (higher level, vehicle control and control). Each assessment provided three dependent variables, mean percentage of number of hazards detected, mean percentage of actions in response to the hazards, and mean percentage of actions in relation to non hazards.

The effect of training can be seen on the figures below for the percentages of hazards detected (see Figure 5.5.5), actions in response to the hazards (Figure 5.5.6) and actions in response to non-hazards (Figure 5.5.7). As indicated by these figures, both training (higher level and vehicle control) improved the mean percentage of hazards detected and the mean percentage of actions in response to the hazards, but the improvement was larger after the higher level skills training. There is no improvement visible for the control group for either of these two variables. All three groups decreased the mean percentage of number of actions to non-hazards.

Non parametric Wilcoxon signed ranks tests confirmed a statistically significant improvement only for the higher level group in regard to the percentage of hazards detected ($Z= -1.988$, $N=10$, $p<0.05$). Conversely, Figure 5.5.7 shows a decrease in the percentage of number of actions in relation to non hazards for all groups, but this decrease was only significant for the control group ($Z=-1.988$, $N=10$, $p<0.05$).

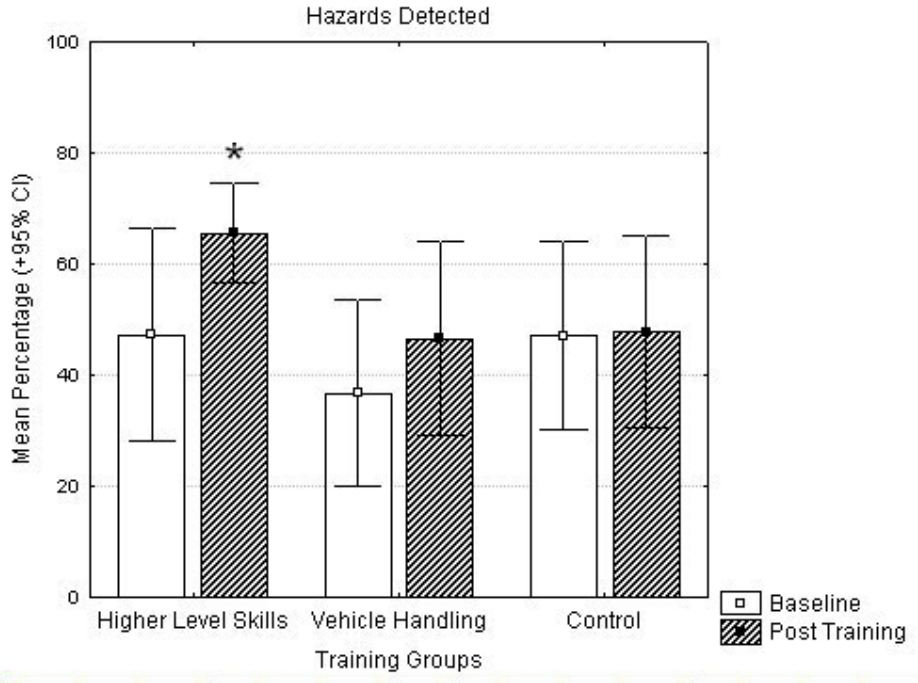


Figure 5.5.5 Effect of training on the mean percentage of hazards detected (*=p<0.05)

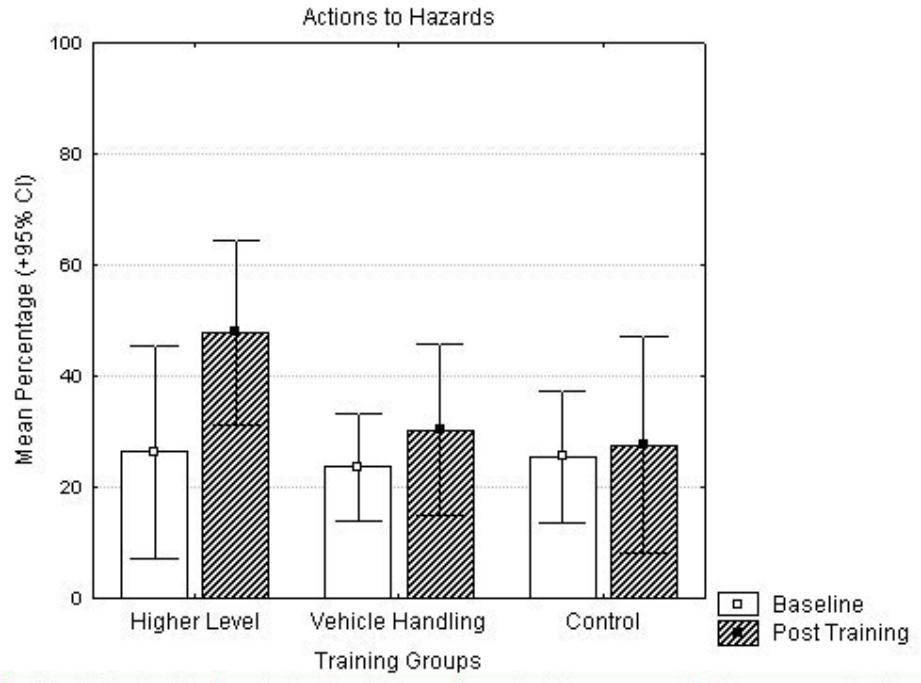


Figure 5.5.6 Effect of training on the mean percentage of actions in response to hazards

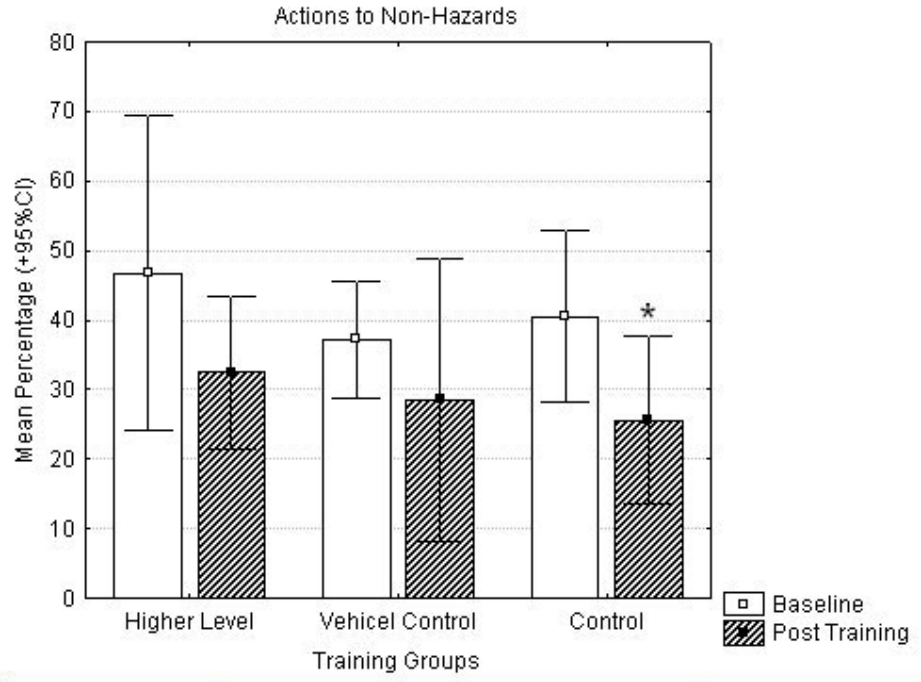


Figure 5.5.7 Effect of training on the mean percentage of actions to non-hazards (p*=p<0.05)

5.5.3 Driver Confidence Questionnaire

With regard to *driver confidence* as assessed by the *Confidence 1* questionnaire (see Appendix 8.3), a total score was obtained for all participants in each of the three training groups (higher level, vehicle control, and control) before the training (Baseline) and after the training (Post Training). Figure 5.5.8 shows that only the higher training decreased the overall confidence level of the participants.

A 2 (time) x 3 (training groups) repeated measures ANOVA revealed a significant interaction between type of training and time, $F(2,32)=3.2$, $p<0.05$. Further post hoc analysis (Scheffe's) revealed that higher level skills training significantly decreased confidence (participants reported feeling more unsafe, $p<0.05$). These participants reported feeling significantly less safe than either the vehicle handling group ($p<0.05$) or the controls ($p<0.05$). In this comparison, however, it has to be pointed out that the vehicle handling and the control group had already felt a little safer at Baseline (although not significantly) compared to the higher level group.

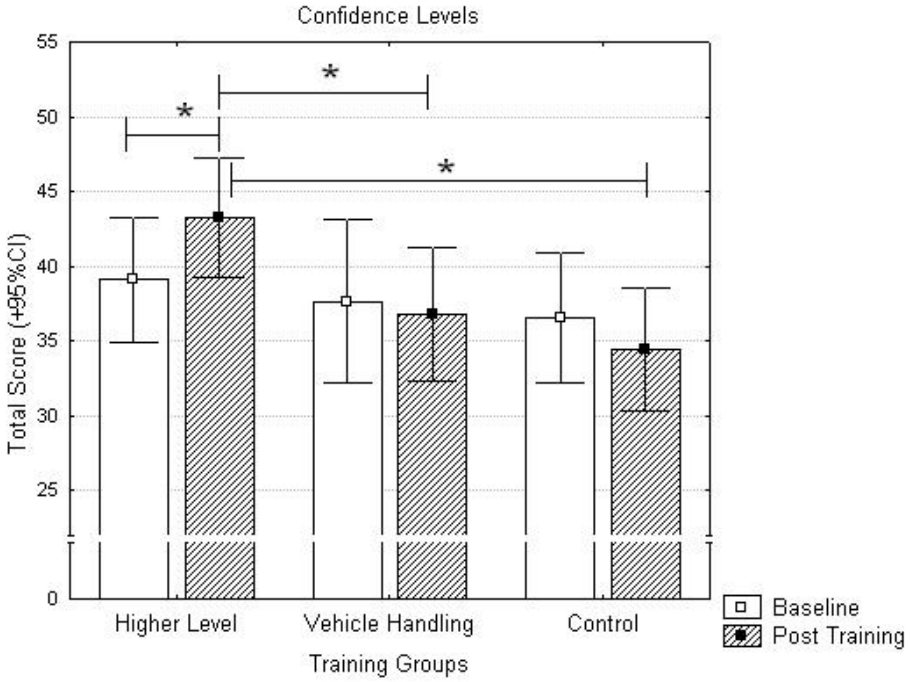


Figure 5.5.8 Effect of training on driving confidence levels
(larger scores mean lower levels of confidence - feeling less safe; *=p<0.05)

Examination of the data revealed that the decrease in confidence was mainly due to alterations in how confident participants felt when driving at 110km/h and 120 km/h. Analysis revealed a significant interaction between training groups and confidence rating before and after training when speeding at 110km/h, $F(2, 30)=3.53$, $p<0.05$.

Further post hoc analysis (see also *Figure 5.5.9*) showed that this was explained by a significant decrease in feelings of safety when driving at 110 km/h following higher level driver

training ($p<0.05$). In addition, those participants in the higher level group reported feeling significantly more unsafe than controls after the training ($p<0.05$). The vehicle handling group also felt less safe after the training but this effect did not reach statistical significance.

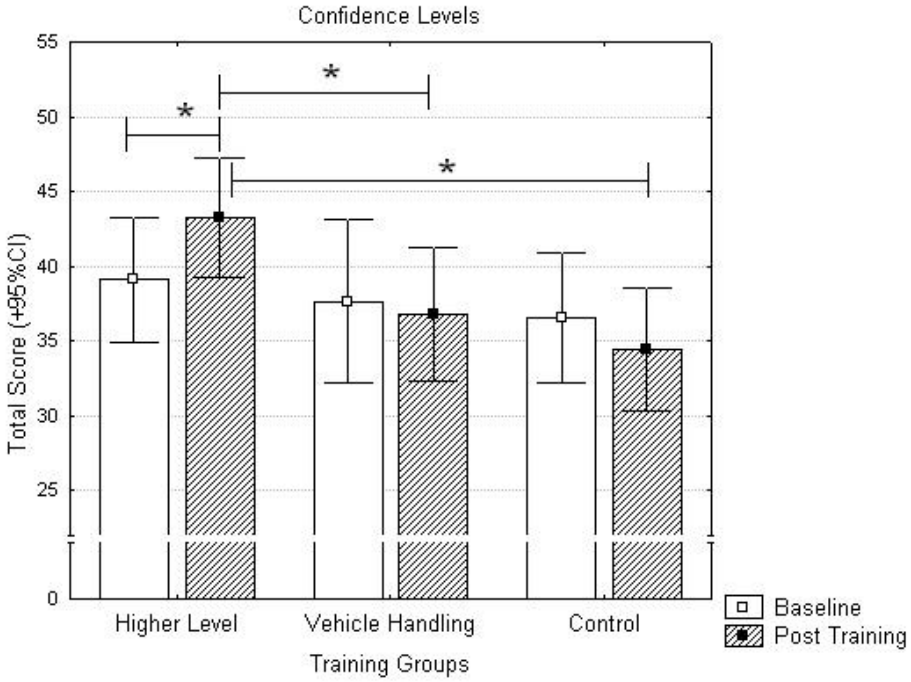


Figure 5.5.9 Effect of training on confidence levels when driving at 110 km/h

There was also a highly significant interaction between training groups and confidence rating before and after training when speeding at 120km/h, $F(2,30)=5.1$, $p<0.01$. These data are presented in *Figure 5.5.10.* Post-hoc tests revealed that this was due to the higher level driving skills group feeling significantly less safe driving at 120km/h after the training ($p<0.05$). In addition, this group reported feeling significantly less safe after training than the controls ($p<0.05$). Those in the vehicle handling group also showed a decrease in their feeling of safety, which approached significance ($p<0.1$)

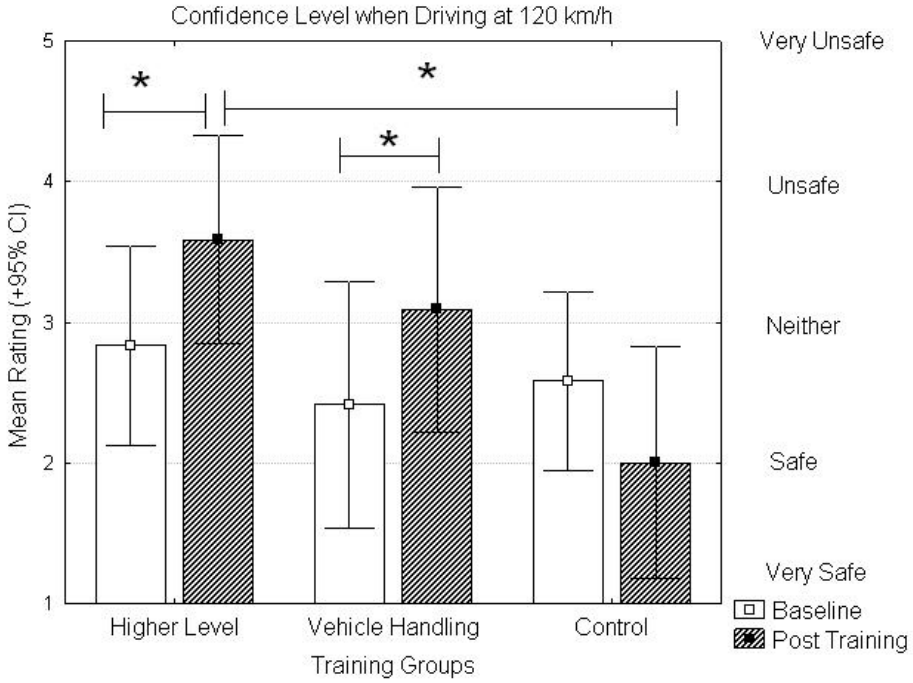


Figure 5.5.10 Effect of training on confidence levels when driving at 120 km/h (*=p<0.05)

5.5.4 Driver Attitudes

With regard to participants' *attitudes* as assessed by the *Driver Attitude* questionnaire (DAQ) questionnaire (see Appendix 8.3), a total response score was received for all participants in each of the three training groups (higher level, vehicle control, and control) before the training (Baseline) and after the training (Post Training). Visual inspection of Figure 5.5.11 indicates that only higher level skills training decreased the total response score for driver attitudes.

A 2 (time) x 3 (training groups) repeated measures ANOVA on the attitude total response scores revealed a significant interaction between type of training and time, $F(2,32)=4.1$, $p<0.05$. Further post hoc tests (Scheffe's) confirmed that only higher level skills training significantly decreased the total response score for driver attitudes ($p<0.05$), suggesting that training in higher level driving skills generally led to a more positive driver attitudes.

The effect of training was then examined on the 4 subscales of the *Driver Attitude* questionnaire *(close following, overtaking, speeding and drink driving).* Figure 5.5.12 and Figure 5.5.13 show an improvement of attitudes (safer) to *close following* and *overtaking* only for the higher level groups. Figure 5.5.14 and Figure 5.5.15 show an improving of attitude to speeding in the vehicle handling group but this group had a worse attitude to speeding in the baseline compared to the other group and after the training no difference between the attitudes was visible. The training did not seem to have had an effect on the attitudes to drink driving in either groups. The attitudes of all groups were already pretty safe to drink driving before the training.

Further repeated measures ANOVAs revealed that training altered driver attitudes on both the *close following* and *overtaking* subscales of the DAQ (Close following: $F(2,32)=7.5$, $p<0.01$; Overtaking, $F(2,32)=7.2$, $p<0.01$, but not on *speeding* and *drink driving.* Follow-up post hoc tests showed that higher level skills training improved attitudes to *close following* ($p<0.01$) and *overtaking* ($p<0.01$) but not to *speeding* and *drink driving.*

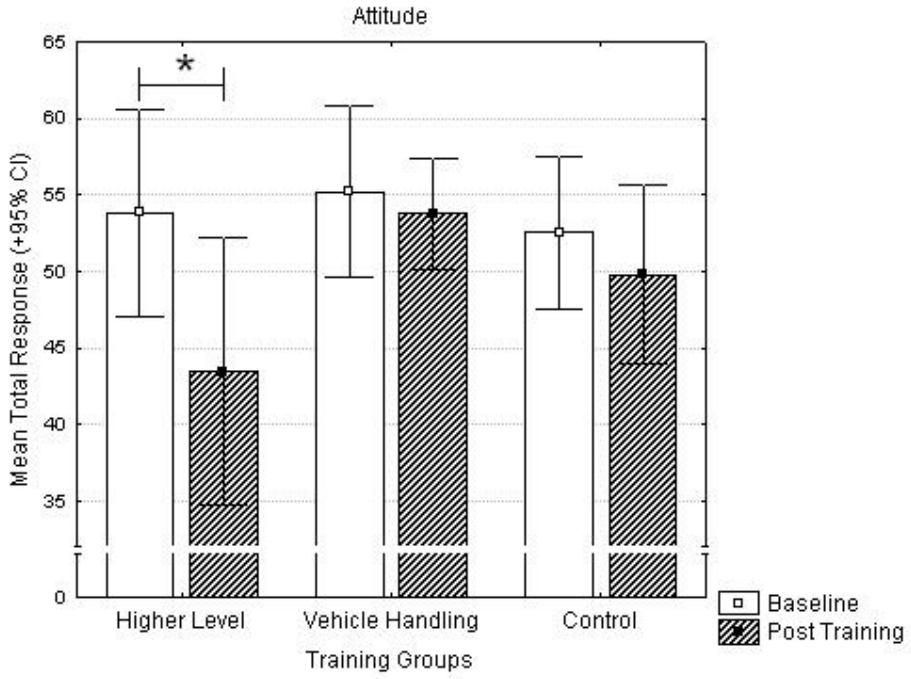


Figure 5.5.11 Effect of training on general attitude to driving
(larger values mean more unsafe (less positive) attitudes, *=p<0.05)

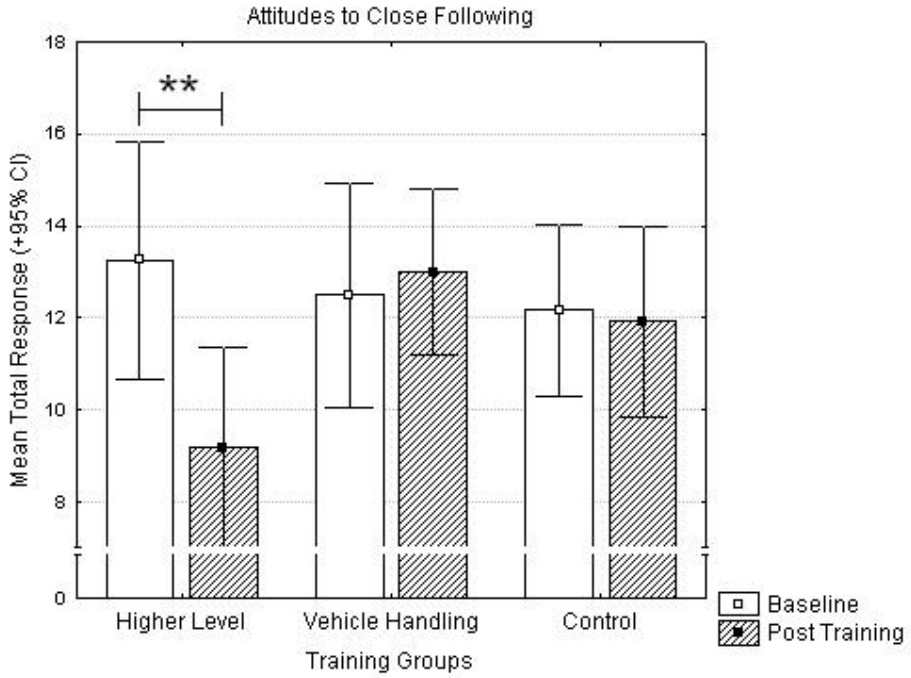


Figure 5.5.12 Effect of training on attitude to *close following* (DAQ questionnaire – larger values mean more unsafe (less positive) attitudes)

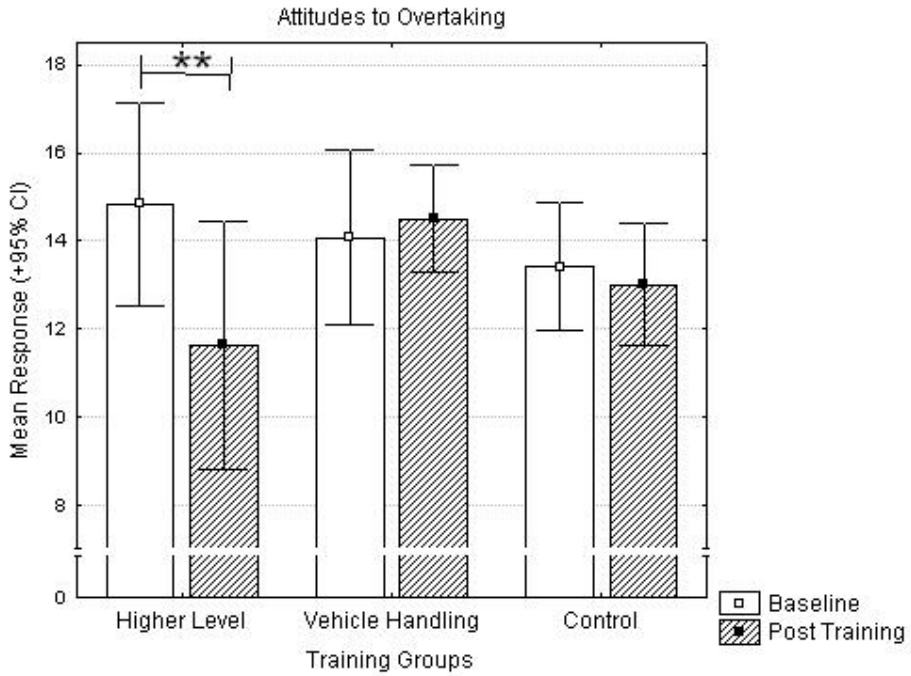


Figure 5.5.13 Effect of training on attitude to *overtaking*
(larger values mean more unsafe (less positive) attitudes)

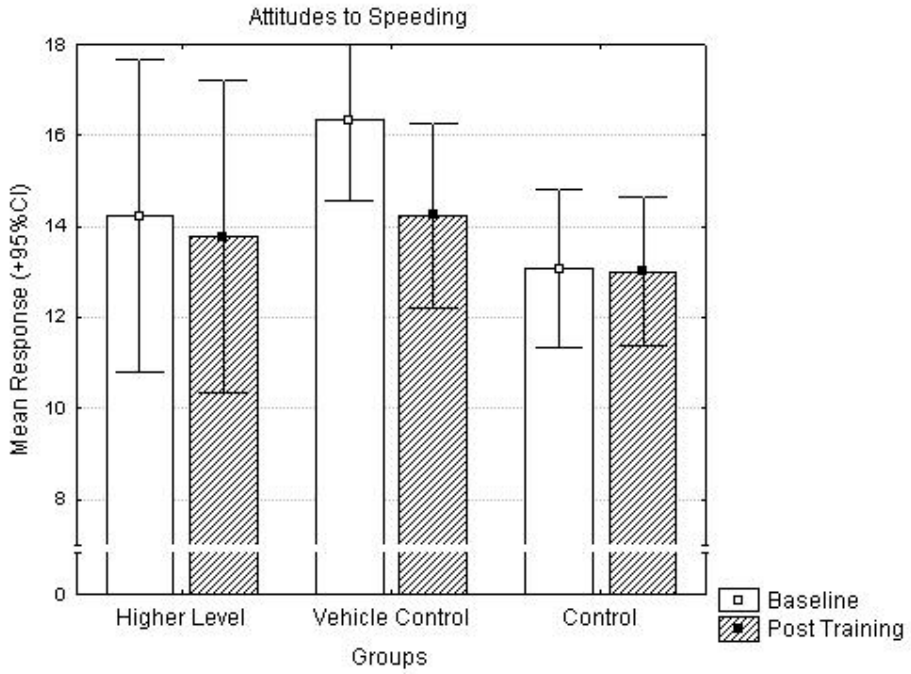


Figure 5.5.14 Effect of training on attitude to *speeding*
(larger values mean more unsafe (less positive) attitudes)

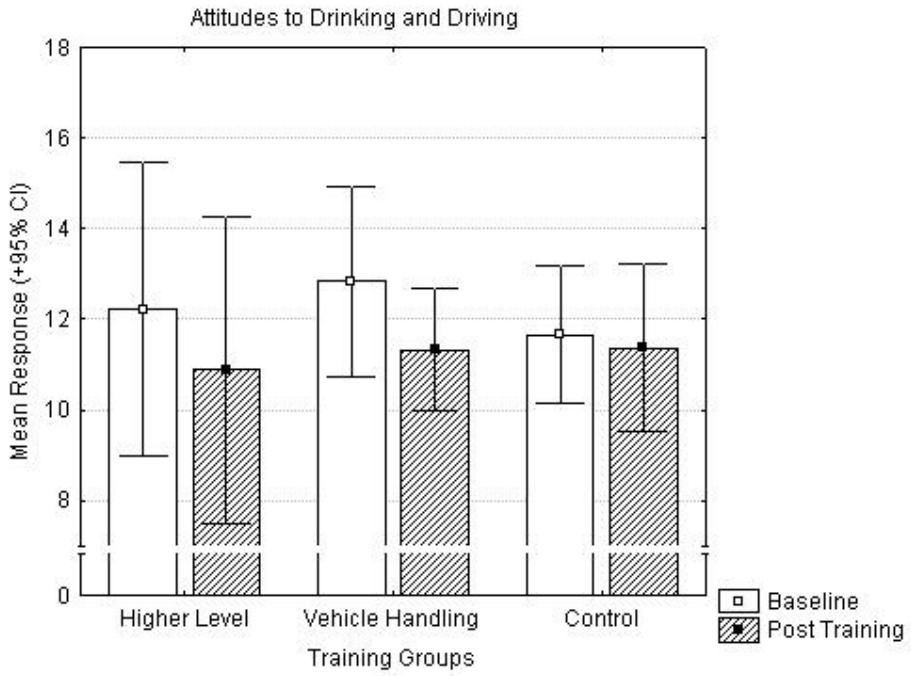


Figure 5.5.15 Effect of training on attitude to *drinking and driving* (larger values mean more unsafe (less positive) attitudes)

5.5.5 Driver Risk Taking and Driver Violations

With regard to participants' responses to the *Driver Risk Taking* questionnaire (DRT, see Appendix 8.3 - on how they felt about laws regarding risky driving behaviour being too strict or not strict enough) a total response score was obtained for each participants in each of the three training groups (higher level, vehicle control, and control) before the training (Baseline) and after the training (Post Training). Figure 5.5.16 shows that only the higher level group improved this score.

A 2 (time) x 3 (training groups) repeated measures ANOVA on the total response scores revealed a significant interaction between type of training and time, $F(2,32)=3.8$, $p<0.05$. This was explained via post hoc tests (Sheffe's) revealing a significant increase on the total response score on the DRT in the higher level skills group compared to baseline ($p<0.01$). There were no significant effects of training in either the vehicle handling or control groups. This suggests that the higher level training helped the participants appreciate the need for road laws on risky driving behaviour.

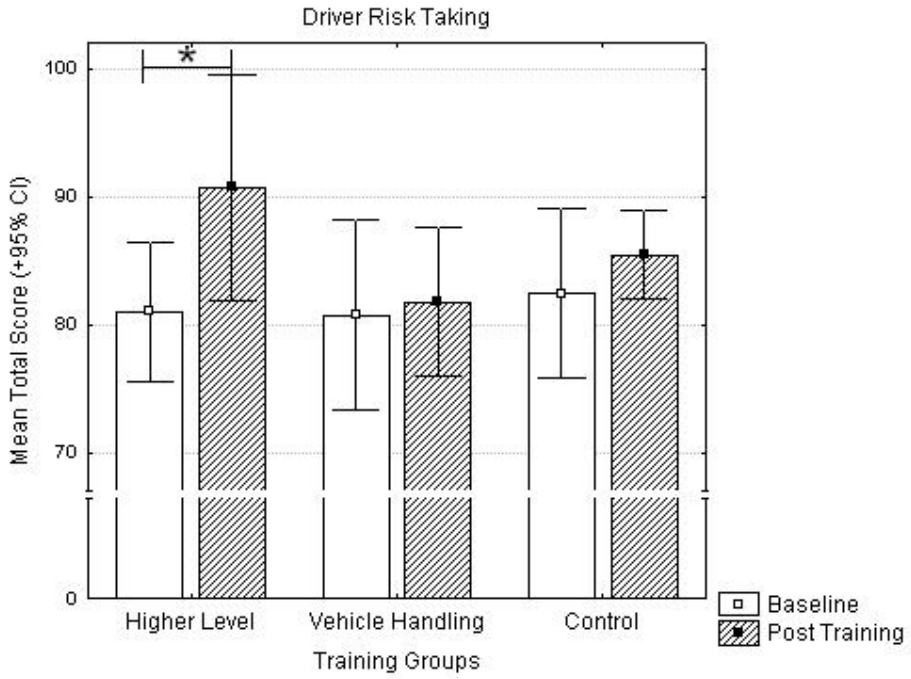


Figure 5.5.16 Effect of training on attitudes to Risk Taking (DRT questionnaire – larger values mean more safe (more positive) attitudes to risks)

No significant overall effect of time (2 (time) x 3 (training groups) repeated measures ANOVA) was found in relation to the responses of the participants to the *Driver Violations* questionnaire for any of the three training groups, however, a small non significant decrease in the overall mean total response score between baseline one and post training was found for each of the training groups. This was most pronounced but for vehicle handling group (mean total response score at baseline=13.0; post training=10.25).

5.6 SUMMARY PART 3

Part three of the results assessed the effects of training in higher level and vehicle handling skills on participants' driving performance (on-road driving and road commentary), confidence levels, and attitudes to risk taking behaviour. The on-road driving performance was assessed by experimentally 'blind' professional driver assessors who delivered three performance measures: search, speed choice and direction control. The road commentary assessment used video based traffic scenarios.

The participants received the highest baseline scores for direction control and the lowest for search, possibly indicating superior skills in direction control compared to visual search for the sample. Both higher level and vehicle handling driving skills training improved the search behaviour of the participants to some extent but only the improvement after higher level driving skills training reached statistical significance. The scores for speed choice were also improved for both training groups (higher level and vehicle control) but the improvement only reached

statistical significance following vehicle control training. Direction control was also improved by both types of training, but for this measure the vehicle control skills training was more effective. Overall, both training groups were able to significantly improve their composite score of the on road driving assessment.

The road commentary scores relating to hazard detection and actions to hazards improved after both higher level and vehicle control skills training, but the improvement was only significant for the higher level skills training. All three groups (including controls) were able to decrease the number of actions to non-hazards but the decreases observed were not significant.

Overall, it seems that non risky higher level driving skills training was able to improve real driving performance in a very similar fashion to the on-road vehicle control training that exposed participants to considerable risk. However, higher level skills training was clearly more effective in improving search behaviour which also resulted in more hazards detected and a larger number of actions to hazards.

But most importantly, higher level skills training significantly decreased driving confidence levels, and improved attitudes towards speeding (at 110 and 120 km/hr), close following and overtaking. In comparison, training in vehicle control skills did not significantly change any of the confidence and attitude measures.

5.7 RESULTS PART 4

Aim 4: To determine if the training had any long-term effects in the sample over a period of six months

The fourth aim of the study will be addressed by providing an assessment of the completed fortnightly driving diary (see Appendix 8.4) responses over the six month time period or twelve fortnights.

5.7.1 Driving Diaries

Although the response rate from the participants who attended the *Driver Training Research Camp* in Taupo (N=36) began reasonably well (72%; N=26) for the first diary and 69% (N=25) for the following two, by fortnight six, the response rate was only 50% (18 responses) and this decreased even further to the point where only 28% (N=10) of the diaries were received at fortnight twelve.

Understandably, for those 36 participants who had not been involved in any of the training and acted as a post camp control group, the response rate was even lower and had dwindled to zero by the halfway time period. It was therefore not feasible to make any of the anticipated training vs. control comparisons on this measure of self reported driving behaviour.

For the 36 participants who had received training, an examination of the percentage of responses made on each category for each question did however reveal some changes over the 12 fortnights. In the first fortnight responses to the first question asking if they had been driving more than 10kms over the speed limit, were distributed over four of the five options. Twenty six percent reported no incidence of speeding, 52% indicated they had sped between 1 and 5 times, 15% between 6 and 10 times, only 7% reported speeding between 11 – 15 times, and no one reported they had sped more than 15 times. In comparison, although the numbers were well reduced, by the 12th diary, 50% of the respondents reported no incidence of speeding, 40% reported speeding between I and 5 times and 10% (N=1) reported speeding more than 15 times.

In comparison, question two of the diary which addressed the issue of unsafe following distances, showed less variability in the degree of 'offending' and very little change in the percentage of respondents reporting each option. For the first diary, 67% reported they had not engaged in any unsafe following behaviour, 30% indicated unsafe following between 1 and 5 times and 3% indicated they had engaged in unsafe following practices 6 to 10 times. Similarly, the responses in the final diary indicated that 70% had not engaged in any unsafe following practices and the remaining 30% reported engaging in unsafe following practices between 1 and 5 times.

Similar to unsafe following, question 3 which asked about unsafe overtaking, also had little variability in the degree of offending. In this instance, 85% reported no unsafe overtaking in the first fortnight, 11% reported unsafe overtaking 1 to 5 times, and 4% (N=1) reported unsafe overtaking 11 to 15 times. By the 12th fortnight however, any variability in the responses had disappeared altogether as 100% of the respondents reported no unsafe overtaking.

Question 4 addressed the issue of text messaging while driving, and surprisingly this did show some improvement over the 12 fortnights. The first diary revealed that 41% of respondents did not text message at all, 41% text messaged 1 to 5 times, 11% text messaged 6 to 10 times, while 7% (N=2) reported text messaging more than 15 times. By diary 12, 50% did not text message at all, 30% reported text messaging 1 – 5 times, and 10% (N=1) reported text messaging 6 to 10 times, with another one respondent also reporting text messaging 11 to 15 times.

The final question, which related to cell phone use while driving, initially indicated a relatively low incidence of infringement, but even this showed evidence of improvement over the 12 fortnights. Initially 56% reported they did not use a cell phone at all while driving, 37% reported using a cell phone between 1 and 5 times, with 7% (N=2) reporting using a cell phone more than 15 times. By the final diary, 90% of respondents reported no cell phone use while driving, with only 10% (N=1) indicating they had used a cell phone while driving between 1 and 5 times.

Unfortunately, due to the drop off in numbers of responses, no definitive conclusions can be drawn from this data. However, it does seem that for each of the issues addressed by the five questions, with the possible exception of unsafe following, there was a tendency for the rate of infringing to decline.

5.8 SUMMARY PART 4

The method of using fortnightly driver behaviour diaries in order to assess post training effects in the 36 teenagers who attended the Driver Training Research camp and received at least as five days of higher level driving skills training, proved to be unsatisfactory due to the very poor response rate of the participants - particularly of those who did not attend the *Driver Training Research Camp* and should have acted as post camp controls. Unfortunately, a comparison of the self reported driver behaviour between the participants who received training and the controls was therefore not feasible.

However, It is interesting to note that many participants reported speeding violations and texting while driving behaviour – which validated the driver violations questionnaires that predicted such risky behaviour as very frequent.

6 GENERAL DISCUSSION

The over-arching aim of this study was to evaluate the effectiveness of higher level skills training to improve frontal lobe executive function related driving performance in young drivers (16-17 years). The study used a double-blind, randomized controlled, between-subjects design and involved a sample of 36 teenage drivers (23 males, 13 females) who attended a *Driver Training Research* camp over a two week period in the Taupo area, New Zealand. An additional 36 teenagers (26 males, 10 females), who did not attend the *Driver Training Research* camp, acted as a post-camp control group to evaluate any long-term training effects.

6.1 Aim one

The first aim of the study was to determine the behavioural characteristics of thirty-six teenage drivers including their attitudes and confidence levels in regard to their driving behaviour and the associated risks involved. The sample was considered as representative of many young drivers in New Zealand who are at a considerable risk of having a crash often resulting in death or serious injury.

Overall, it was revealed that the majority of participants in this study had not previously been involved in a crash, but almost all had experienced a 'near miss'. They did not generally anticipate driving after drinking but on average thought they would exceed the 100 km/h speed limit at least 60% of the time - unsafe attitudes that were reflected repeatedly on a number of measures. Female drivers tended to have safer attitudes than male drivers. Many of the participants rated their driving skills as better than the average driver, and thought they were less likely than others to be involved in an accident. They also reported high levels of confidence in their driving skills which related strongly to unsafe attitudes in relation to many risk taking behaviours. Comparing these results with those of other studies on novice drivers, a comprehensive review by Engström, Gregersen, Hernetkoski, Keskinen, and Nyberg (2003) suggests that the sample in this study was a reasonable representation of 'typical' teenage drivers, not only in New Zealand but worldwide.

The global similarity of the characteristics of teenage drivers was the first obvious finding of this study and validated the current sample as an appropriate cross section of the target population. Consistent with international studies and local data which show the disproportionate crash rate for younger drivers (Deery, 1999; Wylie, 1996; Karpf & Williams, 1983; MacDonald, 1994a; Ministry of Transport, 2006a & b; Trimpop & Kirkaldy, 1997), our sample, 9 of the 36 participants (25%) reported having had a least one crash in the last 12 months. This is in spite of the fact that the maximum period a driver's licence had been held was only 20 months, again

providing support for previous findings that the crash rate for novice drivers is highest in the early months (Mayhew, Simpson & Pak, 2003).

Consistent with previous research (e.g., Delhomme, 1991, Finn & Bragg, 1986; Mathews & Moran, 1986) the majority of participants in this study also indicated they considered their driving to be equally as good as or better than other drivers.

Interestingly, the participants also thought that they would be equally or less likely to be involved in a crash than other drivers - in spite of the fact that on average they thought they would exceed the 100 km/h speed limit 60% of the time, engage in fast driving 50% of the time and exceed the 50 km/h speed limit 40% of the time. Speeding is considered as one of the biggest risk factors of crash likelihood (MOT, 2007). Consistent with previous literature (e.g. Parker, Manstead, Stradling & Reason, 1992), it was also the case that males were significantly more likely to hold these views than females.

Similar contradictions of beliefs were demonstrated by Evans and Wasielewski (1983) in relation to close following, and further demonstrated in this study by the responses to the Driver Risk Taking Questionnaire. These indicated an acknowledgement of the fact that speeding is a major cause of accidents, yet they also revealed a tendency to disagree with the idea that speed limits should be strictly enforced. Along similar lines it was also recognised that using a mobile phone while driving is dangerous, yet other responses indicated that it was OK to send a text message while driving. Interestingly, this questionnaire also revealed a tendency toward unsafe attitudes in relation to risky overtaking while on the other hand accepting that risky overtaking makes you less safe as a driver. In relation to these attitudes no significant difference between males and females was evident, and the responses would suggest that the young drivers in this research have little ability to realistically assess risk.

Confidence, or over confidence, has been offered as one explanation as to why young drivers over estimate their driving ability (McKenna, Stanier, & Lewis, 1991), and it is possible that training they have received in vehicle handling skills may fuel these levels of confidence. However, in keeping with the responses reported above, the two driving scenarios where the participants in this study felt the safest, were travelling at speed and driving at night. For all other situations, feelings of safety ranged from neutral to various degrees of feeling unsafe, suggesting that in most driving situations, over confidence was not a characteristic of this sample. Also, as would be expected, females tended to feel less safe than males in a number of the driving scenarios presented.

In contrast to this, when asked directly about levels of confidence (as opposed to feelings of safety), all driving scenarios, apart from parallel parking, were, on average, associated with confidence levels that were above average, thus supporting the ‘positive self’ theory of bias in relation to perception of ones relative driving ability (McKenna, Stanier & Lewis, 1991). As with the previous questions, males again demonstrated a tendency to be more confident than females.

Although there was not a direct overlap between the two questionnaires, correlations between the two were high, therefore it is difficult to determine why feelings of 'safety' were reported as being lower than levels of confidence for similar situations. It could be, in accord with the contradictions reported above, that the word 'safety' evokes the reality of a situation and is evaluated on a more intellectual level, whereas 'confidence' is more personal and somehow becomes dissociated with the reality of the situation.

Although higher levels of driver confidence do not always result in an increase in the crash rate (Katila, Keskinen, Hatakka & Laapotti, 2004), in this study higher levels of confidence were often associated with less safe attitudes and behaviours. Those whose confidence was high were less likely to agree with road rules addressing risky driving behaviour, and were less concerned about being in an accident, although paradoxically again, they also had less safe attitudes to speeding than those whose confidence levels were lower. Consistent with this profile, those more confident participants were also more likely than those who were less confident to get a thrill from driving and were more likely to feel their driving skills were better than others. While it has been suggested that the seeming lack of ability in young drivers to realistically assess their own driving ability and crash likelihood could be due to lack of experience, and therefore a lack of, or limited exposure to, realistic comparisons (Mathews & Moran, 1986) it seems, in this study, there is some evidence to suggest that young drivers are not very adept at assimilating and translating what they know in terms of others into consequences of their own behaviour.

As well as high levels of confidence, Extraversion, Neuroticism and Conscientiousness have been the personality factors most often linked with risky driving (Lajunen, 2001; Martin & Boomsma, 1989; Renner & Anderle, 2000; Schwebel, Severson, Ball & Rizzo, 2006; Smith & Kirkham, 1981), however, in this sample it was Openness and Agreeableness that were the most dominant types of personality. It was also found that those who were more agreeable were more likely to approve of the rules of the road, and to have safer attitudes to driving, in particular close following, than those who were less agreeable. Similarly those who were more open were also more likely to approve of road rules and have safer driving attitudes than those who were less open, however for this trait, differences were seen for attitudes to drink/driving, and overtaking as well as close following. Interestingly speeding was the one factor that did not reveal any significant differences in attitude for this personality trait.

Although there are only a limited number of studies which have compared driving variables with degrees of Openness and Agreeableness, an inverse relationship between openness and at fault accidents was found by Arthur and Grazanio (1996), and both agreeableness and openness (low scores) were two of a number of significant predictors of aggressive and risky driving behaviour among college students (Dahlen & White, 2006). In so far as we have shown that the presence of these two personality traits coincide with both a willingness to abide by road rules and a safer driving attitude, this study adds support to previous findings.

Although Impulsive tendencies were not strong in this sample of participants, higher levels of impulsivity were linked with both an increased indication of an intent to engage in risky driving behaviour (Driver Violations) and a greater tendency to get a thrill from driving. It was also evident there was an association, which did not quite reach significance, between higher levels of impulsivity and a lesser concern about being involved in an accident. These associations are in line with previous research which has also linked higher levels of impulsivity with an increased likelihood of engaging in risky driving behaviours (Dahlen, Martin, Ragan & Kuhlman, 2005; Stanford, Greve, Boudreaux, & Mathias, 1996), and an increased number of driver errors and violations (Owsley, McGwin & McNeal, 2003).

Finally in this section, and similar to the findings of Assum, 1997, who determined that drivers with less safe attitudes were more likely to commit driver violations and/or be involved in accidents, this study showed that those participants who had been involved in the most crashes or near misses were also less accepting of road rules and had a less safe attitude to risk taking.

Thus in relation to aim one, it has been demonstrated, that similar to young drivers throughout the world, the participants in this study had already been involved in a disproportionate number of crashes, had unrealistic expectations of their accident risk and their driving ability, while holding very unsafe attitudes to speeding in particular, seemingly with little realization of the possible consequences to themselves. Interestingly this group did not appear to be especially thrill seeking in their activities, and were more open and agreeable than they were neurotic, extravert or conscientious. Contrary to expectations, they were not especially impulsive but paradoxically they tended to feel unsafe in most driving scenarios, while indicating elevated levels of confidence in similar situations. As expected, those with high levels of confidence also reported attitudes and behaviours that were the least conducive to safe driving.

6.2 Aim two

As mentioned in the introduction, there is evidence that frontal lobe executive functions are developing until the age of 25 years, which is the time that age disappears as a risk factor in relation to driving. Therefore, the second aim of the study was to test the executive functions of the sample and examine if such functions relate to on-road driving performance in regards to search, speed choice and direction control, as well as to the ability of recognizing hazards. These functions were also related to their accuracy of self assessing their driving performance.

Overall our participants appeared to have below average levels of working memory, complex information processing and sustained attention, but higher than average general ability. The normative data were age matched and published relatively recently, but not based on a New Zealand sample, as such data was not available. It is generally accepted that IQ scores tend to increase over time, so the higher than average level of general ability of this sample may be explained by the general improvement in IQ over time. However, their below average

performance on the other tasks is harder to explain and could be due to either i) unique characteristics of this sample, ii) New Zealanders perform more poorly on these tasks compared to the populations from which the norms were derived (US & European) or iii) there has been a general downward shift in ability on these tasks since the norms were published. The first explanation is unlikely as another driving related study conducted in our laboratory (results not yet published), with a different sample of young drivers also revealed that the participants performed in the bottom 4th percentile on a visual scanning and attention task similar to the sustained attention task used here. Thus, the latter two explanations appear more likely, although further research needs to be conducted before any firm conclusions can be drawn.

The results showed some evidence that frontal lobe executive functions were indeed associated with driving related performance. Better performances in the on road driving assessment and more accurate self evaluations were associated with higher levels of working memory, cognitive switching, and sustained attention. In the road commentary, good cognitive switching was associated with better hazard detection, better inhibition with increased Actions to Hazards and higher inhibition and switching scores with Actions to Non Hazards.

These results concur with Kurtzhaler et al (2005) suggestions that working memory, psychomotor speed and mental flexibility are all important cognitive skills which relate to driving. In addition, these results show some similarities with studies conducted in older drivers. For example, working memory has been linked to safe driving in TBI patients (Lundqvist, 2001), complex information processing in PD patients and those with early cognitive decline (Stolwyk et al, 2007; Whelihan et al, 2005; Zesiewicz et al, 2002), and sustained attention has been linked to driving ability in those with PD, TBI and early cognitive decline (Haikonen et al, 1998; Radford et al, 2004; Whelihan et al, 2005). Indeed, in contrast to the lack of association between executive functions and driving in a 'normal' older sample, it appears that within a younger population there is some evidence for a small link between executive functions and driving behaviour/ability.

Despite these associations between executive functions and driving, general ability was more closely linked to all the driving related measures. Many of the executive function measures correlated quite highly with general ability, which is to be expected as some of the tasks (e.g. digits backwards) form part of the WAIS III assessment battery. One previous study has described a link between general ability and driving behaviour in young drivers (Sanchez Martin & Estevez, 2005); those with lower intelligence and less education had more frequent and more severe accidents. How intelligence links to driving behaviour is unclear, often those with lower intelligence have had less traditional schooling and come from poorer backgrounds, thus this general ability measure may reflect some other, unmeasured link between ability and driving. Alternatively, higher general ability may compensate for the lack of driving specific abilities.

Together, these data suggest that executive functions, general ability and sustained attention all have an important role to play in safe driving. Clearly, given our relatively small sample size,

further research is needed. Indeed, this study suggests that additional work in this area may have promising results. As explained in the introduction, learning to drive places significant demands on the brain's central processing capacity and even though teenagers may appear as proficient as an adult on a task, they require much more 'brain power' to achieve that same level of performance (Keating 2007). Given the poor working memory, complex information processing and sustained attention of our sample it is important that we ensure that teenagers driving skills become automated as quickly as possible and that we minimize distractions until their executive functions become more fully developed.

6.3 Aim three

The third aim of this study was to determine the effect of higher level and vehicle handling driving skills training on participants' driving related performance, confidence levels, and attitudes to risk taking behaviour. Compared to the vehicle handling skills training, the higher level skills training involved less exposure to risk as most of the training was off-road and involved video traffic simulations, road commentary, driving self evaluation, focus groups, coaching and peer teaching. Overall, the effects of the higher level skills training on the driving related assessments were pronounced. Higher level skills training significantly improved search behaviour and the composite score of the on-road driving assessment. This training method also increased the number of hazards detected and number of actions in response to hazards and improved attitudes to many risk taking behaviour such as speeding, close following and overtaking while at the same time decreasing confidence levels in their driving skills. In comparison, the car handling skills training improved speed choice, direction control and the composite score of the on-road driving assessment but had no effect on the attitudes and confidence measures.

Regarding the baseline on-road skills of the participants, the highest baseline scores were obtained for direction control and the lowest scores for visual search behaviour, confirming that they seem to have already well advanced in the vehicle control skills but are still lagging behind in displaying efficient visual search patterns. Lestina and Miller (1994) identified a failure to search the road as the single most frequent crash factor in young novice drivers. Underwood (2007), who researched in detail the eye scanning patterns of novice and experienced drivers using eye tracking technology found that novice drivers concentrated their search in a smaller area, closer to the front of the car, have longer fixation times in hazardous situations and have a smaller spread of search when driving on dual-carriage ways. Increase in eye scanning is one of the remarkable changes that occur when drivers become more skilled and it is interesting to put these changes in the context of Endsley's (1995) three level model of situation awareness. The top level which is most relevant for safe driving requires 'being able to predict the behaviour of other road users, and to anticipate how the current situation might develop as other vehicles

manoeuvre around' certainly requires skilled eye scanning techniques. Chapman, Underwood and Roberts (2002) found that simple hazard anticipation training interventions using video based traffic simulations can increase visual scanning of novice drivers and situation awareness, and they also observed transfer of these new skills to on-road situations. Fisher, Pollatsek, & Pradhan, (2006) found that younger drivers attended to (fixated on) areas of a virtual world that contained potential risks much less frequently than more advanced drivers. A PC-based training program subsequently improved the visual attention of the young drivers and also showed a transfer of those skills to real driving situations.

Our road commentary procedure on video based traffic simulations seems to be the hazard anticipation training component that was most likely to have helped improve the search behaviour of the participants in the higher level driving skills training group, while simultaneously improving their hazard perception skills and risk taking attitudes.

This would support the research by McKenna and Horswill (1999) who found that hazard anticipation skills training via video based traffic simulations improved hazard awareness skills. Although some have argued that skill levels and risk taking are independent (e.g. Elander, West & French, 1993), that would then imply that an increase in the level of driving related skill would have no impact on driving related risk taking behaviour. Conversely, if skills training and risk taking are related it may seem probable that improvement in any driving related skill would have some effect on risk taking behaviour. This study also shows a limited/weak relationship between improved higher level skills and risk taking attitudes, but previous studies have not necessarily found this to be the case. For example, Gregersen (1996), found that skid training increased driver confidence with no corresponding increase in actual skill level, we also found that vehicle control training increased confidence levels, improved on road driving performance but at the same time increased the level of unsafe attitudes to driving behaviour and risk taking. In contrast, the road commentary, or training in hazard detection seemed to improve search patterns and the number of hazards detected, as well as improving driver attitudes and decreasing risk taking. Because there was an improvement in risk taking attitudes subsequent to hazard detection training, this suggests that the participants became aware of potential dangers that they would otherwise have been unaware of, thus increasing awareness of the many possible scenarios that may unfold on the roads. This, in turn may have had the effect of reducing their levels of confidence and resulted in safer driving practices. Although increasing drivers' awareness of the numbers of potential hazards on the roads improved attitudes to safe driving and risk taking in this sample and in previous research (McKenna, Horswill & Alexander, 2006), it would probably not serve to eliminate the risk taking behaviour of those who deliberately seek risk taking activities. Rather this training would be most effective for those who are too inexperienced on the roads to fully realize the dangers that do exist, and who, prior to training have an unjustified level of confidence in their driving ability and therefore engage in ignorance based risk taking. This was in fact demonstrated by McKenna, Horswill and

Alexander (2006), who showed that the reduction in risk taking resulting from improved hazard detection related specifically to driving behaviours and was not the result of a reduction of risk taking generally.

In addition to the positive change in attitudes and driving behaviour that hazard detection training can facilitate, this training can be conducted safely in an off-road environment with as little as 4 hours training (Chapman, Underwood & Roberts, 2002; McKenna, Horswill & Alexander, 2006). A recent Masters study project, (Williamson, 2008) found that after only 12 trials of a road commentary training intervention, novice drivers improved their hazard perception skills to the level of the experienced drivers. This is in contrast to the vehicle handling skills training which usually requires some special facility to enable the training to be conducted safely.

In comparison to the higher level skills training group in this study, the vehicle control training group did not improve their search behaviour significantly. This suggests that although they had been trained in skills relating to their vehicle handling, their scanning techniques had seemingly not improved beyond the patterns of novice drivers revealed by Underwood (2007), mentioned above, and concentration on the newly acquired vehicle handling skills possibly left little attentional capacity for searching the road ahead. In addition, this group would be likely to have maintained the novice driver characteristics of

"*assessing traffic hazards on the basis of a single characteristic*" (Deery, 1999, page.),

thereby lacking the ability to quantify the degree of danger in any given situation (Ferguson, 2003). Consequently, this could explain the improvement seen in the higher level skills training group in relation to the number of hazards detected and number of responses to hazards on video based traffic simulations that were not apparent in the car handling skills training group.

Most encouraging was the fact that higher level driving skills training improved attitudes to risk taking behaviour relating to speeding, following distance and overtaking. They also lost confidence in their driving skills which, as discussed before, could have important safety benefits. It could be argued however, that we were measuring how participants think they should respond after a week of training (high level of demand characteristics). But this would not explain why there was no improvement of attitude to risk taking in the car handling skill group. Furthermore, loss of confidence in their driving skills in the higher skills group would be difficult to recognize as a 'desirable response' by the participants.

6.4 Aim four

Using diaries for self reported driving behaviour as a method of evaluating post training effects proved to be unsatisfactory, largely because of the poor completion rate. However, even with a higher response rate, there would have been issues regarding the reliability of the diary entries. In particular, we have no control over who completes the diary, when they are

completed or how accurate the information is. Thus, there is a need for a more objective measure of post training driver behaviour.

There is much discussion about the value of driver training evaluations in the road safety literature which use the number of crashes as an outcome measures. Unfortunately, it seems that such outcome data are difficult to obtain and often not sensitive enough to reveal any training effects even for very large samples. In addition, if crash data relies on police reports, many minor incidents may go unrecorded.

To address these issues, we piloted a telemetric data tracking system that could provide more objective (compared to diaries) and sensitive (compared to crash data) outcome measures of training interventions (see full report of this part of the study in Appendix 8.1).

6.5 Limitations of the study

6.5.1 Sample size and self selection of participants

One could consider the relatively small sample size as a limitation of the study and we agree that this study was more at risk of committing type 2 errors (not enough statistical power to reveal significant statistical effects) than type 1 errors, even when multiple analyses (correlations) were conducted that normally increases the danger of committing type 1 errors. However, we found some solid training effects which seem to validate the research design as powerful and the main driving related out come measures as reliable. However, many effects that approached statistical significance should be considered as encouraging as they may become significant with increased statistical power. The participants were ‘self-selecting’ as they responded to the ads in the school. Thus, as with any research which relies upon volunteers to participate, they might not have been fully representative of the New Zealand population of teenage drivers. We would have liked more female and Maori participants in the sample, but we don’t think that this affected our main results.

6.5.2 Short-term training effects

The on-road driving assessment only revealed short-term effects of the training and we agree with a reviewer who commented that “it would be extremely interesting to know if those changes continued beyond this very limited time period and that they also translated into longer term safer road driving behaviour and reduced injury crashes among these young drivers in the future.”

Our fourth aim was to examine possible long-term effects using fortnightly driving diaries that the participants were required to fill in. Self-report measures have been widely used in driver training evaluation studies, however they have severe limitations. For example one can not verify how truthfully the participants self report their driving behaviour responded and of course they only can report driving incidents they are aware of and remember. Unfortunately, as it turned out in our study, most participants lost interest in completing the driving diaries despite

much encouragement and many prizes they were able to win (see Appendix 8.4 for an example of a diary). Administrating the driving diaries was a very time consuming exercise for everyone involved and we were disappointed about the outcome of this particular part of the study. Perhaps it underlines the difficulty that researchers face when it comes to evaluate long-term driver training effects.

On the positive side however, in addition, we piloted sensitive and objective long-term driver training outcome measures which could be very promising for future evaluations. We installed GPS-based data trackers in the cars of eight participants and monitored and recorded in real time a number of dependent variables that could reveal unsafe driving (e.g., large g forces and speeding). The problem with this new technology is that it is rather expensive and largely untested in a research context. So we thought it would be important to pilot this technology first with only a few participants and report on our experience (See Appendix 8.1 for a full report).

Research is a step by step process. The current study found reliable and robust short-term training effects on attitudes to risky driving and search aspects of the on-road driving performance tests. This is very encouraging and allows us to consider a second stage of the 'frontal lobe' study focusing on the long-term effects of driver training in teenagers using telemetric data from GPS-based data trackers as more objective training outcome measures than self reported driving diaries. A second stage of the frontal lobe study would also allow us to replicate some of the main findings in the current study and to perform power analysis to determine the required optimal sample size.

6.6 How could the safety of young drivers be improved in New Zealand?

In the New Zealand environment, there seems to be plenty of room for improving the safety situation of young drivers. There are few arguments left against increasing the driver licensing age that would bring it in line with the 'world standard' (ECMT, 2006) of allowing young drivers to become solo at 18 years. The parents/caregivers could be encouraged to be more involved in assessing the maturity and 'readiness' of their teenagers to obtain a driver licence. New Zealand could increase the age for the learner licence to 16 years and require the learner to experience at least 120 hours of supervised driving (using a certified log book) before they can apply for the restricted driver licence test. While at least 50 hours of supervised practice are recommendable, experience in Sweden showed that increasing this to about 120 hours reduced crashes in the two years following by about 40% (ECMT, 2006). The supervisors could have access to information on a wide range of supervision techniques delivered through a web facility and could be invited to workshops on how to be an effective supervisor. For example the supervisors could learn how to teach road commentary to the learners that has been found so effective in this study.

Web-based resources could also be made available for learner drivers (e.g. high definition video based traffic simulations) so that they can learn higher level skills such as eye scanning, hazard perception and risk management from the safety of their homes. Focus groups could be conducted in high schools (as recommended by Engstroem et al., 2003) to enhance young drivers' self-assessment skills and possibly other executive functions. In addition, the learner licence tests could include the assessment of hazard perception and risk management skills that are acquired through driving experience and after specific higher level skills training.

After 18 months solo driving on a restricted licence, they could get a full driver licence if they had not received any demerit points during the restricted phase. As an extra incentive to drive safely some insurance premium discount could be received if they had not had any demerit points in the first 12 months of solo driving (the most risky time period) and had received some certified professional driver training that focused on advanced higher level skills. This would go beyond the education that parents and caregivers could deliver and also beyond preparing the drivers to pass the test. The GDLS restrictions should be maintained and enforced not only by the police but also by the parents and caregivers.

Reductions in young driver risk could also result from technological applications. For example a recent study by McGeehee, Raby, Carney, Lee and Reyes (2007) showed that using an event-triggered video device installed in the cars of novice drivers significantly improved unsafe driving behaviour. Other devices such as Intelligent Speed Adaptation, Adaptive Cruise Control, black boxes, alco-locks and smart cards could have safety effects for young drivers, but more research should be conducted in theses areas to verify the safety effects of such devices for young drivers (ECMT, 2006)

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8 APPENDICES

8.1 Isler, R.B., Starkey, N., Sheppard, P., and Yu, C. (2008):
Piloting a telemetric data tracking system to asses pot-training real driving performance of young drivers, in Driver Behaviour and Training (Volume III), edited by Lisa Dorn

8.2 Photographic impressions from the *Driver Training Research* camp in Taupo, 16 September 2006 – 1 October 2006

8.3 Questionnaires (Aim 1)

8.4 Further results (Aim 2)

8.5 Copy of on-road driving assessment form (Aim 3)

8.6 Copy of a diary to evaluate long term effects of the training (Aim 4)

Appendix 8.1

Chapter 2

Piloting a telemetric data tracking system to assess post-training real driving performance of young novice drivers

Robert B. Isler, Nicola J. Starkey, Peter Sheppard* and Chris Yu#
University of Waikato,
**AA Driver Education Foundation,*
#SmarTrak,
New Zealand

Introduction

Evaluating the effects of driver training interventions is a difficult research task. The ultimate goal of such interventions is to make the driver safer and therefore less likely to be involved in a road crash. A particular driver training intervention can only be considered to be effective if it can show a significant reduction in the number crashes for the driver, or a significant change in driver behaviour that clearly implies safer driving. Getting accurate and comprehensive crash records is difficult and to measure post training behavioural driving changes based on self-reports (e.g., log books) may not be accurate enough to be statistically meaningful.

The majority of driver training evaluation studies in the last thirty years concluded that driver education and training contributes little to reduce crash risk / involvement for road users (pre-licence, defensive, advanced, or driver improvement). And even more puzzling and paradoxical is the fact that there was no evidence that professional driver training is effective in reducing crash risk.

However, failing to find a driver training effect does not necessarily mean that it does not exist. In fact, there has been a heated scientific debate about the usefulness of the hypothesis testing procedures employed by most of these evaluation studies (Shrout, P.E., 1997). For example, the fact that statistical procedures are generally geared towards preventing type 1 errors (claiming an effect when there is in fact no effect) but at the same time are quite likely to lead to type 2 errors (failing to detect an effect when there is an effect) biases results towards non-significance. Furthermore, Crick and McKenna (1991) maintained that the lack of evidence for the benefits of road safety education / training may be ascribed to a lack of methodological soundness in previous evaluations and / or to the content of the course.

It is indeed interesting to note that many driver training evaluations have been published as technical reports and therefore were not subject to peer review. Often, evaluation studies have failed to use appropriate control groups and used hypothesis testing procedures inappropriately, with very little statistical power to detect any effects.

The content of the driver training courses that have been evaluated in the past tended to emphasise the teaching of vehicle control skills or alternatively, were classroom based. Since then, research has shown that increasing driver skills does not necessarily lead to safer drivers. For example, skid training may lead to drivers overestimating their own driving ability, without actually improving the way they manoeuvre the car (Gregersen, 1996). Furthermore, studies suggest that crash involvement is more often the result of risk taking behaviour, rather than poor driving ability (Clarke, Ward and Truman, 2005). Thus, driver training programmes which concentrate on vehicle handling skills, may actually lead to increased risk taking due to learners' inflated self-confidence and self-rated skills.

Consequently, a growing consensus among driver training and road safety researchers is that greater emphasis should be placed on higher level cognitive functions underlying driving skills (Senserrick, 2007). Some researchers have argued further that there is an urgent need for a holistic and structured plan of education and training that addresses all goals of driver education, as outlined in the 'Goals for Driver Education' (GDE) model (see Engstroem, Gregerson, Hernetkostki, Keeskinen, & Nyberg, 2003 for a comprehensive review on young drivers, driver education and training). At the same time there is a call for employing more sensitive and objective behavioural outcome measures, so that their accuracy can be increased and at the same time the probability for committing a type 2 error can be minimised.

We recently conducted a large scale driver training study (Isler, Starkey, Charlton & Sheppard, 2007) in New Zealand to compare the effects of training in higher level driving skills (such as eye scanning, hazard detection and risk management) and vehicle control skills (such as manoeuvring, braking and parking) on teenagers' real driving

and risk taking behaviour, confidence levels and self-rated driving skills. Thirty-six teenage drivers (across a range of ethnic and social backgrounds) on a restricted driver licence were recruited via 500 secondary schools.

After the driver training camp, we installed telemetric data trackers in the vehicles of eight participants to pilot how well this technology measured post-training real driving behaviour. We tracked the driving behaviour of the participants for 32 weeks in order to evaluate if such data acquisition could help fill a methodological gap in driver training evaluations. From the outset, we knew that the number of data trackers would be too small for making conclusive claims about any potential long-term effects of the driver training in our study. The idea was to test this new and promising evaluation technology and report on our findings.

Method

Participants

From a total of 36 participants who attended the driver training study, eight participants (4 males and 4 females) who brought their private vehicles to the training were selected to participate in this pilot study. They were all 16 years old and were required to hold a current New Zealand restricted driver's licence. This ensured that they all had some unsupervised driving experience. Their vehicles were fitted with a telemetric data tracking system and their driving behaviour was monitored on-line via the internet over a 32-week period.

The telemetric data tracking system

The tracking system consisted of a small credit card sized global positioning module (SmarTrak Lite GPRS / GPS) fitted with an accelerometer (Figure 1). The system was powered by the vehicles' battery (16 Volt). It took approximately 30 minutes to install the system in a vehicle. In order to obtain accurate data, the device had to be pointing forward and on a flat surface. In most cases it was installed below the driver's seat.

Figure 1. The telemetric data tracking system used in this study

This system uses a GPS receiver and provides reliable and accurate navigational data. The software for the tracking and reporting interface via the internet was developed by SmarTrak Ltd (www.smartrak.co.nz). It allowed us to monitor, in real time, the driving performance (updated every 2 seconds) of the eight participants on the computer screen (see Figure 4 as an example of a map based online tracking). The built-in accelerometer also provided g-force data from the vehicles. Daily, weekly and monthly reports of the driving measures for each participant could be produced and downloaded as a Microsoft Office EXCEL spreadsheet.

The following driving measures were used as dependent variables in this study:

Distance driven:
Number of kilometres driven for each trip

Number of trips:
A trip started from a 'key on' event (starting the engine of the vehicle) to a 'key off' event (shutting down the engine).

Mean Speed per trip:
Every 4 kilometres the current speed was recorded and the mean speed for each trip was calculated.

Maximum Speed: The maximum speed was recorded for each trip.

Speeding Violation: Each time a participant exceeded 100 km/h (62 mph), which is the maximum speed limit for New Zealand. Lower speed limit violations (e.g., driving 60km/h on a road with a 50km/h speed limit) were not monitored.

Large G-force: Each time the vehicle created a g-force (longitudinal or lateral) that was larger than 0.50 an event was triggered. The threshold setting was the same as that used by McGehee, Raby, Carney, Lee and Reyes (2007) for their event-triggered video driver intervention trial. Negative longitudinal g-force events

indicated hard braking while positive events indicated levels of acceleration that would be difficult to reach without external impacts (e.g., rear end collision). The system did not allow differentiation between longitudinal g-forces created by hard braking and those created by hard cornering or swerving.

Results

Thirty six participants (15 females, 21 males) attended the driver training study where they were first assessed on a number of psychometric tests and asked to fill in a variety of driver behaviour questionnaires. The data from these pre-assessments are currently being analysed.

Participants were asked to rate how safe they felt driving in a variety of situations on a 5-point Likert scale (1=Very Safe to 5 = Very Unsafe; adapted from Bergdahl, 2005). The responses from the eight participants in this pilot study did not differ significantly from the responses of the other participants in the driver training camp, and therefore the results from all participants (N=36) are presented in Figure 2.

Most participants felt safe in the majority of driving situations, except after drinking (rated between unsafe and very unsafe), when they are sleepy or tired, and when they are angry or being tailgated (rated as between 'neither safe nor unsafe' and 'unsafe'). Interestingly, they felt quite safe speeding at 120 km/h even though they indicated in a different questionnaire that speeding is one of the most frequent causes of young driver crashes.

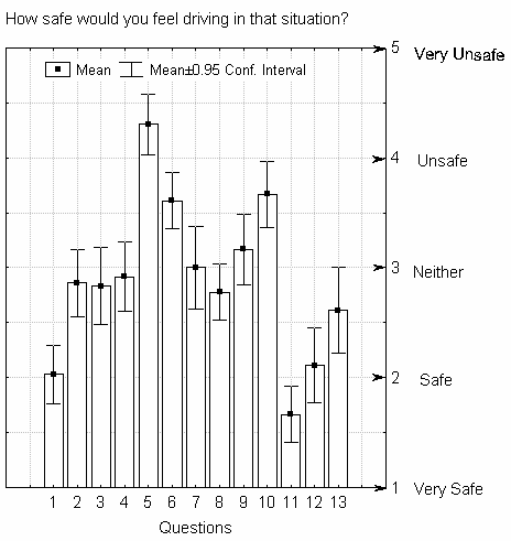

Figure 2. Mean responses and 95% confidence intervals of the participants in the driver training study (N=36) for the question: How safe do you feel driving 1) at night? 2) in an unfamiliar area? 3) in the city? 4) in bad weather? 5) after drinking? 6) sleepy or tired? 7) towing a trailer? 8) an unfamiliar car? 9) when angry? 10) when being tailgated? 11) at 100 km/h? 12) at 110 km/h? 13) at 120 km/h?

We received valid telemetric driving behaviour data from six of the eight participants for the entire 32 weeks' period. The data for one of the six participants (#8) was not analysed, as the tracking system did not provide the data for the variable 'distance driven'. Two of the participants crashed during the study and the GPS system allowed us to examine their driving behaviour just before (and, in one case, during and after) the crash.

Participant #1 crashed in week 19. The tracking system did not transmit any data during the crash as the power supply was disrupted, and we were not able to retrieve any data from the tracker in the crashed car (see Figure 3). The last data we received from the vehicle was two minutes before the crash occurred, indicating that the vehicle was travelling at 75 km/h sometime within that time period.

Figure 3. The crashed car of participant #1

The participant's account of the crash was as follows:

"*Hit a stationary vehicle parked half on / half off road. Was travelling at about 100 km/h when hit the vehicle. I just did not see the car - obviously lack of concentration. I was not text messaging or using phone prior to crash. I did have a passenger though I can't remember all that happened so I don't know what I was doing to not see the car*"

The participant suffered only some minor injuries but was shaken by the experience and decided not to drive for a while.

Participant #2 crashed in week 30. She started her journey at 6.24 a.m., lost control on a bend at 7.22 a.m. and swerved 180 degrees when she was hit by an oncoming car. For this incident we have a complete set of telemetric data available as the car was still functioning after the crash and power was continuously supplied to the data tracker. Figure 4 shows the map function of the on-line monitoring system listing the transmitted driving events on the right side of the map. The map revealed that the crash happened at 7:22 a.m. and was preceded by a large negative g-force (-0.56), probably caused by hard braking. At that time, the vehicle was travelling at 83 km/h when it swerved 180 degrees and hit an oncoming car creating a very large positive g-force (2.85). Within the same minute (7.22 a.m.) the car was decelerated to 1 km/h. We later received the information that the crash occurred during very wet driving conditions.

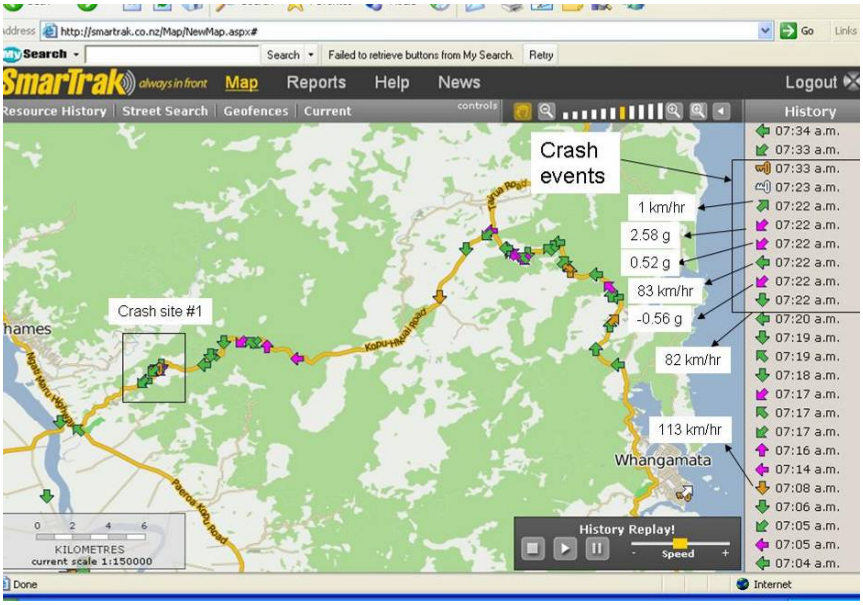

Figure 4. The map function of the on-line monitoring system (see text for explanations)

The vehicle of participant #3 was stolen in week 5, in an early morning at 2.43 a.m. It seems that the vehicle was used for a 'joy ride' that lasted 11 minutes. Telemetric data showed that the car created seven negative large g-forces (up to -0.65), possibly indicating unsafe driving before the data flow was interrupted at 2:54 a.m. We were later informed that the car was found burnt out in a remote parking area.

Table 1 shows the mean weekly distance driven (in kilometres, 1 km=0.62 miles), number of trips and mean speed per trip for 7 participants. As previously mentioned, the data from participant #8 could not be analysed. The table reveals that participants #1 and #2 travelled much longer weekly distances, compared to the other participants. Participant #7 had the smallest mean weekly number of trips. In addition, it is apparent that the weekly mean speeds per trip were by far the highest for participant #1 and #2.

Table 1. The mean (M) weekly distance driven (Dist) in kilometres (km), number of trips (Trips) and mean speed per trip (Mean Speed) in kilometres (km/h) for seven of the eight participants. Standard Deviations (SD), minimum (Min) and maximum (Max) values are also given.

Part.	Dist (km)				Trips				Mean Speed (km/h)				Weeks
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	
#1	512	290	23	1317	47	14	11	74	81	5.3	60	89	1-32
#2	460	307	0	991	31	25	0	69	84	2.5	0	90	1-18
#3	206	160	5	499	43	19	14	66	51	8.6	40	63	1-6
#4	199	111	59	340	25	12	4	54	69	19.6	18	93	1-32
#5	242	827	0	827	46	32	0	168	65	14.7	0	87	1-32
#6	339	217	0	962	74	45	0	139	54	22.4	0	94	1-32
#7	110	63	0	270	33	11	0	5	69	17.3	0	84	1-32

Table 2 summarises the mean weekly maximum speed, number of speeding violations per 100 km and number of large g-forces per 100km for seven of the eight participants. It shows that participant #1 and #2 had the highest mean weekly maximum speeds. The number of mean weekly speeding violations per 100km was highest for participant #4, followed by participant #1. All participants had a great number of mean weekly large g-forces, with participant #1 and #2 having the two largest numbers. Participant #2, #5, #6, and #7 had some weeks without driving.

Table 2. Weekly means of maximum speed in km/h (Max Speed), number of speeding violations per 100 km (Speeding Viol) and number of large g-forces per 100 km (G-force) for seven of the eight participants

Part.	Max Speed (km/h)				Speeding Viol				G-force				Weeks
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	
#1	123	9.4	89	141	8.7	6.1	1.3	22.8	81	5.3	60	89	1-32
#2	112	9.4	97	124	1.9	3.0	0.0	10.7	84	2.5	0	90	1-18
#3	96	25.5	68	117	0.4	0.4	0.0	1.1	51	8.6	40	63	1-6
#4	98	27.5	27	126	8.9	10.1	0.0	31.4	69	19.6	18	93	1-32
#5	100	19.3	0	111	7.3	10.3	0.0	32.8	65	14.7	0	87	1-32
#6	111	32.9	0	138	3.8	5.4	0.0	23.5	54	22.4	0	94	1-32
#7	86	620	0	121	2.2	5.2	0.0	21.7	69	17.3	0	84	1-32

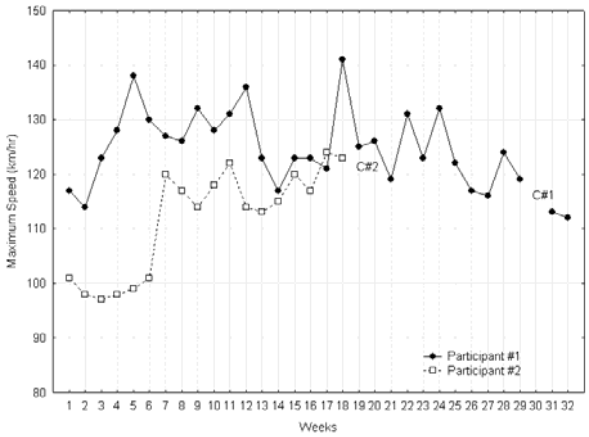

Figure 5. Mean weekly maximum speeds for participant #1 and #2. Participant #1 crashed in week 30 (C#1) but continued to drive in week 31 and 32. Participant #2 crashed in week 19 (C#2) and stopped driving.

Figure 5 shows mean weekly maximum speeds for participant #1 and #2 who crashed during the 32 week period after the driver training study. As the Figure shows, these participants had lower mean maximum speeds right after the driver training study with participant #2 keeping to the New Zealand maximum speed limit of 100 km/h for the first 6 weeks before there was a substantial increase in her maximum speed in week 7, and more or less maintaining it until she crashed in week 19. Participant #1 had much higher mean weekly maximum driving speeds which in some weeks reached up to 140 km/h. She had maximum speeds reaching 120 km/h for most weeks, except for the first two weeks after the driver training study and the two weeks following her crash.

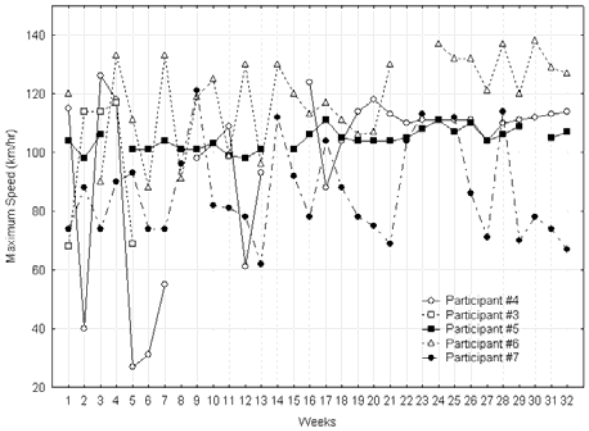

Figure 6. Mean weekly maximum speeds for participants #3 - #7.

Figure 6 shows the mean weekly maximum speeds for participants #3 - #7. The speeds varied considerably for all participants, except for participant #5 who reached maximum speeds at around 100 km/h for most of the monitored weeks. The other participants often reached maximum speeds of up to 120 km/h with participant #6 reaching speeds close to 140 km/h (week 32).

Discussion

Driving behaviour research literature has identified a need for more sensitive and objective intervention outcome measures. Thus, the aim of this pilot study was to test a telemetric data tracking system to measure post-training driving behaviour of young novice drivers. Specifically, this pilot study evaluated a tool that could help close a methodological gap that seems to exist in evaluation research of driver training interventions.

We received valid post-training real driver behaviour data from seven of the eight participants. Two participants, both living in rural areas, crashed their cars within the monitoring period, without being seriously injured. Their telemetric data indicated that they were travelling longer distances, had higher average speeds, and higher maximum speeds than any of the other participants. It is interesting to note that road crash statistics in New Zealand indicate that young drivers in rural areas are at greater risk of being involved in a severe crash, than those who live in urban areas. Consistent with our data, these drivers normally have a higher risk exposure as they typically drive longer distances and more frequently use rural roads that allow for higher speeds than roads in urban areas.

Speeding is known to be one of the most important factors of teenage crashes in New Zealand. However, our participants indicated that they felt relatively safe when speeding, even at speeds as high as 120 km/h. This is a particularly interesting finding as most of the participants were aware that speeding is one of the most common causes of road crashes. Most participants in this study had maximum speeds reaching 120 km/h and some of them had speeds up to 140 km/h. It seems pertinent that driver training interventions should involve methods that could decrease this high risk behaviour. One of these methods could involve hazard anticipation training, using video simulation, which clearly improved speed choice behaviour (McKenna, Horswill, and Alexander, 2006).

All participants had many large g-force events, either caused by hard braking (longitudinal g-force), and / or hard cornering / swerving (lateral g-force). Our tracking system was not able to differentiate between these events and perhaps recorded also some non risky g-forces caused by hitting a bump / pothole in the road. An event-triggered video recording system manufactured by DriveCam and used by McGehee, Raby Carney, Lee and Reyes (2007), for their event-triggered video driver intervention trial could help verify the cause of each large g-force.

Hard braking events could have been caused by long hazard detection times of the participants which are typically 30% longer in inexperienced novice drivers compared to experienced drivers (Deery, 1999). Hazard detection times have been found to be related strongly to crash risk in young drivers and can be improved using road commentary methods or video based hazard detection training.

In summary, the telemetric data tracking system used in this study seems to be a promising research tool for evaluating post-training effects by providing an objective and sensitive driver behaviour outcome measures. By using the map based tracking function all the recorded driver behaviour events, including crashes could be mapped, replayed and analysed in detail on the internet. It also allowed us to create daily, weekly and monthly reports of important risk-taking behaviour variables (such as speeding, average speed, large g-forces) and could also provide information on risk exposure (driving distance).

In order to improve the system, an event triggered video recording system could help verify each large g-force that was created by the monitored vehicles. It would also be beneficial to record lower speeding events such as driving 60 km/h on a road with a 50 km/h speed limit, but this depends on GPS based speed limit data for all roadways being available.

To fully evaluate the utility of this system and the effects of a driver training intervention, ideally the tracking device would be installed into the vehicles of the participants several months before the driver training programme, in order to obtain data based on the participants real driving behaviour. Baseline driving behaviour in experimental and control participants can then be established, so that any potential changes in the post–training driving behaviour of the experimental group can be clearly attributed to the effect of the driver training.

Acknowledgment

We would like to thank the Accident Compensation Corporation, the Road Safety Trust, and the ITO for funding this project. Thanks to the board of the AA Driver Education Foundation and to the a2om Driving Academy (UK) who both inspired us to conduct this study. We are grateful to all people who helped us to make the 'frontal lobe' training camp possible. And finally, a very special thanks to all 36 participants who invested two weeks of their holidays to become safer drivers.

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Appendix 8.2 Photographic impressions of the *Driver Training Research* camp

Appendix 8.2 cont








Appendix 8.3 Questionnaires (Aim 1)

Demographics

Instructions
Please provide the following information by entering your response in the appropriate place

1. What is your date of birth? _____
Day Month Year

2. Please indicate which best describes your ethnic background:

☐ New Zealand European
☐ New Zealand Māori
☐ Asian
☐ Pacific Islander
☐ None of the above, please specify_____

3. Are you currently

☐ single
☐ in a relationship
☐ married / civil union
☐ divorced
☐ widowed

4. What type of drivers licence do you hold?

☐ restricted for car
☐ full for car

5. What date did you obtain your restricted / full **car** driving licence? _____
Month Year

6. How many kilometers do you drive in a usual week? _____ km

Instructions
Almost every driver becomes involved in an adverse traffic event (accident or near-hits) of some sort during their driving years. We would like to know how often people experience such events. Please tell us how many ACCIDENTS or NEAR HITS that you have been involved in during **the last twelve months**

7. In the last twelve months, how many accidents have you been involved in?
An *accident* is any collision that occurred *on the public roads* (but not private property), while you were the driver of the vehicle and irrespective of who was at fault.

_____ accidents

8. In the last twelve months, how many near misses have you experienced?
A *near hit* is when you narrowly avoided being in an accident on public roads, while you were the driver of the vehicle and irrespective of who was at fault.

_____ near misses

Instructions
Nearly all drivers commit traffic offences and we would like you to estimate how often these have happened. Please let us know whether you have committed any traffic offences **in the last twelve months.** For each of the offences below indicate approximately **how many times** these happened. **Please write the number of times in the space provided. If you have no traffic convictions or warnings please put zero.**
A **conviction** is when your offence has legal consequences resulting in a fine and / or demerit points.
A **warning** is when you are stopped by the police regarding your driving but no further action is taken

Offence type	Convictions	Warnings
Speeding - e.g., over the legal limit		
Racing - e.g., competing with other drivers		
Reckless driving - e.g., cutting off other drivers		
Drinking or drug related e.g. driving under the influence		
Dangerous overtaking - e.g., overtaking with limited visibility		
Following too close - e.g., not obeying the two second rule		
Roundabout offences - e.g., using the wrong lane or use of inappropriate signals		
Failing to obey road signs - e.g., a stop sign		
Traffic signal offence - e.g., running a red light		
Parking offence - e.g., parking in disabled parking, on footpath		
Failing to stop - e.g., for police, after an accident		
Vehicle defects - e.g., broken headlamp, noisy vehicle		
Uncertified vehicle modification - e.g., lowered suspension		
Seatbelt offence - e.g., driving without a seatbelt		
Taking a vehicle without consent - e.g., theft		
Driver Licence offense - e.g., driving whilst disqualified, driving outside of license restrictions		
Driving without legal certification - e.g., driving without a warrant of fitness or without registration		
Traffic signal offence - e.g., running a red light		

Other, please provide details

_____
_____

_____
_____

Driving Violations (DV)

Instructions
Every driver makes occasional mistakes. Even the best drivers make errors or bend the rules sometimes. For each of the statements below indicate how likely you are to engage in this type of behaviour **in the future**. If you would never engage in that behaviour **circle 0**, if you think you will carry out the behaviour very frequently or most of the times that you drive **circle 4**. Use the remaining numbers to indicate the varying likelihood of your carrying out that behaviour.

In the future, how often would you expect to do each of the following?

Hardly ever 0% time	**Close to 25% of the time**	**Close to 50% of the time**	**Close to 75% of the time**	**Nearly 100% of the**
0	**1**	**2**	**3**	**4**

1.	Drive especially close to the car in front as a signal to its driver to go faster to get out of the way	0	1	2	3	4
2.	Become impatient with a slow driver in the outer lane and overtake on the inside	0	1	2	3	4
3.	Cross a junction knowing that the traffic lights have already turned against you	0	1	2	3	4
4.	Angered by another driver's behaviour, you give chase with the intention of giving him/her a piece of your mind	0	1	2	3	4
5.	Disregard the speed limits late at night or very early in the morning	0	1	2	3	4
6.	Drive even though you realize you may be over the legal blood-alcohol limit	0	1	2	3	4
7.	Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can	0	1	2	3	4
8.	Get involved in unofficial 'races' with other drivers	0	1	2	3	4
9.	Exceed the 100 km/h speed limit on the open road	0	1	2	3	4
10.	Drive fast	0	1	2	3	4
11.	Exceed the 50 km/h speed limit in built-up areas	0	1	2	3	4

Driver Attitude Questionnaire Versions A

Instructions
To what extent do you agree or disagree with each of the following statements?Please read each statement carefully, and then **circle** the number that corresponds to your reply.

Strongly disagree	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**
1	**2**	**3**	**4**	**5**

1.	Some people can drive perfectly safely after drinking three or four pints of beer	1	2	3	4	5
2.	People stopped by the police for close following are unlucky because lots of people do it	1	2	3	4	5
3.	I would welcome further use of double yellow lines to let me know when it is unsafe to overtake	1	2	3	4	5
4.	Speed limits are often set too low, with the result that many drivers ignore them	1	2	3	4	5
5.	I think the police should start breathalysing a lot more drivers around pub closing times	1	2	3	4	5
6.	It is quite acceptable to take a slight risk when overtaking	1	2	3	4	5
7.	Close following isn't really a serious problem at the moment	1	2	3	4	5
8.	I know exactly how fast I can drive and still drive safely	1	2	3	4	5
9.	Some drivers can be perfectly safe overtaking in situations which would be risky for others	1	2	3	4	5
10	Even one drink makes you drive less safely	1	2	3	4	5
11	I would favour stricter enforcement of the speed limit on 50 km per hour roads	1	2	3	4	5
12	Some people can drive perfectly safely even when they only leave a small gap behind the vehicle in front	1	2	3	4	5
13	The aim of the police should be to stop as many people as possible overtaking in risky circumstances	1	2	3	4	5
14	Even driving slightly faster than the speed limit makes you less safe as a driver	1	2	3	4	5
15	It's hard to have a good time if everyone else is drinking but you have to limit yourself because you're driving	1	2	3	4	5
16	I would be happier if close following regulations were more strictly applied	1	2	3	4	5
17	Stricter enforcement of speed limits on 50kmph roads would be effective in reducing the occurrence of road accidents	1	2	3	4	5
18	Even driving slightly too close to the car in front makes you less safe as a driver	1	2	3	4	5
19	I think it is O.K. to overtake in risky circumstances as long as you drive within your own capabilities	1	2	3	4	5
20.	The law should be changed so that drivers aren't allowed to drink any alcohol	1	2	3	4	5

Driver Attitude Questionnaire Versions B

Instructions
To what extent do you agree or disagree with each of the following statements? Please read each statement carefully, and then **circle** the number that corresponds to your reply.

Strongly disagree	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**
1	**2**	**3**	**4**	**5**

1.	It is quite acceptable to drive after only one or two drinks	1	2	3	4	5
2.	On the whole people aren't aware of the dangers involved in close following	1	2	3	4	5
3.	Even overtaking in a slightly risky situation makes you less safe as a driver	1	2	3	4	5
4.	I would be happier if the speed limits were more strictly enforced	1	2	3	4	5
5.	The aim of the police should be to stop as many drink-drivers as possible	1	2	3	4	5
6.	People stopped by the police for risky overtaking are unlucky because lots of people do it	1	2	3	4	5
7.	Harsher penalties should be introduced for drivers who drive too close to the car in front	1	2	3	4	5
8.	It's O.K. to drive faster than the speed limit as long as you drive carefully	1	2	3	4	5
9.	I know exactly what risks I can take when I overtake	1	2	3	4	5
10	Random breath testing of drivers should be continued	1	2	3	4	5
11	People stopped by the police for speeding are unlucky because lots of people do it	1	2	3	4	5
12	I think the 2 second rule (for following distance in the road code) is too long for people to use all the time	1	2	3	4	5
13	I would be happier if there was a clamp down on dangerous overtaking	1	2	3	4	5
14	Speeding is one of the main causes of road accidents	1	2	3	4	5
15	I think I know exactly how much I can drink and still be under the limit	1	2	3	4	5
16	It is quite acceptable to drive closer to the car in front than is recommended	1	2	3	4	5
17	Sometimes you have to drive in excess of the speed limit in order to keep up with the flow of traffic	1	2	3	4	5
18	I would favour a clamp down on drivers who drive too close to the vehicle in front	1	2	3	4	5
19	Risky overtaking isn't really a serious problem at the moment	1	2	3	4	5
20.	The amount of alcohol you're allowed to drink before driving is too high	1	2	3	4	5

Driver Risk Taking

Instructions
Sometimes the laws of the road seem either too strict or not strict enough. Tell us how you feel about each of these laws. For each statement **circle** the number indicating to what extent you **agree** or **disagree.**

Strongly disagree	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**
1	**2**	**3**	**4**	**5**

1.	I think it is OK to overtake in risky circumstances as long as you drive within your own capabilities	1	2	3	4	5
2.	The law should be changed so that drivers aren't allowed to drink any alcohol	1	2	3	4	5
3.	It is quite acceptable to drive after only one or two drinks	1	2	3	4	5
4.	On the whole people aren't aware of the dangers involved in close following	1	2	3	4	5
5.	Even overtaking in a slightly risky situation makes you less safe as a driver	1	2	3	4	5
6.	I would be happier if the speed limits were more strictly enforced	1	2	3	4	5
7.	The aim of the police should be to stop as many drink drivers as possible	1	2	3	4	5
8.	People stopped by the police for risky overtaking are unlucky because lots of people do it	1	2	3	4	5
9.	Harsher penalties should be introduced for drivers who drive too close to the car in front	1	2	3	4	5
10.	It's OK to drive faster than the speed limit as long as you drive carefully	1	2	3	4	5
11.	I know exactly what risks I can take when I overtake	1	2	3	4	5
12.	Random breath testing of drivers is a good idea	1	2	3	4	5
13.	People stopped by the police for speeding are unlucky because lots of people do it	1	2	3	4	5
14.	I think the stopping distances in the Road Code are too great for people to take notice of them	1	2	3	4	5
15.	I would be happier if there was a clamp down on dangerous overtaking	1	2	3	4	5
16.	Speeding is one of the main causes of road accidents	1	2	3	4	5
17.	I think I know exactly how much I can drink and still be under the limit	1	2	3	4	5
18.	I think it is OK to send text messages whilst driving	1	2	3	4	5
19.	It is quite acceptable to drive close to the car in front than is recommended	1	2	3	4	5
20.	Sometimes you have to drive in excess of the speed limit in order to keep up with the flow of traffic	1	2	3	4	5
21.	I would favour a clamp down on drivers who drive too close to the vehicle in front	1	2	3	4	5
22.	Risky overtaking isn't really a serious problem as the moment	1	2	3	4	5
23.	The amount of alcohol you're allowed to drink before driving is too high	1	2	3	4	5
24.	It is dangerous to talk on your mobile phone whilst driving	1	2	3	4	5

Self Evaluation Questions

Instructions
Please rate how strongly you agree or disagree with the following statement by circling the appropriate number.

1. I sometimes feel worried that I will be involved in an accident

1	2	3	4	5	6	7	8	9
Strongly Disagree				Neither Agree/ Disagree				Strongly Agree

2. I often get a thrill from driving

1	2	3	4	5	6	7	8	9
Strongly Disagree				Neither Agree/ Disagree				Strongly Agree

3. How likely are you to be involved in accidents in the future compared with the average driver?

1	2	3	4	5	6	7	8	9	10	11
Much less likely					About the same					Much more likely

4. How skilful do you think you are compared with the average driver?

1	2	3	4	5	6	7	8	9	10	11
Much less skilful					About the same					Much more skilful

Confidence 1

Instructions

We would like to know how you feel about driving in different circumstances. Read each of the statements below and indicate **how safe** you would feel driving in that situation. If you would feel **very safe**, **circle 1**, if you would feel **very unsafe, circle 5.** How do you feel about driving……..

Very Safe	**Safe**	**Neither**	**Unsafe**	**Very Unsafe**
1	**2**	**3**	**4**	**5**

1	At night?	1	2	3	4	5
2	In unfamiliar area?	1	2	3	4	5
3	In the city?	1	2	3	4	5
4	In bad weather?	1	2	3	4	5
5	After drinking?	1	2	3	4	5
6	Sleepy or tired?	1	2	3	4	5
7	Towing a trailer?	1	2	3	4	5
8	An unfamiliar car?	1	2	3	4	5
9	When angry?	1	2	3	4	5
10	Being tailgated?	1	2	3	4	5
11	At 100 km/ph?	1	2	3	4	5
12	At 110 km/ph?	1	2	3	4	5
13	At 120 km/ph?	1	2	3	4	5

Confidence 2

Instructions
Drivers vary in how confident they feel in different situations. Please rate how confident you feel driving in each of the situations described below. Circle **10** if you feel **completely confident** and circle **0** if you are **not at all confident**

Not at all confident — Completely confident

0 1 2 3 4 5 6 7 8 9 10

1	At night	0	1	2	3	4	5	6	7	8	9	10
2	In bad weather	0	1	2	3	4	5	6	7	8	9	10
3	In rush hour or heavy traffic	0	1	2	3	4	5	6	7	8	9	10
4	On the highway	0	1	2	3	4	5	6	7	8	9	10
5	On long trips	0	1	2	3	4	5	6	7	8	9	10
6	Changing lanes on a busy street	0	1	2	3	4	5	6	7	8	9	10
7	Reacting quickly	0	1	2	3	4	5	6	7	8	9	10
8	Pulling into traffic from a stop	0	1	2	3	4	5	6	7	8	9	10
9	Making a right turn across traffic	0	1	2	3	4	5	6	7	8	9	10
10	Parallel parking or backing into a space between cars	0	1	2	3	4	5	6	7	8	9	10

Attitudes Towards Risk

Instructions
Indicate using a 5 point scale the degree to which each of the following statements describes you.

Circle 1 to indicate it does not describe you at all (**not like me**) and **circle 5** if the description is a very good description of you (**like me**). Use remaining numbers to indicate the varying degrees that the statement is like you or not like you.

Please read each statement carefully and then circle the number that corresponds to your reply.

Not Like Me **Like Me**

1 **2** **3** **4** **5**

1	I like the feeling that comes with taking physical risks	1	2	3	4	5
2	While I don't deliberately seek out situations or activities that society disapproves of, I find that I often end up doing things that society disapproves of.	1	2	3	4	5
3	I often do things that I know my parents would disapprove of	1	2	3	4	5
4	I consider myself a risk-taker	1	2	3	4	5
5	Being afraid of doing something new often makes it more fun in the end	1	2	3	4	5
6	The greater the risk the more fun the activity	1	2	3	4	5
7	I like to do things that almost paralyse me with fear	1	2	3	4	5
8	I do not let the fact that something is considered immoral stop me from doing it	1	2	3	4	5
9	I often think about doing things that I know my friends would disapprove of	1	2	3	4	5
10	I often think about doing things that are illegal	1	2	3	4	5

Physical Risk Assessment Inventory

Instructions
Circle the appropriate number for each of the following activities to indicate their level of physical risk to **an average person**. In each case **click** any number from **0** (**No Physical Risk**) to **6** (**Extreme Physical Risk**).

No Physical Risk — **Moderate Physical Risk** — **Extreme Physical Risk**

		0	**1**	**2**	**3**	**4**	**5**	**6**
1	Mountain climbing	0	1	2	3	4	5	6
2	Smoking marijuana	0	1	2	3	4	5	6
3	Water skiing	0	1	2	3	4	5	6
4	Eating fatty foods	0	1	2	3	4	5	6
5	Parachute jumping	0	1	2	3	4	5	6
6	Skiing fast down a mountain	0	1	2	3	4	5	6
7	Being sexually promiscuous	0	1	2	3	4	5	6
8	Scuba diving	0	1	2	3	4	5	6
9	Driving recklessly	0	1	2	3	4	5	6
10	Heavy drinking	0	1	2	3	4	5	6
11	Rock climbing	0	1	2	3	4	5	6
12	Hang gliding	0	1	2	3	4	5	6
13	Using hallucinogenic drugs	0	1	2	3	4	5	6
14	White water kayaking	0	1	2	3	4	5	6
15	Using illegal stimulants	0	1	2	3	4	5	6
16	Smoking cigarettes	0	1	2	3	4	5	6
17	Mountain biking	0	1	2	3	4	5	6
18	Having unprotected sex	0	1	2	3	4	5	6
19	Piloting a small plane	0	1	2	3	4	5	6
20	Using cocaine	0	1	2	3	4	5	6
21	Surfing	0	1	2	3	4	5	6

No Physical Risk		Moderate Physical Risk				Extreme Physical Risk		
0	**1**	**2**	**3**	**4**		**5**	**6**	
22	Not exercising regularly	0	1	2	3	4	5	6
23	Driving after drinking alcohol	0	1	2	3	4	5	6
24	Horse riding	0	1	2	3	4	5	6
25	Ocean sailing	0	1	2	3	4	5	6
26	Using heroin	0	1	2	3	4	5	6
27	Diving off a high board	0	1	2	3	4	5	6

International Personality Item Pool

Instructions
Please use the rating scale to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly the same age. Please read each statement carefully, and then **circle** the number that corresponds to your reply.

Very **Inaccurate**	Moderately **Inaccurate**	Neither Inaccurate **nor Accurate**	Moderately **Accurate**	Very **Accurate**
1	**2**	**3**	**4**	**5**

1	Am the life of the party.	1	2	3	4	5
2	Feel little concern for others.	1	2	3	4	5
3	Am always prepared.	1	2	3	4	5
4	Get stressed out easily.	1	2	3	4	5
5	Have a rich vocabulary.	1	2	3	4	5
6	Don't talk a lot.	1	2	3	4	5
7	Am interested in people.	1	2	3	4	5
8	Leave my belongings around.	1	2	3	4	5
9	Am relaxed most of the time.	1	2	3	4	5
10	Have difficulty understanding abstract ideas.	1	2	3	4	5
11	Feel comfortable around people.	1	2	3	4	5
12	Insult people.	1	2	3	4	5
13	Pay attention to details.	1	2	3	4	5
14	Worry about things.	1	2	3	4	5
15	Have a vivid imagination.	1	2	3	4	5
16	Keep in the background.	1	2	3	4	5
17	Sympathize with others' feelings.	1	2	3	4	5
18	Make a mess of things.	1	2	3	4	5
19	Seldom feel blue.	1	2	3	4	5
20	Am not interested in abstract ideas.	1	2	3	4	5
21	Start conversations.	1	2	3	4	5
22	Am not interested in other people's problems.	1	2	3	4	5
23	Get chores done right away.	1	2	3	4	5
24	Am easily disturbed.	1	2	3	4	5
25	Have excellent ideas.	1	2	3	4	5

Very **Inaccurate**	Moderately **Inaccurate**	Neither Inaccurate **nor Accurate**	Moderately **Accurate**		Very **Accurate**	
1	**2**	**3**	**4**		**5**	
26	Have little to say.	1	2	3	4	5
27	Have a soft heart.	1	2	3	4	5
28	Often forget to put things back in their proper place.	1	2	3	4	5
29	Get upset easily.	1	2	3	4	5
30	Do not have a good imagination.	1	2	3	4	5
31	Talk to a lot of different people at parties.	1	2	3	4	5
32	Am not really interested in others.	1	2	3	4	5
33	Like order.	1	2	3	4	5
34	Change my mood a lot.	1	2	3	4	5
35	Am quick to understand things.	1	2	3	4	5
36	Don't like to draw attention to myself.	1	2	3	4	5
37	Take time out for others.	1	2	3	4	5
38	Shirk my duties.	1	2	3	4	5
39	Have frequent mood swings.	1	2	3	4	5
40	Use difficult words.	1	2	3	4	5
41	Don't mind being the center of attention.	1	2	3	4	5
42	Feel others' emotions.	1	2	3	4	5
43	Follow a schedule.	1	2	3	4	5
44	Get irritated easily.	1	2	3	4	5
45	Spend time reflecting on things.	1	2	3	4	5
46	Am quiet around strangers.	1	2	3	4	5
47	Make people feel at ease.	1	2	3	4	5
48	Am exacting in my work.	1	2	3	4	5
49	Often feel blue.	1	2	3	4	5
50	Am full of ideas.	1	2	3	4	5

Barratt Impulsiveness Scale

Instructions

We all act and think differently in day to day situations. Please read each statement and circle the answer that best describes the way you act and think. Do not spend too much time on any one statement. Answer quickly and honestly.

Rarely/Never	**Occasionally**	**Often**	**Almost always/always**
1	**2**	**3**	**4**

1.	I plan tasks carefully	1	2	3	4
2.	I do things without thinking	1	2	3	4
3.	I am happy-go-lucky	1	2	3	4
4	My thoughts race	1	2	3	4
5	I plan trips well ahead of time	1	2	3	4
6	I am self-controlled	1	2	3	4
7.	I concentrate easily	1	2	3	4
8.	I save regularly	1	2	3	4
9.	I find it hard to sit still for long periods of time	1	2	3	4
10.	I am a careful thinker	1	2	3	4
11.	I say things without thinking	1	2	3	4
12.	I like to think about complex problems	1	2	3	4
13.	I change jobs	1	2	3	4
14.	I act on impulse	1	2	3	4
15.	I get easily bored when solving though problems	1	2	3	4
16.	I have regular medical/dental check ups	1	2	3	4
17.	I act on the spur of the moment	1	2	3	4
18.	I am a steady thinker	1	2	3	4
19.	I buy things on impulse	1	2	3	4
20	I finish what I start	1	2	3	4
21.	I walk and move fast	1	2	3	4
22.	I solve problems by trial and error	1	2	3	4
23.	I spend or charge more than I earn	1	2	3	4
24.	I talk fast	1	2	3	4
25.	I have outside thoughts when thinking	1	2	3	4
26.	I am more interested in the present than the future	1	2	3	4
27.	I am restless in class/groups	1	2	3	4
28.	I plan for the future	1	2	3	4

Appendix 8.4 Further Results (Aim 2)

	Personality Factor								
	Extraversion			Agreeableness			Conscientiousness		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low (Mean (SD)
On Road Driving									
Search	.14	.72(.2)	.72(.2)	.10	.75(.2)	.68(.2)	-.07	.71(.2)	.70(.2)
Speed Choice	.27	.85(.2)	.78(.2)	.19	.87(.1)	.76(.2)	-.11	.79(.2)	.80(.2)
Direction Control	-.01	.84(.2)	.86(.2)	-.04	.85(.2)	.85(.1)	-.06	.87(.2)	.82(.2)
Composite	.16	.80(.2)	.79(.2)	.10	.82(.1)	.76(.2)	-.06	.79(.2)	.78(.2)
Driving Self Assessment									
Average Difference	-.16	3.26(9.2)	4.86(9.7)	-.21	.76(6.8)	7.8(13.2)	.27	4.06(10.5)	-1.6(7.7)
Road Commentary									
Hazards detected	-.24	8.22(4.2)	12.88(5.7)	.13	11.67(5.6)	8.00(5.0)	-.11	9.38(5.3)	9.00(5.6)
Action to Hazard	.01	4.78(2.9)	5.88(5.5)	.01	5.78(3.0)	4.88(4.2)	.06	5.78(5.1)	4.33(2.1)
Action to Non Hazard	.11	6.89(3.7)	6.00(3.7)	-.34*****	5.00(2.2)	8.2(4.6)	-.13	5.11(2.1)	6.22(3.8)

Table 1.1a. The relationship between personality variables and driving related assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$).

	Personality Factor								
	Neuroticism			Openness			Impulsivity		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low (Mean (SD)
On Road Driving									
Search	.04	.74(.1)	.72(.2)	-.10	.71(.1)	.74(.2)	-.19	.64(.2)	.73(.2)
Speed Choice	-.05	.77(.2)	.81(.2)	-.01	.84(.2)	.82(.2)	-.05	.75(.2)	.78(.2)
Direction Control	.04	.85(.2)	.85(.08)	-.22	.84(.2)	.87(.1)	-.24	.78(.1)	.88(.1)
Composite	.01	.79(.1)	.79(.1)	-.11	.80(.1)	.81(.1)	-.16	.72(.2)	.79(.2)
Driving Self Assessment									
Average Difference	.09	3.86(11.0)	3.05(14.1)	.01	4.24(12.1)	4.9(8.5)	-.06	5.90(7.4)	6.90(11.0)
Road Commentary									
Hazards detected	-.04	9.13(5.7)	9.56(4.0)	.19	9.75(5.0)	9.50(6.0)	-.20	6.56(3.8)	10.13(4.7)
Action to Hazard	-.02	5.25(3.1)	5.44(3.5)	.14	4.00(1.7)	4.50(1.6)	-.02	5.50(2.6)	3.75(1.8)
Action to Non Hazard	-.12	5.33(1.9)	6.89(4.2)	-.34*****	5.67(1.8)	6.11(4.6)	.27	7.78(4.1)	4.50(19.)

Table 1.1b. The relationship between personality variables and driving related assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$).

	Mood								
	Beck Depression Inventory (BDI)			Beck Anxiety Inventory (BAI)			Confidence		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low (Mean (SD)
On Road Driving									
Search	.16	.74(.1)	.68(.2)	.30	.80(.1)	.67(.2)*****	-.06	.75(.2)	.70(.1)
Speed Choice	.24	.84(.2)	.75(.2)	.34*****	.89(.1)	.72(.2)*****	-.05	.83(.2)	.76(.2)
Direction Control	.15	.86(.1)	.80(.2)	.16	.90(.1)	.85(.2)	.11	.87(.1)	.82(.1)
Composite	.21	.82(.1)	.74(.2)	.30	.86(.1)	.74(.2)	-.01	.82(.2)	.76(.1)
Driving Self Assessment									
Average Difference	-.36*****	-.49(11.8)	8.6(6.7)	-.40*	.55(10.8)	9.90(12.9)	.03	3.36(11.8)	8.68(9.1)
Road Commentary									
Hazards detected	.11	8.75(4.3)	6.56(3.6)	.10	8.88(4.3)	8.38(6.3)	.16	11.63(5.8)	6.63(4.7)
Action to Hazard	.04	4.33(1.6)	3.44(1.7)	.13	5.56(3.2)	5.57(4.3)	-.02	4.50(1.2)	4.43(1.8)
Action to Non Hazard	-.10	5.00(1.9)	6.33(3.3)	-.14	5.11(1.9)	6.67(3.2)	-.12	4.63(1.8)	7.44(4.4)

Table 1.2. The relationship between the mood measures and driving related assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$).

	Driver Violations			Driver Risk Taking			Driver Attitude Total		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On Road Driving									
Search	-.07	.67(.2)	.68(.1)	.16	.71(.1)	.68(.2)	0.16	.69(.2)	.68(.2)
Speed Choice	-.08	.75(.20	.76(.2)	.10	.79(.2)	.78(.3)	.07	.77(.2)	.80(.2)
Direction Control	-.19	.80(.1)	.89(.1)	.30	.86(.1)	.79(.2)	.21	.82(.1)	.82(.2)
Composite	-.12	.74(.1)	.78(.1)	.19	.79(.1)	.75(.2)	.15	.76(.1)	.76(.2)
Driving Self Assessment									
Average Difference	-.06	3.35(12.5)	6.00(9.3)	-.07	2.50(6.0)	3.08(8.8)	-.09	2.99(6.6)	2.32(9.4)
Road Commentary									
Hazards detected	-.04	7.67(4.1)	9.63(5.3)	-0.43*****	5.33(3.7)	11.89(4.8)*****	-.23	7.67(4.6)	11.56(4.6)
Action to Hazard	.36*****	6.67(4.1)	3.13(2.2)*****	.11	5.38(3.7)	4.75(2.0)	.26	8.00(5.4)	4.38(2.2)
Action to Non Hazard	.19	6.22(3.9)	5.50(2.1)	.03	6.67(4.8)	5.25(2.3)	.03	5.78(3.5)	5.63(2.3)

Table 1.3a. The relationship between responses to the driving related questionnaires and driving related assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$).

DAQ	Speeding			Drink Driving			Close Following			Overtaking		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On Road												
Search	.24	.78(.1)	.70(.2)	0.30	.74(.1)	.66(.2)	-.14	.65(.2)	.73(.2)	.11	.69(.2)	.70(.2)
Speed Choice	.13	.81(.13)	.77(.2)	.17	.80(.2)	.78(.2)	-.03	.75(.2)	.82(.2)	.06	.79(.2)	.78(.2)
Direction Control	.13	.88(.1)	.86(.2)	.22	.87(.2)	.81(.2)	.01	.82(.1)	.87(.2)	.10	.83(.1)	.81(.2)
Composite	.18	.83(.1)	.78(.2)	.25	.80(.1)	.75(.2)	-.06	.74(.1)	.81(.1)	.10	.77(.1)	.76(.2)
Driver Self Assessment												
Average Difference	-.11	4.6(10.8)	5.7(10.2)	-.16	1.74(8.5)	3.50(10.2)	-.10	3.5(6.05)	2.71(9.8)	-.05	4.51(10.7)	5.3(11.3)
Road Commentary												
Hazards detected	-.07	9.25(4.7)	11.25(5.6)	-.11	8.22(5.7)	10.67(5.7)	-.12	5.78(4.5)	10.88(4.8)*****	-.05	9.00(4.4)	9.38(3.7)
Action to Hazard	.18	5.75(3.3)	4.00(2.1)	.19	5.75(3.5)	5.56(5.2)	.03	5.88(5.7)	5.44(3.2)	.43*****	8.22(5.8)	3.63(1.6)*****
Action to Non Hazard	-.05	5.89(3.4)	5.78(2.1)	-.21	4.89(1.8)	7.00(3.5)	.23	7.56(5.2)	5.44(1.9)	.11	7.22(4.3)	4.63(2.1)

Table 1.3b. The relationship between responses to the driving related questionnaires and driving related assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$).

Self Evaluation Questions	Accident involvement			Thrill from driving			Accident in the future			Skill as a driver		
	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)	r (N=36)	High Mean (SD)	Low Mean (SD)
On Road Driving												
Search	.47*	.77(.2)	.58(.2)*	-.06	.67(.1)	.75(.2)	-.09	.72(.2)	.74(.1)	.14	.75(.1)	.70(.2)
Speed Choice	.37*	.84(.2)	.66(.2)	-.05	.74(.2)	.85(.2)	-.03	.78(.2)	.81(.1)	.07	.79(.1)	.80(.2)
Direction Control	.15	.84(.2)	.80(.1)	-.16	.78(.1)	.91(.1)	-.15	.80(.1)	.87(.1)	.20	.86(.1)	.80(.2)
Composite	.37*	.82(.2)	.68(.1)	-.09	.73(.1)	.84(.2)	-.09	.77(.1)	.81(.1)	.14	.80(.1)	.76(.2)
Driver Self Assessment												
Self Assessment	-.09	3.5(12.0)	5.1(9.6)	.15	8.47(13.7)	2.04(7.3)	-.06	3.3(16.2)	5.49(7.7)	.29	8.72(13.2)	.93(9.3)
Road Commentary												
Hazards detected	.34*	12.38(5.3)	7.56(5.8)	-.15	8.38(4.0)	9.78(5.6)	.09	10.00(4.7)	8.11(4.0)	-.09	9.75(3.9)	12.22(5.5)
Action to Hazard	.25	4.67(1.2)	3.75(1.8)	.23	6.00(4.2)	3.25(2.4)	-.05	5.63(3.7)	5.13(3.8)	.11	6.56(4.2)	6.13(5.3)
Action to Non Hazard	-.13	5.78(3.6)	7.11(4.2)	.14	6.78(3.4)	5.75(4.0)	.06	7.33(4.24)	5.13(2.2)	.18	5.89(1.4)	4.75(2.2)

Table 1.4.The relationship between participants self estimation of their driving and the driving related assessments from the first weekend. Data are presented as correlation (r), and the mean (standard deviation) of the upper and lower quartile. * indicates a significant correlation, or a significant difference between the upper and lower quartiles ($p<0.05$

Appendix 8.5 Copy of on-road driving assessment form (Aim3)

Name	**SEARCH**	Y	N	n.a	**SPEED CONTROL**	Y	N	n.a	**DIRECTION CONTROL**	Y	N	n.a	Total Y	Total N	Total N/Cr
1.Driving straight	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: SH1 50 kph sign to the bridge	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a.**							
2. Suburban St	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
Where: Spa Rd –	360	Y	N	n.a	Headway	Y	N	n.a							
Waiora House to Rotokawa St	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
3. Drive Left Curve	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Centennial Drive	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
A C Baths Ave to Warning sign.	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
4. U Turn	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Taupo Clay Pigeon Club	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	**n.a**			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
5. Drive Right Curve	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Kennel Club to A C Baths Ave	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	**n.a**			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**.							
Other Incidents															
TOTALS															
TOTAL Crucial NO															

Name	**SEARCH**	Y	N	n.a	**SPEED CONTROL**	Y	N	n.a	**DIRECTION CONTROL**	Y	N	n.a	Total Y	Total N	Total N/CR
6. Straight ahead - cross roads.	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
Where: A C Baths/ Tauhara	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**.							
7. Right turn - Roundabout /Shops	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
Where: Tahareapa/ Riflerange	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a.**							
8. Suburban Shops/ Driving Right Curve	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
Where: Tahareapa Rd from Elizabeth St to Bus Stop.	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**.							
9. Roundabout	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Taharepa	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
from Warning sign to School sign.	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	n.a							
10. Driving Downhill/ Turn right across S.H.	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	**n.a**			
Where: Taharepa/ Nhamotu - S H 1	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
Other incidents															
TOTALS															
TOTAL Crucial NO															

Name	**SEARCH**	Y	N	n.a	**SPEED CONTROL**	Y	N	n.a	**DIRECTION CONTROL**	Y	N	n.a	Total Y	Total N	Total N/Cr
11. Right Turn across	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: SH1 into Riflerange	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
From 50 kph sign – Roberts St	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**.							
12. Right Turn Stop Sign	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Riflerange/ Tamamutu	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	**n.a**			
From Gillies Ave to side road	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a.**							
13. Right Turn Unburdened	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
Where: Whakaipo into Gillies.	360	Y	N	n.a	Headway	Y	N	n.a							
From White fence to	HC	Y	N	n.	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a.**							
14. Drive right curve	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Gillies Ave	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	**n.a**			
from Rimu to Huia	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
15. Right Turn Give Way	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	**n.a**			
Where: Riflerange/Te Heuheu	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
Other Incidents															
TOTALS															
TOTAL Crucial NO															

Name	**SEARCH**	Y	N	n.a	**SPEED CONTROL**	Y	N	n.a	**DIRECTION CONTROL**	Y	N	n.a	Total Y	Total N	Total N/Cr
16. Right Turn across	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: SH1 into Riflerange	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
From 50 kph sign – Roberts St	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
17. Shopping Precinct	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Te Heu Heu	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
18. Angle Park	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Story Place	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	**n.a**			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
19. Reverse Parallel Park	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	n.a			
Where: Mission Road /Story Place	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
20. Shopping Precinct	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
Where: Te Heu Heu /Ruapehu	**12 Sec**	**Y**	**N**	**n.a**	**Reduces**	**Y**	**N**	**n.a**	**Steers away**	**Y**	**N**	n.a			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
Other incidents															
TOTALS															
TOTAL Crucial NO															

Name	**SEARCH**	Y	N	n.a	**SPEED CONTROL**	Y	N	n.a	**DIRECTION CONTROL**	Y	N	n.a	Total Y	Total N	Total N/Cr
21. Right Turn - Roundabout – Two lanes to one. Where: Spa/ S H 1	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	n.a	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	n.a			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
22. Right Turn across S H 1 Where: SH 1 from Kinloch to 100 kph	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	n.a	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	n.a			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
23. Drive rural road Where: From Huka Vineyard to Falls lookout sign	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	n.a	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	n.a			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
24. Right Turn across SH 1 Where: Huka Falls Rd / S H 1	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	n.a	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	n.a			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
25. Reverse into drive Where: Camp	2 Sec	Y	N	n.a	Legal	Y	N	n.a	Indicates	Y	N	n.a			
	4 Sec	Y	N	n.a	Safe	Y	N	n.a	Legal	Y	N	n.a			
	12 Sec	**Y**	**N**	n.a	**Reduces**	**Y**	**N**	n.a	**Steers away**	**Y**	**N**	n.a			
	360	Y	N	n.a	Headway	Y	N	n.a							
	HC	Y	N	n.a	Accelerates	Y	N	n.a							
	Selects Gap	**Y**	**N**	**n.a**	**Braking OK**	**Y**	**N**	**n.a**							
Other incidents															
TOTALS															
TOTAL Crucial NO															

Appendix 8.6 Copy of a diary (aim 4)

Frontal Lobe Project

Driving Diary 1

for the time period Monday, 16 October 2006 – Sunday, 22 October 2006

Your driving diary will be treated as anonymous. Your responses are kept confidential, i.e., means that they will only be used for research purposes (not reported in a way that there is a link to your name) and will not be disclosed to any third party. After the research, the diaries will be destroyed.

Odometer reading:

Date of reading:

My Time:
Conditions:

Successes e.g., a safe maneuvers - a car was tailgating me but I slowed down and then the other car passed me	
Problems/issues e.g., I still feel unsafe when I drive at night I got really angry about an older driver	
Near misses Please list here any unsafe maneuvers that may have ended in a crash. e.g., I was entering a roundabout in an unsafe manner and almost hit a car.	
Errors, lapses e.g., used wrong lane in roundabout forgot to indicate during lane change	
Crashes Describe crash situations that caused some damage to your car even when the damage was very minor. Who was at fault?	
Traffic fines Please describe the type of traffic offence e.g., parking ticket, speeding etc.,	
Other Comments/ Notes	

Please turn page

During the last two weeks - *Monday, 23 October – Sunday 5 November*

Have you been/used:

speeding (over 10 km/hr over speed limit)? No ☐ Yes ☐
if Yes - how often: 1-5 ☐ 6-10 ☐ 11-15 ☐ more ☐

unsafe following distances (less than 2 seconds)? No ☐ Yes ☐
if Yes - how often: 1-5 ☐ 6-10 ☐ 11-15 ☐ more ☐

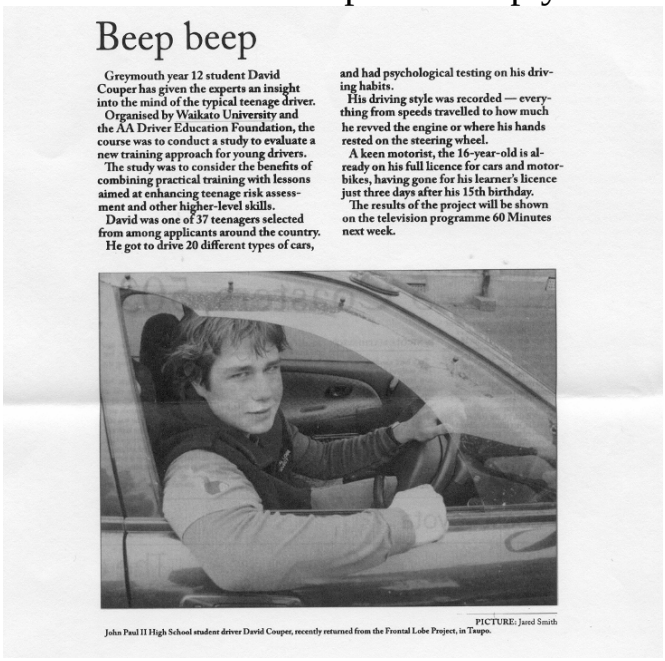
involved in unsafe overtaking maneuvers? No ☐ Yes ☐
if Yes - how often: 1-5 ☐ 6-10 ☐ 11-15 ☐ more ☐

text messaging while driving? No ☐ Yes ☐
if Yes - how often: 1-5 ☐ 6-10 ☐ 11-15 ☐ more ☐

a cell phone while driving? No ☐ Yes ☐
if Yes - how often: 1-5 ☐ 6-10 ☐ 11-15 ☐ more ☐

And finally,
Please estimate the number of kilometers you were driving over the last two weeks: _____ kms

THANK YOU SO MUCH!
And please keep yourself safe!



Beep beep

Greymouth year 12 student David Couper has given the experts an insight into the mind of the typical teenage driver.

Organised by Waikato University and the AA Driver Education Foundation, the course was to conduct a study to evaluate a new training approach for young drivers.

The study was to consider the benefits of combining practical training with lessons aimed at enhancing teenage risk assessment and other higher-level skills.

David was one of 37 teenagers selected from among applicants around the country. He got to drive 20 different types of cars, and had psychological testing on his driving habits.

His driving style was recorded — everything from speeds travelled to how much he revved the engine or where his hands rested on the steering wheel.

A keen motorist, the 16-year-old is already on his full licence for cars and motorbikes, having gone for his learner's licence just three days after his 15th birthday.

The results of the project will be shown on the television programme 60 Minutes next week.

PICTURE: Jared Smith

John Paul II High School student driver David Couper, recently returned from the Frontal Lobe Project, in Taupo.

Frontal Lobe Project

Dear Frontal Lobe project participant,

Thanks to those who returned their first driving diary – MUCH appreciated.

The winner for the first diary was Chloe Foden – She was the first who returned her diary. Your prize is in the mail!

One participant suggested to keep a little notebook in the car and record the driving events as they happen so that you don't forget..

As promised we would like to keep you informed about the data analysis

1) *Check out one of the next TV3 60 minutes documentary.*
2) *Again we received a lot of media attention in the few days. See the article about David Couper.*

And now we need again your help (-;

- *Please complete the second diary (for the previous two weeks). Please fill in the first section of the diary even if you have not been driving at all during that time.*
- *Send your diary in the enclosed and stamped envelope ASAP, but* ***please not later than Wednesday, 8 November, 2006.***
- *Remember there are still tonnes of prizes to be won - and your diaries are extremely important for the project so please keep them going.*

THANK YOU SOOO MUCH!

With Frontal Lobe wishes! *Robert Isler and Peter Sheppard*