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DOES A VIDEO SPEED TASK PREDICT RISKY SPEEDING BEHAVIOUR IN YOUNG AND INEXPERIENCED DRIVERS?

A THESIS

SUBMITTED IN FULFILMENT

OF THE REQUIREMENTS FOR THE DEGREE

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BY

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"Youth are heated by nature as drunken men by wine"

- ARISTOTLE

Abstract

Vehicle crashes account for the highest number of fatalities for persons aged between 17 and 25 years of age in New Zealand. Despite a myriad of factors precipitating vehicle crashes, excess or inappropriate vehicle speed has been identified as the greatest predictor of crash likelihood and severity. Excess or inappropriate speed reduces a driver's control over the vehicle, while exaggerating both collision force and the distances required in stopping or safely maneuvering. One of the major differences identified between young and inexperienced and older more experienced drivers is the ability to adapt driving behavior to road conditions. Young drivers are more prone to speeding through both a lack of awareness of risks and a desire to seek out novel and stimulating experiences. Recent developments in cognitive models of risk taking propose that older more experienced drivers may adapt their speed by "feeling out" the road conditions, where as young drivers may depend more upon posted limits to determine their speed.

A video speed task was developed to measure speed preferences on a selection of road conditions (or 'environments') commonly confronting New Zealand motorists. Analyses of speed preferences revealed that young and inexperienced drivers preferred speeds close to the road-limit irrespective of conditions, whereas older and more experienced drivers preferred speeds clearly below the road limit, and demonstrated greater variation in speed preferences on different road environments. This suggests that young and inexperienced drivers both prefer faster speeds and may use the road limit as a target in determining an appropriate speed. Older and more experienced drivers prefer slower speeds, and adapt driving to changing road conditions. Faster preferred speeds were found to be related to a riskier attitudes towards driving in general, and more lenient attitudes toward speeding in particular. In addition, faster preferred speeds were found to be related to a heightened enjoyment of risk taking, as well as the number of speeding convictions issued in the previous 12 months.

The used video speed task provided a convenient measure of speeding behavior in natural driving scenarios, and appeared to be sensitive to differences in the way drivers adjust their behavior across changing driving conditions. The video speed task might be useful in determining differences in speed choice

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between day and night time driving scenarios, as well as expanding the road conditions to including wet or foggy driving situations. This may be particularly useful in determining the pre- and post-effectiveness of driver training programs.

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Ethical Information

This research was conducted in accordance with University of Waikato Ethical Guidelines concerning human testing (University of Waikato Handbook on Ethical Conduct in Research, 2001). Application for human testing was submitted to the University Ethics Committee on 21 Nov 2006, and with addendum was approved on the 22 Feb 2007.

Participants were briefed concerning their rights as participants under the department ethical guidelines, and were informed about the nature of the experiment with opportunity to enquire regarding the research. Participants gave written consent before undergoing testing. Participants enrolled in first year psychology papers were given 1.5 points course credit for their involvement towards their final grade. Participants were emailed a breakdown of research findings, and were given opportunity to obtain a complete copy of this report from the faculty library.

THIS THESIS IS DEDICATED TO MY GRANDFATHER

GRAEME REGINALD CANTWELL

(1927-2009)

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1. Literature Review

1.1. The Young Driver Problem – Dying to Drive

Young adults present as a unique population of individuals in numerous regards, and for many individuals, this transition marks a period of unprecedented liberty and exploration, where vivid colour emerges to form the masterpiece of adulthood from the childhood sketches fashioned upon life's canvas.

1.1.1. Risk taking is a common characteristic of young persons

According to Arnett (2000), the years from ages 18 to 25 cover a period of life best described as 'emerging adulthood' in which individuals undergo a variety of developmental changes, maturing both personal identity and higher cognitive processes (Roisman, Masten, Coatsworth, & Tellegen, 2004; Schulenberg, Maggs, & O'Malley, 2003; Dahl, 2004). While emerging adulthood is a sociological construct, the transition through young adulthood is accompanied by numerous refinements to behavioural and personality characteristics which establishes the cognitive architecture which flavours adulthood. Concurrent to these physiological and cognitive changes are changes in social responsibilities, and unfortunately often accompanying the many rewarding opportunities is also the potential for poor decision-making and disadvantageous actions which may negatively affect the span of life following.

Young adulthood is characterized by marked increases in experimentation and novelty-seeking, often involving potentially risky behaviours which may involve health-damaging consequences. According to both Spear (2000) and Dahl (2004), the adolescent population exhibits a disproportionately high tendency to engage in poor decision-making when compared to older persons - in part owing to physiological and neurological changes in the maturing brain. This predisposition may lean young people towards a variety of reckless, risky, gratifying, or impulsive behaviours which may hold detrimental effects. As a general consensus in contemporary literature, young people are overrepresented in the prevalence of substance use and abuse, excessive consumption of alcohol, precocious unprotected or otherwise risky sexual behaviour, cigarette smoking, and suicidal behaviour (Johnston, O'Malley, & Bachman, 2001; Irwin, 1992; Igra & Irwin, 1996). These risky activities account for a significant proportion of morbidity and mortality for young persons (Irwin, 1994). In addition to this, reckless or dangerous driving has been identified as a reasonably common behaviour exhibited by young people that leads to injury or death (Jonah, 1986).

Young adults cannot be treated as a homogenous group - in that not all young persons engage in unfavourable levels of risk-taking. However, amongst those who do undertake frequently high-risk activities, engaging in one type of risky behaviour is often part of a much larger accompanying propensity to engage in other forms of risky behaviours (Dryfoos, 1990). For instance, reckless or dangerous driving amongst young people is often found to accompany a sphere of other behaviours such as delinquency and social deviance, unsafe sexual practices, drug abuse, cigarette smoking, a history of driving offence, frequent and heavy drinking, and travelling in a vehicle operated by an intoxicated driver (Jessor, Donovan, & Costa, 1991).

1.1.2. Traffic accidents constitute highest proportion of adolescent fatalities

While all the aforementioned risky behaviours are of great concern to the public and policy-makers alike, Evans (1991) has suggested that reckless or dangerous driving accounts for the greatest proportion of all deaths amongst young persons. This suggestion by Evans (1991) is also reinforced across numerous studies that utilise the wealth of evidence accrued through international mortality statistics. While many of the unwise activities common to youth may have long term health consequences manifesting in later life (i.e., experimentation with smoking or drugs), vehicle crashes are responsible for the most immediate deaths during young adulthood. Detailed surveying of mortality statistics reveal that vehicle crashes are the leading cause of death for persons aged fifteen through to twenty-nine years (Peden, McGee & Krug, 2002). For instance, the American-based Centre for Disease Control and Prevention (2001) concluded that three quarters of deaths for persons aged between 10 and 24 years of age were due to motor vehicle crashes.

Evidence from crash statistics reveals that young and inexperienced drivers, particularly young men, are consistently at higher risk of crashing compared to older and more experienced drivers (Williamson, 2001). An analysis of international crash statistics by MacDonald (1994a) found that young drivers (aged 18 - 24) were at a greater risk of being involved in an accident than their older counterparts (25+ years) even after distance driven and licence classification were taken into account. What is curious about these mortality statistics is that, although young and inexperienced drivers comprise only a relatively small proportion of the total driving population, they nonetheless account for the greatest number of fatal vehicle crashes for any age group (Deery, 1999; MacDonald, 1994a).

In the United Kingdom, 29% of fatal accidents in 2006 involved a young person even though they account for only 13% of the driving population (Brake, 2007). Similarly in Victoria Australia, 27% of drivers killed each year are young and inexperienced even though they constitute only 13% of all drivers (Australian Transport Accident Commission, 2008). This trend of young drivers being involved in vehicle crashes is also found across the international stage in statistics from the United States (Karpf & Williams, 1983; Williams, 2003), Canada (Transport Canada, 2003), Sweden (Thulin & Nilsson, 1994), Japan (Hitosugi & Takatsu, 2002), Netherlands (Vlakveld, 2004), and New Zealand (Land Transport Safety Authority, 2008).

Internationally, it is recognised that this group of drivers aged between 15 and 24 years of age – although a relative minority in the entire driving population - comprise the highest proportion killed on roads each year. Justifiably, this constitutes a significant financial, health, and policy concern in developed countries.

1.1.3. The young driver problem in New Zealand

The disproportionate representation of young and inexperienced drivers in international crash statistics is consistent with trends observed in New Zealand. More over, it has been suggested by several researchers that the severity of crashes involving young drivers is worse for New Zealand when compared to other developed countries (Langley, Wangenar, & Begg, 1996) and a continuously growing wealth of statistical research seems to justify this conclusion. It is noteworthy that this disparity may be in part owing to differences in road conditions and speed restrictions between nations, and that older vehicles with fewer safety features are still in operation in New Zealand.

In 2007, drivers in New Zealand aged 15 to 24 were at fault in 106 fatal crashes resulting in 125 deaths, 638 serious injury crashes resulting in 848 serious injuries, and 3,164 minor injury crashes which resulted in 4,719 minor injuries. Excess speed and driving under the influence of alcohol or drugs were identified as the major contributing factors in fatal crashes. It has been suggested that crash rates of young drivers are two and half times more likely to have speed as a contributing factor than those crashes involving drivers aged over 25 years (Land Transport Safety Authority, 2008; MacDonald, 1994a). Excessive or inappropriate speeding, leading to a loss of vehicle control, is one of the most common precipitant of severe crashes, and it has been suggested that driving too quickly elevates the crash risk to a similar extent to that of driving under the influence of alcohol (Kloeden, McLean, Moore, & Ponte, 1997).

According to a Land Transport Safety Authority (2008) survey of crash statistics in New Zealand, 42% of fatal crashes involving young drivers were attributed to driving at a speed inappropriate to road conditions, followed by driving under the influence which accounted for 34% of fatal crashes. In comparison, fatal crashes involving older drivers were more likely to be owing to other factors apart from speeding or driving under the influence. Driving under the influence was slightly more likely to be implicated in fatal crashes of older drivers (19%) with 16% of fatal crashes attributed to inappropriate speed.

1.1.4. The graduated licensing system in New Zealand

Due to concern over the high rate of young people implicated in injurious or fatal crashes on New Zealand roads, a number of policies have been implemented in attempt to curb their gross over-representation in severe crashes. One such strategy is the graduated driver licensing scheme (GDLS), which was introduced by the New Zealand transport authority in 1987. The GDLS attempts to reduce the crash likelihood of an inexperienced driver by enforcing restrictions on the conditions which contribute to the majority of serious vehicle crashes (i.e., driving with passengers or at night). These restrictions especially target those factors which contribute toward crashes involving young drivers (MacDonald, 1994a; Karpf & Williams, 1983). Under the GDLS, drivers obtain a series of consecutive permits (or licences) which involve degrees of restriction under which novice drivers are authorised to operate a vehicle (such as the time of day or supervision; for a review see Falk & Montgomery, 2007). At the age of 15 years, a driver may apply for a 'learners' permit, for which they must be accompanied by a fully licensed person at all times whilst driving. After six months of 'supervised' driving, a 'learner' may then apply to graduate to a restricted license where they are entitled to operate a vehicle unaccompanied, but are still not permitted to carry passengers or drive during the night time.

Within the graduated licensing scheme, the time from which a young person may begin learning to drive through until being able to drive without restriction might take as little as 12 months. This means that by the age of 16 years a driver may become eligible to hold a 'full' unrestricted license. This age is still considerably lower when taken in comparison to other developed countries (which range in eligibility for full licenses from an age of 17 through to 20 years).

Despite the introduction of the graduated driving scheme, it has been suggested by Langley, Wangenar, & Begg (1996) that young-driver crashes have been reduced by as little as 7 percent - a reduction that might reflect the decreasing trend of crashes overall as opposed to the restrictions which precipitate serious incidents. This proposition has been fortified again more recently by Kingham, Pearce, Dorling, & Faulk (2008). There is however, some research which suggests that the graduated licensing system has had significant impact in reducing the rates of accidents. Begg & Stephenson (2003) have concluded that over the period of 1987-1998 the rate of serious crashes was halved for the young driving group (17-24), attributing this reduction primarily to the introduction of the graduated licensing system. It is worth noting that many of the fatal crashes involving young drivers occur in situations where the restrictions of the GDLS have been deliberately violated, and research suggests that attitudes of disregard or contempt for traffic restrictions often accompany those young persons exposed to a greater driving risk.

One issue appears to lie at the heart of the GDLS, in that it is focused on increasing the quantity of driving experience without addressing the need for skill acquisition and improving hazard detection. Hazard awareness is a critical skill in safe driving, and Senserrick (2007) notes several recent changes in the Australian GDLS paradigm which introduce additional hazard awareness measures as part of licensing scheme. It will be interesting to note how these shifts influences crash rates over time for young driver in Australia.

Regardless of the provisional success of the GDLS – of which there is ongoing research and debate - the problematic overrepresentation of young and inexperienced drivers in serious crashes remains a significant concern for policy makers in the transport authority. Sadly, irrespective of proactive policy changes and awareness campaigns, New Zealand remains one of the world leaders in crash involvement in general by young drivers, particular those aged young than 25 years.

1.1.5. Young driver problem or young problem driver?

It is important to consider that the driving population is not homogenous in propensity to take risks, but is rather composed of variegated groups which have different characteristics and rates of crash involvement. Researchers have made several distinctions within the young driver population by studying the characteristics of drivers who are at higher likelihood to engage in dangerous driving. While there is a problematic over-representation of young drivers in vehicle crashes in general, the majority of serious crashes may be attributed to a particularly high-risk group of young drivers in particular.

This distinction between the general 'young driver problem' and the particular high-risk individuals known as 'young problem drivers' has been helpful in identifying the traits surrounding dangerous driving (Crettenden and Drummond, 1994). The young driver problem is one where factors such as inexperience and lack of hazard detection are most likely to contribute, with errors and lapses occurring unintentionally, or a failure to identify the present risks inherent in, but still precipitating a crash. In comparison to this, young problem drivers may undertake dangerous manoeuvres or take excessive and unwarranted risks while driving, deliberately doing so in order to receive thrill or peer approval (Senserrick, 2006). Age and driving experience both seem to be important considerations in understanding the young driver problem, and it is important to discriminate between deliberate and non-deliberate risk taking amongst drivers.

In summary, risk taking is common to young persons, and has been viewed as a natural part of maturation during young adulthood. While risk-taking is a normal component of life, taking unwarranted risks may also lead to potentially negative consequences. Dangerous driving has been found to be one of leading causes of death during youth. Young and inexperienced drivers are particularly over-represented in crash statistics despite their relatively small representation of the driving population, and among the factors that precipitate crashes excess or inappropriate speed plays a significant role in explaining the crash likelihood of young drivers.

1.2. Age, experience, and the need for speed

1.2.1. Excess speed plays a significant role in increased crash likelihood

Excess or inappropriate speed has been identified as one of the principal contributors toward serious vehicle crashes, and travelling at an excessive or inappropriate speed elevates both the risk of being involved in a crash, as well as increasing the severity of those crashes. Although the distinction between excess speed and inappropriate speed will be explored in greater detail later, there is an undeniable connection between speed and the risk and severity of vehicle crashes (Elvik, Christensen, & Amundsen, 2004).

Elliot and colleagues suggest that driving at a speed inappropriate to the road condition is the strongest predictor of severe crashes irrespective of the age and experience of the driver (Elliot, Armitage, & Baughan, 2005). Although excessive speed has been identified across the wider driving population, it is a particularly frequent activity for young drivers (Janke, Masten, McKenzie, Gebers, & Kelsey, 2003; Williams, Kyrychenko, & Retting, 2006). Several studies have found speeding to be the most common kind of driving offence perpetrated by young drivers (Cooper, 1997; Clarke, Ward, & Truman, 2005); and given that young drivers are prone to speeding, it is not surprising that excessive or inappropriate speed has been identified to be the greatest contributing factor toward single-vehicle crashes for drivers aged under 25-years. Campbell and Stradling (2003) found in a survey of Scottish drivers, that drivers aged between 21 and 29 years of age were generally the highest proportion of those who would deliberately violate the speed limit, with young males aged between 16 and 25 years of age identified as the group most likely to drive at an excessive speed. As speeding is a common behaviour for young drivers, and a frequent precipitant of crashes (MacDonald, 1994a), due attention needs to be emphasised towards excessive or inappropriate speeding amongst other problem behaviours address by policy makers.

The types of crashes, and the factors which precipitate them, have been identified in the literature to differ between young and inexperienced and older more experienced drivers. Young and inexperienced drivers are more likely to be involved in crashes involving a single vehicle (such as losing control on corners, leaving the road, rolling the vehicle, or colliding with a stationary object), as opposed to incidents involving multiple vehicles such as head-on collisions (Gonzales, Dickinson, DiGuiseppi, & Lowenstein, 2005). When compared with older and more experienced drivers, young and inexperienced drivers are more likely to be involved in crashes where speeding, reckless driving, and/or alcohol were contributing factors. They are also more prone to engage in other risky driving behaviours such as close following, dangerous overtaking, and failing to allow sufficient time to merge traffic lanes (Gullone & Moore, 2000). While some of these risky driving behaviours are obviously the consequence of insufficient driving experience (e.g., merging, dangerous overtaking) others might be better explained by the heightened risk-taking and thrill-seeking that accompanies emerging adulthood (e.g., deliberate speeding or driving recklessly).

The New Zealand Land Transport Safety Authority (2008) deduced loss of vehicle control to be the third major factor (37 percent of crashes) involved in fatal crashes for young drivers, compared to 22 percent for older drivers. Loss of control and speeding are likely to be cooperative factors in fatal crashes, where a vehicle either leaves the road or enters the path of oncoming traffic. Braitman and colleagues (2008) examined police reports in conjunction with interviews with drivers, and identified the primary factors in contributing increased crash risk to be poor hazard awareness and detection, followed by excess speed and loss of vehicle control, excess speed emerged as the primary factor, often preceding and contributing to loss of vehicle control (Braitman, Kirley, McCartt, & Chaudhary, 2008). This indicates that both excess speed and poor hazard awareness may together contribute to the loss of vehicle control, elevating crash likelihood and severity.

1.2.2. Accumulating driving experience reduces crash likelihood

As drivers' gain more driving experience, their ability to identify hazards and execute safe vehicle manoeuvring improves. Greater ability to detect hazards and safely manoeuvre together may influence how a driver adapts to road conditions, especially at high speeds (Lee, 2007). Speeding in excess of the posted limit increases the risk that the driver will either misjudge important hazard cues or lose control of the vehicle, while extending the distanced travelled after executing a manoeuvre or applying the brakes (Frith, Strachan, & Patterson, 2005).

Inability to judge road conditions seems to also elevate the risk of crash involvement. Poorly identifying road conditions and hazards, and not making appropriate adjustments to driving behaviour may have a significant influence on the likelihood of crashing. Many crashes have been traditionally attributed to lack of driver experience and perceptual training in hazard detection, and this lack of driving experience has been identified in playing a significant role in increasing crash risk for young drivers (Horswill and McKenna, 2006). For example, Braitman and colleagues found that young and inexperienced drivers are more likely to be involved in accidents through lack of awareness of other vehicles at intersections or round-abouts, owing to diminished hazard detection (Braitman, Kirley, McCartt, & Chaudhary, 2008).

As the amount of driving experience accumulates, there seem to be changes to the way in which hazard awareness and perceived levels of risk moderate speed preference. In a study employing pre-recorded video of various traffic environments in measuring risk and hazard awareness, Renge (1998) found that the amount of experience had a strong influence on both hazard detection ability, and speed preference between newly licensed, novice and experienced drivers, and driving instructors. Renge (1998) identified a significant relationship between improved hazard detection and both perceived level of risk and lower speed preferences. As driving experience increased, drivers' had a greater ability to perceive hazards and selected slower speeds. However, increased hazard detection was not found to correlate with self-rated driving confidence.

Although primary driving skills can be acquired in a relatively short amount of time, inexperienced drivers often lack developed perceptual skills and the executive processes that are required in processing the sensory information needed to drive safely (Deery & Fildes, 1999), and tend to be less able to anticipate the behaviour of other road users and react accordingly (McKenna, Alexander, & Horswill, 2006). Inexperienced drivers scan the road environment less efficiently than more experienced drivers, and this means that inexperienced drivers might not perceive salient road hazards as well as more experienced drivers do, and tend to only identify hazards that are in the immediate vicinity, and are therefore unlikely to detect hazards much further down the road (Groeger & Brown, 1989). This suggests that inexperienced drivers who travel at high speeds may not detect a hazard until it is too late to safely respond, and at speed may overcorrect in manoeuvring the vehicle leading to an accident.

Additionally, inexperienced drivers might also not identify changes in risk across road environments, and this makes them particularly vulnerable if they fail to adjust driving style in accordance with changes in the levels of hazards. For example, a driver may become habituated to hazards commonly encountered whilst driving in a familiar environment. However, when this driver encounters an unfamiliar environment they may not adjust their learnt driving style to the new road conditions.

1.2.3. Increasing age of drivers reduces crash likelihood

Lack of driving experience clearly has an effect on a driver's ability to both identify and appropriately control the vehicle, and these contribute toward heightened accident risk. However, age also seems to exert some influence over the propensity to engage in risky or reckless behaviour. This raises the question as to whether lack of experience can account for the disproportionately high representation of younger drivers in vehicle crashes.

As driving experience tend to increase concurrently with driver age, it generates a somewhat problematic task for researchers trying to distinguish the influence of experience on driving behaviour from confounding age effects (Groeger, 2006). As young drivers often have little driving experience, there is naturally the difficulty in

disentangling the influence of age and experience, and Jonah (1986) has questioned the fruitfulness of attempting to estrange one from the other.

Despite this, there continues to be significant debate amongst researchers as to the effect that age plays in determining crash risk for young and inexperienced drivers. Many researchers in the field of driving behaviour have suggested that there are two concurrent dimensions needed when investigating young novice drivers - namely, that they are young, and secondly, that they are underdeveloped in their hazard awareness and vehicle handling ability.

Levy (1990) conducted studies to identify the differences between younger novice and older novice drivers, finding an elevated risk of being involved in an accident for all novice drivers regardless of the age at which driving was undertaken; which suggests that experience has a significant effect on crash likelihood apart from the influence of age. This is supported by the findings of Mayhew and colleagues, indicating crash likelihood is greatest in the month immediately following licensing for all drivers regardless of age, and then decreases substantially over the course of the following six months (Mayhew, Simpson, & Pak, 2003).

However, their research also identified a complimentary effect when crash likelihood was predicted in relation to the age of initial licensing. Forsyth and colleagues identified a similar effect between age and experience, with the risk of being involved in a crash being nine percent lower for drivers who begin training at 18 years of age as opposed to those who begin training at 17 (Forsyth, Maycock & Sexton, 1995).

Several studies have found that the crash rates for both experienced and inexperienced drivers tend to decrease with age (Laberge-Nadeau, Magg, & Bourbeau, 1992) which seems to indicate that age has a complimentary but distinct role in predicting crash likelihood. Additionally, driving experience may exert a stronger influence in reducing crash likelihood for older drivers when compared to their younger counterparts (MacDonald, 1994b), and this implies that there may be other age-dependant factors operating alongside inexperience in predicting the crash risk of young drivers (Bina, Graziano, & Bonino, 2006). For instance, although hazard awareness can be vastly improved with training (e.g., experience) there are

also developmental considerations (e.g., age) such as the maturation of the brain that contributes to the ability to process and interpret complex information in a rapid and efficient manner (Keating, 2007).

It is widely acknowledged amongst researchers that a number of factors contribute toward elevated crash likelihood of young drivers (i.e., overconfidence and underestimating the probability of driving risks). Although insufficient experience and underdeveloped driving skills contributing toward predicting inexperienced drivers' crash involvement (Maycook, 2002), there is a growing consensus found in contemporary literature which suggests that a general propensity toward risk-taking contributes more to crash involvement then does poor driving ability (for instance Clarke, Ward, & Truman, 2005).

One perspective is that risky driving involves the enlargement of conditions which might lead to crash involvement; and Brown (1982) has suggested that even when conditions remain static for drivers, some individuals drive in such a way that might lead to being involved in a crash. This suggestion is supported by research conducted by both Jonah (1986) and Jessor (1984). Jonah conducted a substantial review of Canadian driving research finding that drivers aged between 16 and 19 years were found to have an elevated risk of crash involvement, even when both quantity and quality of risk were controlled (Jonah, 1986). Parker and colleagues (1995) suggest that deliberate violations account for more accident involvement than errors or lapses, which indicated that young and inexperienced drivers are more crashes occur from deliberate risk taking as opposed to errors owing to inexperience and lack of developed driving skills.

What has emerged from revision of several driver education initiatives is that while education and skill might increase with training, these might have little influence on post-training driving behaviour (Christie, 2001). Moreover, McKnight and Resnick (1993) have suggested that young drivers tend to engage in risks which have little to do with increased knowledge or skill, but rather more complex individual motivations such as sensation or thrill-seeking. It would appear that the young driver problem is more than mere lack of experience, but rather, that crash risks associated with lack of driving experience might be exacerbated by increased sensation-seeking and attitudinal changes that occur during youth.

A complex interaction between inexperience and neurological changes occurring during youth may predispose young and inexperienced drivers to prefer speeds that are either excessive or inappropriate (refer to section 1.5). Combining poor hazard and risk awareness and lack of vehicle control and manoeuvring skills that come from inexperience with the sensation-seeking and attitudes that accompany late adolescent development might work toward a more holistic explanation as to why young and inexperienced drivers are over-represented in New Zealand crashes.

In summary, researchers have made distinctions between young drivers and inexperienced drivers, with both youth and inexperience contributing to crash involvement. Disentangling age and experience effects has proven a substantial task, as experience tends to increase with age. Increased driving experience is related to improved awareness of road hazards and perceived level of risk, and also greater ability to safely manoeuvre a vehicle at speed. Age also seems to play a role, with young drivers prone to taking more risks whilst driving and having greater cognitive load when processing road cues. Age and inexperience may co-contribute toward elevating crash risk, especially when excessive speed is a factor. Young drivers may judge the ideal speed for conditions incorrectly due to inexperience, but are also likely to deliberately violate the speed limit or engage in reckless driving.

1.3. Speeding with an Attitude

1.3.1. Speeding is related to attitudes and personality characteristics

While most drivers in general tend to regard modest speeding slightly above posted limits not to be a particularly risky behaviour (Oxley & Corben, 2001), young and inexperienced drivers in particular have a stronger tendency to under-rate the risks associated with excessive speed. Young and inexperienced drivers generally perceive the risk of speeding to be low (Jonah, 1986; Sarker & Andreas', 2004), and DeJoy (1989) identified a relationship between faster speeds and a low perception of risks. This seems to confer with the findings of Renge (1998) who found that increased driving experience (closely related to age) is related to drivers' heightened perception of risk, and also slower speed preferences.

It has been suggested that one of the reasons that young drivers have a lesser view of the risks of speeding is that they tend to be overconfident in their capacity to control a vehicle (Brown, 1982). This relationship between confidence and speed preference has also been identified by Corbett (2001), suggesting that drivers who are confident in their ability to control a vehicle tend not to view exceeding speed limits to be dangerous. This is important, considering young and inexperienced drivers tend to have poor hazard awareness and actual driving skill, and that loss of control at speed is strongly related to driver fatalities. If young drivers are over confident in their vehicle handling ability, they may choose to travel at a greater speed despite their actual ability, and this may significantly enlarge their likelihood of becoming involved in a serious crash.

The fact that young and inexperienced drivers are particularly prone to engage in excessive or inappropriate speeding is evidenced by the generally lenient attitude towards speeding held by many young drivers (Strandling & Meadows, 2001). Faster drivers believed themselves to be safer than other road users, and had a previous history of speeding (Harrison, Fitzgerald, Pronk, & Fildes, 1998). In addition to this, Harrison and colleagues (1998) found that observed speeds were closely related to a generally lenient attitude toward speeding, with the relaxed drivers being more comfortable and confident travelling at speeds in excess of the speed limit. They

observed that faster drivers were less likely to view travelling at an excessive speed as dangerous, and were also more tolerant of a range of other dangerous or illegal behaviours.

McKenna and Horswill (2006) have proposed that young drivers may perceive speeding to be less risky because they have had less experience of negative consequences associated with speeding. They found that young drivers found the concern of receiving a speeding ticket was more salient than concern over being involved in a vehicle crash, and this is likely to be owing to drivers' often having greater first-hand exposure to receiving a ticket than exposure to crashes. Drivers who reported excessive speeding also estimate the likelihood of receiving a ticket for speeding as lower than the average driver, and this finding concurs with a number of other previous studies which suggest that younger drivers are particularly prone to a bias towards positive self-assessment in regards to driving skill.

A number of international surveys of traffic statistics have shown that there is a strong relationship between future crash involvement and having been charged with speeding related offences (Janke, Masten, McKenzie, Gebers, & Kelsey, 2003). Young drivers - particularly males - are both more likely to have received a speeding ticket and be involved in a crash attributed to speed. In a study performed by Rajanlin (1994) which compared records of traffic offences against driver fatalities, it was uncovered that fatal crashes were often preceded by a history of speeding offences. The highest speeding offence rate per distance travelled was found amongst young drivers less than 25 years of age, and speeding offences decreased substantially after 35 years of age.

Speeding has been found to be a frequent characteristic of problem drivers who also engage in other forms of risky driving behaviour. In an American government commissioned report on driving safety, speeding was found to be related to a number of other dangerous driving behaviours. Speeders were identified as being more likely than non-speeders to have excess blood-alcohol, not wearing a seatbelt, and have an invalid drivers license (cited in Williams, Kyrychenko, & Retting, 2006). There is some evidence, especially in studies of risk-taking that dangerous driving is one instance of risky behaviour occurring alongside a spectrum of other behaviours which constitutes a 'lifestyle of risk' (Copeland, Shope, & Waller, 1996).

Ajzen (1991) has proposed the theory of planned behaviour, which has been incorporated into a number of studies to provide a theoretical framework whereby risky behaviour can be predicted using a combination of personal and attitudinal measures such as attitudes towards risk taking, social norms, beliefs, and perception of ability and behavioural control (Reason, Stradling, Baxter, & Campbell, 1990; Baldock, Mathias, McLean, & Berndt, 2006). Within these models, attitudes towards traffic safety, self-perceived driving ability and skilfulness, as well as sensation seeking have been found to correlate strongly with speeding and self-reported involvement in accidents (Parker, Stradling, & Manstead, 1996; Parker, Lajunen, & Stradling, 1998; dePelsmacker & Janssens, 2007).

There appears to be good justification in surmising that attitudes and intentions to commit traffic violations are related to the real-world occurrence of these behaviours (Iverson, 2004). For instance, Assum (1996) found that a generally *lenient* attitude toward speeding tended to reflect the likelihood of actually being involved in an accident, and this finding has been supported by a number of different studies.

1.3.2. Sensation-seeking and impulsivity are common amongst risky drivers

Research into the young driver problem has revealed a number of behavioural, personality characteristics, attitudes and beliefs, and social factors contribute towards the greater representation of young drivers involved in crashes (Assum, 1997; Iversen & Rundmo, 2002; Ulleberg & Rundmo, 2003). These studies have identified specific personality characteristics such as impulsivity, over-confidence, sensation seeking, aggression, and indifference as common amongst young risky drivers (Gregerson & Berg, 1994; Deffenbacher, Lynch, Deffenbacher, & Oetting 2001).

Sensations seeking is defined a the personality characteristic of individuals who are prone to seek out novel and intense experiences (Arnett, 1994; Zuckerman, 1994), and has been associated with a number of risky activities including dangerous driving (Arnett, Offer, and Fine, 1997; Jonah, 1997). Sensation seeking is found to emerge during adolescence, and appears to diminish in intensity with age (Stradling,

Meadows, & Beatty, 2000). Although sensation seeking behaviour peaks in youth it has been argued that individuals who desire intense arousal may continue to seek out and engage in highly stimulating activities throughout adult life (Hovarth & Zuckerman, 1993) though they may 'mature away' from unnecessarily reckless behaviours.

Several studies involving Problem Behaviour Theory (Jessor, 1987) have emphasised that sensation seeking is a central personality characteristic for a variety of different risky behaviours, and often is found in individuals who have what is referred to as 'a risky lifestyle' (Jessor, Turbin, Costa, Dong, Zhang, & Wang, 2003). Drivers who have high levels of sensation seeking are likely to commit more traffic offences and be more daring in their driving style with a 'general risk-taking propensity' (Jonah, 1997). Additionally, individuals who have a high level of sensation seeking tend to view the world as less threatening and engage in higher levels of risky behaviour (Franken, Gibson, & Rowland, 1992).

There is sufficient evidence to indicate that individuals with a high level of sensation seeking are more likely engage in risky driving and become involved in a serious crash than those possessing lower sensation seeking (Jonah, 1997; Stradling et al. 2000). In a study by Goldenbeld and van Schagen (2007) employing photographed rural road scenes to investigate the credibility of speed limits, it was found that drivers with higher sensation seeking preferred faster driving speeds and tended to regard a higher speed limit to be safe. Young drivers had higher levels of sensation seeking, and both age and sensation seeking were found to be powerful predictors of drivers' speed preference.

A number of measures of risk-taking have employed overlapping conceptual constructs of sensation-seeking and impulsivity (Gullone & Moore, 2000). As a general distinction, sensation seeking refers to the seeking out novel and intense stimuli, whereas impulsivity refers to the ability to regulate thoughts and behaviours (Dahlen, et al., 2005); and while these two constructs are not equivalent instruments, there is sufficient research to suggest that both measures relate to some underlying stressor that involves both constructs.

Impulsivity (which is commonly measured using the Barrett Impulsivity Scale) is a multidimensional personality construct found to be involved in moderating risk taking propensity (Eyesenck, 1993; Beirness, 1993). Like sensation seeking, impulsivity has been related to a number of risky behaviours (Patton, Stanford, & Barrett, 1995) including reckless driving (Mayer & Treat, 1977). Impulsivity is associated with a broad and somewhat bewildering array of neurobehavioural pathologies which all involve the inability to control behaviour - such as hyperactivity, restlessness, diminished planning or capacity to delay gratification, and inability to consider consequences prior to action. These in turn have been implicated in a nebulous plethora of risky and disadvantageous behaviours.

Due to a myriad of different constructs relating to impulsivity it may be helpful to explore the conceptual infrastructure as originally developed by Barratt (1985) and later revised by Patton, Stanford, & Barratt (1995). According to this conceptualisation of impulsivity, there are three converging factors: cognitive impulsiveness involved in making rapid and poorly contemplated decisions, motor impulsiveness involved acting without thinking, and attentional impulsiveness involved the inability to focus attention on the current circumstance. Within this construct it becomes easy to see how both inattention and motor impulsiveness might very well predispose a person to situations in which a crash is likely to occur (Underwood, 2007). Considering that impulsivity is a characteristic frequently found amongst young persons, it is not surprising that high impulsivity scores have been correlated with more reckless driving activities (Cherpitel & Tam, 2000).

Impulsivity and sensation seeking seem to be mediated by several neurological circuits that undergo structural remodelling during the late adolescent transition into adulthood, and these changes in regulation have been proposed as reasons as to why young persons engage in increased novelty seeking and exploration, generally subsiding into the late twenties (Spear, 2001). These neurological changes may help in explaining why young drivers are at greater risk of being involved in an accident.

1.3.3. Speeding is related to self-perceived skill and accident concern

Additionally, drivers who rate highly in sensation seeking are prone to underestimate the risks associated with dangerous driving behaviours (Franken et al., 1992) and speeding in particular (Walton, 1999). In the research conducted by Franken et al., (1992) a negative correlation was found to exist between sensation seeking (measured by the Attitude Toward Risk questionnaire) and the perceived threat of risk-taking, suggesting that individuals with high sensation seeking tended to consider risk-taking as less threatening. In relation to self-ratings of skill, it has been observed that most drivers rate their own driving ability superior to that of the average driver (Horswill, Waylen, & Tolfield, 2004), with an evident relationship between self-rated superiority and the intention to drive faster. McKenna and Horswill (2006) found that thrill seeking and self-perceived driving skill were the strongest determinants of driving speed in a video speed-choice task. Concern over crash involvement was the least predictive factor in speed choice, and they suggest that thrill-seeking and over confidence in driving skill were more influential in dangerous driving rather than concern over negative consequences. However, Ullberg and Rundmo (2003) found that low concern or worry over being involved in a crash was related to increased dangerous driving behaviour.

MacDonald (1994b) cites a number of studies which reveal that younger drivers tend to rate themselves to be similar in ability to that of older drivers and superior to their peers, despite a relatively smaller amount of driving experience or exposure. When self-ratings of overall driving ability, driving handling skills and reflexes, and good driving judgements were analysed, Matthews & Moran (1986) found that younger drivers were prone to rate their ability as superior, and under-estimate their likelihood of being involved in a crash in relation to both their similar-aged peers (though these self-ratings were comparable with older and more experienced drivers). The positive self-bias is more pronounced for male drivers than female. While this tendency to rate ability greater than that of same-aged peers is not restricted to young drivers, the effect is certainly more pronounced for the young driving population. Young drivers also tend to perceive speeding to be less dangerous than that of older and more experienced drivers. While young drivers are often aware of the risks associated with dangerous driving, these risks may not act as a deterrent as they are prone to see themselves as an exception (Finn & Bragg, 1986). As belief-based measures (such as thrill-seeking) and the affective measures (accident concern) appear to be inversely related constructs, there is good evidence to suggest that both beliefs and emotions are involved in predicting dangerous driving. The theory of reasoned action (Ajzen, 1991) involves both beliefs and attitudes, as well as affect in moderating drivers intentions and subsequent actions. Manstead and colleagues suggest that drivers may speed - although they perceive the risks - because it brings about feelings of enjoyment and pleasure (Manstead, et al., 2002).

In an earlier study, Parker, Stradling, and Manstead (1996) gave strong consideration to the way in which attitudes and beliefs play a role in driving behaviours such as speed choice. In their analysis of British motorists, they found that young and inexperienced drivers were more likely to emphasise the positive aspects of speeding more so than older and more experienced drivers. Additionally, young drivers were more likely to note that social pressures influence their choice to undertake dangerous driving behaviours, rating greater peer approval for speeding, dangerous overtaking, and close following. Walton and Bathurst (1998) noted in a study of New Zealand drivers that as self-rated driving safety increased there was a tendency to exaggerate the frequency of speeding by the average road user, indicating these drivers viewed speeding to be normative.

Beside these belief and affect based measures, attitudes opposed to, or in disregard of speed limitations or countermeasures (such as chicanes) have been identified in increasing the intention to speed (Elliot, 2001). In a European survey of attitudes toward enforcement (such as speed limits), Cauzard and Quimby (2000) found that young and inexperienced drivers were more likely to be opposed to speed or other driving restrictions. Drivers who believed they were more competent to drive safely whilst speeding were more likely to admit exceeding speed limits – especially on motorway roads.

However, the majority of drivers were in favour of reducing speeds in developed areas such as urban and suburban roads (SARTRE, 2004). It was found that drivers tend not to associate dangerous driving and speeding when considering their own behaviour, but may consider speeding to be dangerous for other drivers. This was suggested by Goldenbeld and van Schagen (2007) as one potential reason why drivers prefer faster speeds than their own self-ratings of what a safe speed would be; that they may assess their own driving ability more favourably than for other drivers.

What has emerged from the literature is that attitudes towards driving tend to reflect real world driving behaviour – and this has lead to the development of a number of self-report questionnaires designed to measure attitudes towards various driving behaviours. One such questionnaire is the Driver Attitude Questionnaire (DAQ) which was developed by Parker, Stradling, and Manstead (1996), and has been widely implemented across a number of studies in measuring the attitudes held by drivers (Meadows, 2002; Davey, Wishart, Freeman, & Champness, 2006).

In a study of fleet vehicle drivers, Davey and colleagues (2006) used the Driver Attitude Questionnaire (DAQ) in conjunction with a number of other behavioural measures to explore the attitudes of drivers towards various risky driving behaviours. They found that attitudes amongst drivers were the most lenient towards speeding, and that dangerous overtaking was a strong predictor of demerit points incurred while driving for work. Lenient attitude towards risky driving behaviours are related to aggressive driving, and predictive of self-reported accident involvement and the intention to speed (Parker & Manstead, 1996). The DAQ has also been utilized in determining the effectiveness of a speed awareness training program, and has been found to be a reliable measure and correlates greater risk perception with more conservative attitude toward speeding (Meadows, 2002). Conner and Lai (2005) employed the DAQ in evaluating the effectiveness of the British National Driver Improvement Scheme (NDIS), and amongst their findings, showed that riskier driving attitudes were related to more self-report traffic violations, greater sensation-seeking, and observed unsafe driving.

1.3.4. Ecological limitations of laboratory testing and driver attitude assessment

One problem facing researchers is the reliability and ecological validity of selfreport or laboratory administered assessment of driving behaviour. While there are advantages to laboratory assessment (such as ease of administration and environmental constancy), it widely and cautiously accepted that self-report measures of driving attitude might be unreliable, depending upon the circumstances surrounding administration and the bias, exaggeration, and truthfulness of the interviewee. While there is good research suggesting that the self-report measures correspond well with real-world driving behaviour there is still due reason to be cautious when relying solely on self-reported measures.

Despite this precautionary note, Iverson (2004) found that there was a good testretest relationship between self-reported attitudes (measured in an initial session) and driving behaviour (measured in a separate subsequent session), implying the reliability and validity of self-report measures. Additionally, Lajunen, Parker, and Summala (2003) found that self-reports of driving behaviour were consistent across public and private settings, suggesting that self-report measures of driver behaviour are relatively reliable and free from social desirability bias.

Concerning ecological validity, West and colleagues found that self-reported speed, attentiveness, and carefulness corresponded well with observed driving behaviour (West, French, Kemp, & Elander, 1993). In a similar study, Groeger and Grande (1996) found no significant differences between self-reported behaviour and observed driving performance – all of which suggests that self-report measures have good reliability and ecological validity.

Various methodologies have been implemented to compensate for potential biases in the ecological validity of self-report measures, such as correlating attitudinal scores with driver histories, official police records, or observational assessment. Utilizing other more objective measures provides a means of scaling self-report measures against external and observable behaviour. When such evidence is unavailable, it may be helpful to employ a plexus of differential risk measures or simulations that are analogous to real-world driving scenarios (such as simulator environments). However, it has been proposed that data gained from driving simulator tasks is limited in terms of ecological validity and can never truly reflect driving behaviour outside the laboratory (Horswill & McKenna, 1999).

The video speed-choice task was an instrument developed by Horswill & McKenna (1999) and utilised in examining the relationship between preferred speeds and crash involvement. A number of studies have employed the use of video in measuring drivers' riskiness in a number of different behaviours, such as speeding and close-following. Horswill and McKenna looked to create an instrument that can be used to measure drivers' speed preference using video footage (depicting driving along a stretch of road) and determined this to be ecologically valid by using speed preferences to predict the number of accidents that participants had been involved in.

Seven sequences of video footage showing the driver's perspective were selected in accordance with criteria that had been established in a previous pilot study (Horswill, 1994). For each video, participants were required to indicate how much faster or slower they would be comfortable travelling. When speed preference was correlated with speed related accident involvement, a significant relationship was identified between faster speeds and higher crash involvement, even when age, gender, and mileage were accounted for.

From their study Horswill and McKenna concluded that a video speed test was a convenient and ecologically valid method of determining the everyday risk-taking, specifically that of speeding behaviour and road accidents in general (Horswill & McKenna, 1999). They concluded:

"The speed questionnaire might represent a more broad-based measure of risk-taking propensity, whereas the video speed test is a more specific representation of drivers' actual speeding behaviour because it provides a more precise and environmentally rich context for the risk taking decision" (p. 981)

Additionally, as real world driving scenarios can be filmed, the video speed task has enormous potential (above traditional simulator environments) due to its ease of construction, and its natural correspondence to a variety of different road environments. The overall conclusion made by McKenna and Horswill was that:

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"... everyday risk-taking behaviour, such as drivers speed choices, can be measured in a way that offers both rigorous experimental control and degree of external and ecological validity. The video speed test was efficient, ethical, and convenient and was showing to relate specifically to the risk involved, in this case, road accidents. Results also demonstrate how the test could be applied in an experimental context to investigate issues that would be difficult to explore alternative methodologies" (p. 983)

In a latter study, McKenna and Horswill (2006) employed the video task that they had developed to determine whether speed preferences reflected driving attitude and accident concern. They devised a four-item questionnaire (AC/RT) which measured concern over being involved in an accident and self-rated driving skill, which has been previously mentioned. They found that variance in speed preference was both significantly related to self-rated skill and thrill, although the best predictor of riskiness was a low concern over being involved in an accident. These findings indicated that higher speed preference corresponded to riskier driving attitude, and in this way, a video speed task may provide an ecologically valid and more objective instrument in measuring driver risk-taking beyond that of the traditionally employed self-report questionnaires.

In summary, part of maturation occurring at emerging adulthood involves increases in sensation-seeking, risk-taking, and the pursuit of novelty. These characteristics become increasingly common expressions during adolescence, and subside during a 'maturing out' over the twenties. Both inappropriate and excess speeds are related to drivers' attitudes and beliefs, as well as hazard detection and awareness, and these factors are implicated young and inexperienced drivers elevated crash likelihood. Deliberately violating the speed limit has been found related to a generally lenient attitude toward risky driving, sensation or thrill seeking, impulsivity, and reduced concern over being involved in a crash. Additionally, over-confidence in driving ability and ability to control the vehicle may lead a driver to travel at inappropriate speeds for road conditions.

1.4. Pushing New Zealand roads to the Limit

1.4.1. Speeds are related to the characteristics of road environments

Although deliberately violating the speed limit has been found to significantly exaggerate the risk of crashing, crashes do occur when a driver has not exceeded the legal road speed. Excessive speeding (that is, travelling over the posted speed limit) has been found to be closely related to an elevated crash rate irrespective of the road environment. However, the degree to which exceeding the speed limit influences the risk of crashing tends to vary according to road conditions in different environments. Violating the speed limit has been identified as a fairly common characteristic of drivers, and many drivers may choose to travel faster than the speed limit but not to the extent where they believe they will receive a ticket (Corbett, 2001).

Fildes, Rumbold, and Leening (1991) measured the speeds of vehicles travelling on both rural and urban roads unobtrusively, and then subsequently stopped and interviewed drivers concerning their previous crash history and driving attitudes. They found that there was a relationship between measured speed and self-reported history of crashes, with an increased likelihood of crash involvement for individuals travelling at speeds at or above the 85th percentile in comparison with those travelling bellow the 15th percentile. Additionally, they found that young drivers tended to travel at greater speeds and had a history of prior crash involvement.

Derivation from the average speed of traffic has been identified in a number of studies to be causally linked to vehicles' crash likelihood. In an early study focused on measuring crash rates as individual speeds varied from the mean flow of traffic, West and Dunn (1971) found that the risk of being involved in a crash was greatest (6 times more likely) for vehicles that were travelling more than two standard deviations above the mean traffic speed. Later research revealed a similar relationship between greater than average vehicle speeds and increased crash rates. Kloeden, Ponte, and McLean (2001) estimated that the risk of crash involvement doubles when travelling 10km/h above the average vehicle speed, and this likelihood increased by a factor of six when travelling 20km/h above the average. While there is an effect on crash incidence when speeds varied from the average vehicle speed, Klooeden, McLean,

and Glonek (2002) later re-evaluated their previous work and attributed the greatest factor in crash rate to actual vehicle speeds rather than other factors on rural and highway roads.

The relationship between speed and crash likelihood in urban areas has also been found to increase exponentially as vehicle speed increases, and Kloeden, McLean, Moore, and Ponte (1997) have suggested that only a 5km/h increase in vehicle speed above the limit doubles the risk of crashing. They propose that a significant number of crashes could be avoided if vehicles travelled at lower speeds, and within the posted limits.

One finding is that drivers often use their own judgements to determine appropriate speed rather than posted limits. In one study investigating the reduction of speed at road-works, Gardner and Rockwell (1983) found that drivers tend to rely on their personal judgements of what an appropriate speed should be, rather than conform to the posted speed limit. Mustyn and Sheppard (1980) found that the majority of drivers indicated they drove at a speed that the road conditions permitted, irrespective of the road speed limit. Although the drivers they interviewed noted that excessive speed was a major cause of crashes, they did not consider exceeding the speed limit to be particularly wrong. Drivers tended to indicate however, that driving more than ~30km/h above the speed limit was a serious offence. This is in keeping with drivers' concept of an 'elastic' speed limit suggested by Corbett (2001).

Goldenbeld and van Schagen (2007) suggested that as road conditions change, drivers may view the speed limit as being more or less credible, and may consequentially exceed the speed limit under conditions where they view the road limit to be a poor indication of actual safe speed. However, drivers may fail to correctly identify road conditions or hazards and inadvertently travel at a speed which is too fast to adequately execute a safe manoeuvre or maintain control of the vehicle. It is generally accepted amongst researchers that driving behaviour (with particular reference to speed) is adjusted to differing road environments (and the variation of hazards that accompany each environment), and this finding is evidenced through numerous transit authority surveys. Posted speed limits are usually calibrated based on what is considered a safe and acceptable maximum vehicle speed under the road conditions. Despite this, it remains the responsibility of the driver to adjust their speed within the confines of the speed limit to what is appropriate (Ministry of Transport, 2009). As an example, while the speed limit on an open road is legally acceptable at 100km/h, driving at the speed limit may be inappropriate given wet or icy conditions. McKnight and McKnight (2003) found that one of the major contributing factors to road accidents was the inability to adjust driving behaviour to the conditions of the road environment, due to a combination of poor hazard recognition, poor visual search and attention, and an inappropriate speed selection.

The ability to correctly 'read the road' is an important consideration when understanding how drivers select an appropriate speed. Road environments tend to differ between urban and rural (or open) situations both in on-road and off-road characteristics. On-road and off-road characteristics provide a convenient means of classifying different road environments, and play a cooperating role in determining crash likelihood and the kind of crash. For instance, open rural roads differ from motorways in the grade of aggregate and other surface conditions, and these characteristics influence vehicle traction and control. However, urban roads have greater traffic volume, building development, and pedestrian activity than motorways and this increases the number of hazards to identify and respond to within any given period of time and stopping distance.

Warren (1982) has identified a number of different characteristics which influence drivers speed preference under different environmental conditions. These include on-road characteristics such as distance of visibility, surface condition and aggregate, slope and curvature, and curbing. The aggregate and surface consistency of roads has been shown to have a considerable impact on crash rates, with poor surface conditions lending themselves to greater loss of traction (British Transport Department, 1994; PIARC, 2003).

Additionally, Tignor and Warren (1990) suggested that off-road characteristics such as the number of intersecting roads and the extent of commercial and/or urban development had the greatest influence on vehicle speeds. Drivers tend to prefer faster speeds when there is less vegetation and development skirting the roadside. Fildes, Rumbold, and Leening (1991) found that road width and the number of lanes were important in influencing speed choice, and drivers tend to prefer higher speeds when travelling on roads that are wide, have multiple lanes, and clearer road markers (Elliot, et al., 2003).

In addition to this McKenna and Horswill (1999) suggest that non-visual perceptual characteristics of roads have an influence over drivers' speed preference. In their study, they used a video speed-choice task to determine how auditory feedback influenced speed preferences. They found that the presence of vehicle noise had the effect of reducing drivers' preferred speeds.

"Drivers who received the quieter internal car noise on the soundtrack of the video speed test chose to drive faster than those who received louder car noises. One explanation for this finding is that drivers with the quiet auditory feedback estimated their absolute speed to be slower. In other words, the auditory feedback provided a perceptual cue that influenced drivers' perception of speed... The current design philosophy of many car manufacturers is to make cars as quiet and well insulated from the outside world as possible. However, from the perspective of road safety, this philosophy is flawed in that it appears that drivers do take into account perceptual cues when choosing their speed." (p. 983)

Modern vehicles are capable of travelling at greater speeds whilst still ensuring driver comfort (such as reduced noise and vibration), and this may influence drivers toward believing that higher speeds are appropriate even when the conditions suggest otherwise. The suppression of somatic cues from the road (such as vibrations from surface irregularity) by modern vehicles might explain in part drivers' reluctance to reduce speed, especially as road conditions change. This is evidenced by Elliot and colleagues finding that drivers prefer higher speeds on roads that have a smooth surface (Elliot, et al., 2003). Campbell and Stradling (2003) uncovered that 22% of all drivers preferred a speed that was below the posted limit of motorway roads (70 mph / 110 km/h), while 50% of participants preferred a speed less than the posted limit on rural roads. Both males and females irrespective of age group were similar on urban

and suburban road types. This suggests that drivers tend to adapt their speed to the riskiness of road conditions.

However, it must be considered that speed preference is not solely based upon the perceptual characteristics of roads, but is also influenced by personal, altitudinal, and cognitive traits.

1.4.2. Urban and rural roads differ in their crash severity and likelihood

The role of speeding that differentiates rural and urban crashes is perhaps best represented in the statistics collected across road types with differing speed limits. This methodology has been employed within a number of studies. For instance, Mosedale and Purdy (2004) propose that excessive speed was a major contributing factor in accidents on rural roads (18%), but not so for urban roads (9%). Additionally, crashes that occur on rural roads have the tendency to be more severe than those that occur in more established urban areas (Barker, Farmer, & Nicholls, 1998). It must be taken into account that crashes on rural roads and motorways occur at greater speeds, and are more severe merely by virtue of the greater kinetic energy involved. Additionally, deliberate violations are more easily perpetrated on rural roads or inter-city motorways where there is less policing and more opportunity to reach excessive speeds on open-straights. This taken along with attitudinal and social pressures acting upon younger persons to violate speed limits might explain partially the rates of accidents on these roads.

Whelan, Scully, and Newstead (2009) suggest that although rates of crashing were roughly equal between rural and urban roads when all crashes were taken into account, the severity of crashes was much higher on rural roads where vehicles travelled at greater speeds. Although Whelan and colleagues (2009) only compared rural and metropolitan crash rates without exploring the sub-types of road, the large scale survey of New Zealand and Australian roads revealed that the most severe crashes occur on rural and semi-rural roads when vehicles either leave the road or collide with oncoming traffic at speed (New Zealand Ministry of Transport, 2008). A recent report released by the New Zealand Land Transport Safety Authority (2009) found that excess speed was involved in 34 percent of fatal crashes on urban roads,

and 31 percent on rural roads, however, crashes on rural roads were more frequent, and alcohol and speed accounted for almost half of the fatal crashes recorded between 2008 and 2009 (Ministry of Transport, 2009).

1.4.3. Relative crash information for common New Zealand roads

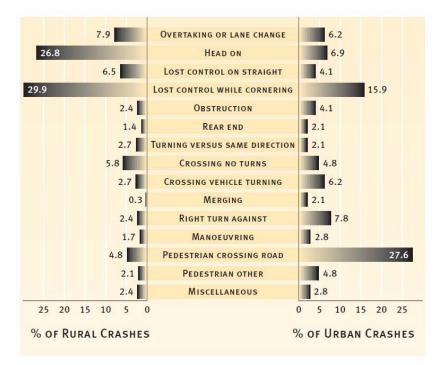
For the purposes of distinguishing between New Zealand roads in the present study, five different road environments were identified based on speed limit and onand off- road characteristics (see Appendix 3.1). The majority of the road network in New Zealand can be considered open rural roads with a 100km/h speed limit, however motorway roads connecting major cities constitutes the more frequently traveled state highway. The state highway system varies depending upon proximity to major centers and traffic arteries, with road conditions ranging from rural (open) road through to more developed expressways. In the present study motorways are differentiated from open roads based upon the presence of multiple lanes and centreguarding, whereas rural roads are considered to be those otherwise encountered in open road driving. The risk associated with rural roads is considerably higher than that of motorways, as drivers may cross the centreline and into the path of oncoming traffic, either by drifting unintentionally or overtaking another vehicle without clear visibility. This is evidenced in a study by Lynam and colleagues, which found that the rates of severe crashes in England were 6 times greater on rural roads than on motorways (Lynam, Hummel, Barker, & Lawson, 2004).

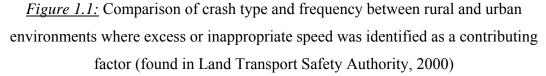
In July of 1985, the open road speed limit in New Zealand was increased from 80km/h to 100km/h, and this means that the majority of open roads were developed under an 80km/h speed regime (Ministry of Transport, 2009). Accordingly, the New Zealand roading system was not intended to support vehicles travelling above 100km/h. Although portions of the state highway network have been modified or redesigned to accommodate 25 years of increasing traffic volume under the new regime, much of the existing road infrastructure was designed for a safe speed margin of +20km/h above the old regime of an 80km/h limit. While the speed limit may be considered a legally acceptable speed, it may be inappropriate to travel at the current speed limit on roads that were developed under the old regime.

This is in part evidenced by a study conducted across several American states. Liu, Chen, Subramanian, and Utter (2005) found that travelling at an inappropriate speed relative to the conditions significantly contributed to the likelihood of crashing on higher-speed roads (100km/h), whereas exceeding the speed limit was more a stronger predictor of crash likelihood on lower speed roads. Additionally, speeding related crashes either owing to excess or inappropriate speed was more likely to occur on open road stretches rather than at intersections. Selecting an appropriate vehicle speed across open (rural) and motorway road environments has a powerful affect on crash likelihood as evidenced in a study conducted by Malyshkina and Mannering (2007).

When crash rates were compared between American inter-state and non-interstate roads (comparable to the New Zealand motorway and rural roads) it was found that increasing the speed limit from 100km/h (65mi/h) to 110km/h (70mi/h) had little affect on crash risk on interstate roads, whereas the risk was greatly inflated in general for non-interstate roads (Malyshkina & Mannering, 2007). It was postulated that increasing the speed limit on interstate roads had little influence on crash likelihood as these roads had a better gradient and surface quality, and this accommodates for modest increases in speed. However, non-interstate roads are less resilient to increases in speed owing to poorer surface conditions. Garber and Gadiraju (1989) found drivers tend to prefer faster speeds on roadways with more consistent gradient and better quality of surface, concluding that speed in excess of posted limits does not necessarily increase crash risk depending on the road environment. Despite this, excess speed still contributes to an elevated risk of crash involvement, although rates are similar to that of speed preferences inappropriate to the conditions (Malyshkina & Mannering, 2007).

In New Zealand, fatal crashes owing to excess speed or inappropriate speed adjustment are more likely to occur on rural roads, largely owing to either loss of control whilst cornering or colliding with on coming traffic (Figure 1.1). While the rates of speed related accidents is similar for urban and non-urban road environments, the severity of crashes is significantly elevated in open road rural and motorway environments due to the greater speeds involved (Ministry of Transport, 2009). Loss of vehicle control (Figure 1.2) due to excess or inappropriate speed is the largest contributor to injurious or fatal crashes in both urban and rural road environments. Excess or inappropriate speed on rural roads is a major contributor to crashes, and when compared with crashes involving drivers 25 years and older, drivers aged between 18 24 years old are far more likely to be involved in fatal crashes on rural roads.





As rural (open) roads interface with major cities or townships, the speed limit decreases to 80km/h to accommodate increased arterial traffic while easing the transition to the 50km/h metropolitan roads. Occasionally, the transition can be more rapid, such as decreasing speed from 100km/h to 50 km/h.

Within metropolitan regions, with more intersecting traffic, the speed limit varies between 60-30km/h depending upon hazard and traffic density, however, the majority of roads have a speed limit of 50km/h. Metropolitan roads can be defined under two categories. Urban roads service business and commercial zones, and are arterial to

suburban roads which service domestic zones. While this distinction is not always made amongst researchers, it is helpful when evaluating how hazards differ in these environments. Suburban crashes have a greater likelihood of hitting a pedestrian, whereas crashes on urban roads are more likely attributable to colliding with either another vehicle or stationary object. In this regard, the role of excess and inappropriate speed begins to converge in predicting loss of control accidents.

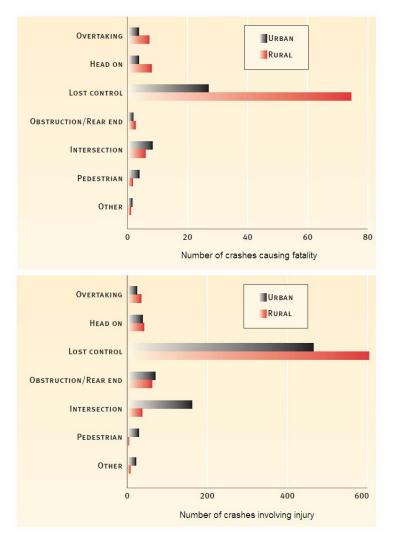


Figure 1.2: Comparison of the type of rural and urban crashes attributed to excess or inappropriate speed where either injury or fatality result (found in Land Transport Safety Authority, 2000)

Fatal crashes in urban environments usually involve colliding with a pedestrian (Figure 1.1), and speed increases the risk due to increased stopping distances and

reduced time to react to a potential hazard. Even modest increases in speed may increase the likelihood of fatally injuring a pedestrian. McLean and colleagues explain that the energy released in a collision is a power function, such that at 60km/h, a collision with a pedestrian has a resulting 93% likelihood of fatality. Collision energy decreases proportionate to speed, so that at a speed of 50km/h (the current average urban limit) the resulting likelihood of death is 73%, and drops away to 5% at a speed of 30km/h. Additionally, stopping distances become elevated at higher speeds, and this is especially important when responding to hazards. At the current 50km/h speed limit a car requires 26 meters to come to a stop, whereas at 60km/h this is increased to 38 meters required to stop (McLean, et al., 1994). After implementing a reduction in the Australian urban limit from 60km/h to 50km/h, it was estimated that the number of fatalities were reduced by approximately 45% overall. However, the number of fatal accidents involving young and inexperienced drivers (~19%) was reduced less by the new speed limit than the reduction for older and more experienced (\sim 50%) drivers. This seems to indicate that lowering the speed limit is less effective in reducing speed-related fatalities involving young and inexperienced drivers (Haworth, Ungers, Vulcan, & Corben, 2001).

The influence of adjusting speed limits seems to have varying degree of effectiveness in reducing crash severity depending on the road environment. In a report released by the Federal Highway administration, the effectiveness of international adjustments of speed limits was analyzed. It was found that adjusting speed limits had a large effect on crash rates on high speed motorway and rural roads, but less effect on reducing crash rates on lower-speed roads (Stuster & Coffman, 1998). The study concluded:

"In general, changing speed limits on low and moderate speed roads appears to have little or no effect on speed and thus little or no effect on crashes. This suggests that drivers travel at speeds they feel are reasonable and safe for the road and traffic regardless of the posted limit. However, on freeways and other high-speed roads, speed limit increases generally lead to higher speeds and crashes. The change in speed is roughly one-fourth the change in speed limit. Results from international studies suggest that for every 1 mi/h change in speed, injury accidents will change by 5 percent (3 percent for every 1km/h). However there is limited evidence that suggests the net effect of speed limits may be positive on a system wide basis."

The literature also suggests that speeding may also contributes to fatal crashes in urban environments due to loss of vehicle control, particularly on corners (Ministry of Transport, 2009). This perhaps owes to urbanized roads having tighter corners with less camber than rural or motorway roads. Speed seems to have a distorting effect on the perception of the sharpness of a corner, and this may cause drivers to overestimate the speed which a corner can be taken (Fildes & Lee, 1993). The radius of a corner has a significant influence on crash likelihood, with more crashes occurring on sharper corners compared to more extended-radius corners (Elvik, Hoye, & Sorensen, 2004; Matthews & Barnes, 1988).

Urban and suburban roads also have greater traffic volume, and a study of American driver behaviour suggests that the presence of other vehicles has a strong influence over drivers speed preferences (NHTSA, 2003). However, this effect was found in the study of rural roads conducted by Goldenbeld and van Schagen (2007) where the presence of other vehicles did not have appear to have an influence over speed preference. It may be that the relative density and flow of traffic between urban and rural roads has some influence on these contradicting findings.

The increased presence of hazards does however seem to affect drivers speed preferences. In this regard, most drivers tend to be in favour of reducing speeds on urban and suburban roads, but are less likely to agree with speed restrictions on motorways (SARTRE, 2004).

The general consensus of the literature is that excess or inappropriate speed plays a significant role in crash likelihood and severity, and although judging appropriate speed involves a number of different factors which vary across road environments, speeding still accounts for a significant number of fatal vehicle crashes or injuries irrespective of road environment. What is important is that speed preference needs to be moderated under different road conditions, and selecting appropriate speeds reflects both risk perception and the capacity for a driver to 'read the road' and make reasonable adjustments. Risk factors do vary across road environments, and this means that faster speeds on some road environments enlarge the danger more than for other environments. Speed judgements need to be made appropriate to the road, and failure to do so significantly elevates the risk of crashing.

In summary, New Zealand has a number of different road environments each presenting with different conditions, and a driver's ability to judge the road and surrounding environment is essential for safe driving. Young and inexperienced drivers tend to be represented by more speeding related crashes than older more experienced drivers, and the ability to read different roads might play a significant role in increasing crash likelihood. Faster vehicle speeds are a significant contributor to crash severity and likelihood in all road environments, due to increased stopping distances and difficulty in controlling a vehicle. Additionally, loss of vehicle control is the most common precipitator of high-speed vehicle crashes. Speed limits are determined as the maximum safe vehicle speed given different road conditions, and while drivers may choose to put themselves at risk by deliberately violating the speed limit, judging the road conditions to determine an appropriate speed beneath the speed limit is also important.

Differing road surfaces and number of hazards make some environments more susceptible to severe crashes, and so making appropriate speed judgments is an essential skill for all drivers. The margin between excessive and inappropriate speed is somewhat narrower for both rural roads and urbanized roads, though in different regards. New Zealand rural roads were designed under an 80km/h regime, and thus are particularly vulnerable to speeds in excess of the current 100km/h limit. The current limit provides a ceiling on what can be deemed an appropriate speed given poor surface conditions and the danger of loosing control or crossing the centre-line into the opposing lane. Inappropriate and excess speeds entertained by young and inexperienced drivers could explain why they are involved in more fatalities on rural roads than on any other road environments.

The ceiling for appropriate speed is close to the limit on urbanized roads, especially owing to the increased number of hazards and vehicles on these roads. Additionally, driving at excess speeds, even slightly above the limit greatly inflates the risk of crashes that involve injury or death of a pedestrian. Owing to these factors, and the greater danger of slightly elevated speed resulting in injury or death to pedestrians, urban and suburban roads also are high-risk roads for drivers who prefer greater speeds.

Motorways are more forgiving towards excess speeds due to higher quality road conditions and other protective measures. However, as the road environment in New Zealand can quite quickly transition from motorway through semi-rural and rural (open) road environments, excess speed on motorways may easily translate to excess speeds where it is inappropriate. As speed limits change, a perceptual effect called 'speed adaptation' comes into effect, where a driver can potentially underestimate the speed of the vehicle and consequentially reduce vehicle speed but continue well in excess of the new posted limit (Fildes & Lee, 1993). Additionally, drivers may become habituated to driving at higher speeds and this may influence their speed choices across road environments.

Irrespective of this, excess speed is still unwarranted even under safer road conditions, and thus encouraging drivers to travel at an appropriate vehicle speed is as important as focusing on reducing the number of deliberate violations of the speed limit.

1.5. Modelling risk-taking for young brains

1.5.1. Current models of risk-taking

Several theories have been proposed by researchers to explain problem risktaking, and have been influential in developing models for problem risk-taking in general. Models of how decision-making involving risk is performed have been useful in understanding how certain factors influence some individuals to take unfavourably risky actions. While the current study does not endeavour to evaluate these theories, they provide a framework toward understanding how attitudes and beliefs as well as neuro-cognitive and personality factors elevate young drivers willingness to engage in risky driving. Additionally there is great promise in the study of how the brain matures in relating to poor hazard awareness and sensation seeking. There are a multitude of theories which have been presented by researchers; however the more popular contemporary ideas will be discussed briefly as they pertain to the young driver problem

As previously mentioned, there is Problem Behaviour Theory (PBT), which was originally proposed by Jessor and Jessor (1977) and has been utilised successfully in understanding how personality characteristics, attitudes, and beliefs are involved in the spectrum risky behaviours (Jessor, 1993). According to this theory, attitudes, beliefs, and personality factors are interrelated, and risk-taking cannot be attributed to a single factor. Risk taking is rather the result of 'multiple interacting domains that now range from biology through to social environment' (Jessor, 1993, pp. 119) that work together to predispose an individual to engaging in risky activities. Within this framework, dangerous driving is one example of problematic behaviour within a broader spectrum of problem behaviours that constitute a 'risky lifestyle' (Jessor, 1993; Jessor, Donovan, & Costa, 1991) – and there is growing evidence to suggest that a number of problem or risky behaviours (such as drug use, reckless driving, and unprotected sex) co-vary and co-occur with one another (Barrera, Biglan, Ary, & Li, 2001).

Jessor (1987) identified four common characteristics of young drivers at risk of being involved in vehicle crashes and employed these in the construction of a questionnaire: self-reported deliberate driving risks, non-use of a seat belt, driving under the influence of alcohol, and regular use of marijuana. He found that not only did these factors work toward predicting crash rates, but also were associated with the broader cross-section of risky behaviours (Jessor, 1987). Beirness and Simpson (1988) expanded on this model developed by Jessor, finding students who had been involved in a crashes expressed a strong desire to engage in novel, risky, and exciting activities. They also held more liberal and lenient attitudes towards alcohol use (including riding with an intoxicated driver), and were more tolerant of social deviancy.

Problem Behaviour Theory implies that research and intervention programs regarding risky behaviour should incorporate both social (including attitudes and beliefs) and neuro-cognitive or biological factors (for instance, sensation-seeking). In this way, risk-taking should be explored as a composite of attitudes and beliefs, social and peer influences, impulsivity and sensation seeking (Zuckerman, 1994), and affect dysregulation and cognitive pathologies (Steinberg, 2005). These models recommend that intervention or training programs should be focused towards a holistic approach of both the cognitive, behavioural, and social aspects of the risky lifestyle that precipitates dangerous driving.

While PBT has been found to be useful in exploring the lifestyle characteristics of young problem drivers, it relies very strongly on retroactive analysis and self-reporting. Firstly, as PBT is dependant upon retrospection and correlation, limitations in the explanatory and predictive scope appear when employing it to explore the causal interaction of factors that accompany risky behaviours. For instance, while a number of factors can be found to co-vary with dangerous driving using the PBT framework, it cannot be known how these work together to induce dangerous driving – rather, PBT can identify common elements for which some underlying construct is active.

Finding this underlying construct alluded to by PBT has given rise to a number of theoretical frameworks which have the explanatory power and scope needed to understand the nexus of factors associated with problem behaviours. However, there is a need for a more comprehensive model which incorporates the several interdisciplinary conceptualization of risk-taking. Such a model should involve beliefs and attitudes held by the individual, psychosocial intermediates, experience and risk-awareness, decision-making processing, and the neurological substrates of risky behaviour. Such an approach may provide some clue as to why young drivers engage in more premeditated risks, as well as many more impulsive, unplanned, and unintentional decisions.

1.5.2. Models of risk explaining the cognitive underpinnings of behaviour

Risk-taking in a psychological domain is a complex concept, and many contemporary approaches have attempted to dissect the anatomy of problem risk-taking. In this regard, the definition of risk-taking found amongst the writings of economists has almost exclusively dominated conceptual psychological approaches, namely because it provides a concise framework. Economical models of risk-taking lend themselves to creating empirically verifiable models, and are hence justifiably the best conceptual hook to hang young driving problem upon. Although attitudes and beliefs are important in understanding the young driver problem, when risk-taking is removed from the psyche and placed within the realm of mechanistic interpretations, these provide the greatest explanatory scope and power – albeit, in terms of behavioural economics or neuro-cognitive process. A number of these theories are discussed in brief.

Risk Homeostasis Theory (RHT) has been proposed by Wilde (1982) to explain how risk-taking is adjusted over changes in risk level in the environment. Wilde (1982) suggested that people have a target amount of acceptable risk which they attempt maintain at a constant level. Maintaining this 'homoeostatic equilibrium' depends upon the expected benefits and costs of risky behaviour, and the expected benefits and costs of safe behaviour - and as a form of cost benefit analysis similar to economic models of risk taking. A constant analysis is conducted to determine the amount of risk in a situation, so that should some influence decrease the overall risk of the situation, behaviour will be adjusted to being more risky to compensate. Risk homeostasis theory suggests that driving behaviour will adjust depending upon changing levels of risk in the environment.

While Wilde's theory is intriguing, it has been largely criticized, particularly because it is poorly defined and therefore difficult to subject to empirical testing (Evans, 1991), and the lack of evidence justifying this claim has been expressed with discontent by a number of researchers, whose cite a number of cases where drivers do not adopt a safe driving strategy when the risk and hazard level of the external environment increases (for a review see McKenna, 1987). Additionally, in order to preserve target risk, it is required that people have a unreasonably comprehensive situational awareness of risk factors. Target risk is thought to be determined at an individual level, and varies across the population – however, a mechanism by which target risk is selected has not been determined, and this makes risk homeostasis an unlikely candidate for a robust model of risk-taking.

The Zero-risk theory proposed by Naatanen and Summala (1974) is worthy of mention. According to this theory, a person adapts their driving behaviour to changes in the environment in an attempt to avoid risks or preserve a risk level close to zero (no risk). Within this framework, adaptation is largely a function of increasing self-confidence and driving experience, so that as these increase, the safety margin (degree of acceptable risk) which a driver in comfortable with also may increase. The likely successor of Zero-risk theory is the threat avoidance model described by Fuller (1984). In this model, rather than attempting to maintain risk at zero, drivers instead learn to anticipate hazardous events and avoid them by modifying their driving behaviour to compensate for the amount of risk. In a similar manner to zero-risk theory, driving confidence and experience play a significant role in the acceptable safety margin - and this may be useful in conceptualising how driving ability.

Another helpful framework for understanding driver behaviour is the expected utility - or utility maximisation models (Jassen, 1990). Within these behavioural economics models, an analysis of the projected cost and benefit of a particular behaviour is performed in regards to risk, so that driving is adjusted to ensure that benefit is maximised, and cost (where applicable) can be minimised. Within driving, the benefits of excessive speed might be seen as arriving at the destination quicker, receiving peer approval, and receiving enjoyment. The perceived costs of speeding might be crashing, receiving a traffic conviction, or social disapproval. The costs and benefits are evaluated and resulting behaviour accords to a maximisation of benefit or a reduction of costs. This model is particularly interesting in relation to the young driver problem, as high-risk individuals often have lesser regard for social norms and respond strongly to peer influences (Donovan, Jessor & Costa, 1988). Gullone and Moore (2000) in promoting the 'negative risk' theory explain how decisions are made through weighing of positive and negative aspects:

If the positives far outweigh the negatives, the behaviour is rarely perceived to be risky, whereas when the negatives outweigh the positives, the behaviour is generally regarded to be extremely risky or even foolish. Thus the perceived risk can predictably be determined by the balance between these two types of consequences. (p. 347)

While these classical models have some advantages in explaining why young drivers engage in more frequent risk-taking behaviour (such as perceived detriments of speeding offset by both increased vehicle safety features and prospective gains), there were also some significant difficulties emerging when the assumptions of these models are explored in greater detail (such as imperfect knowledge of risk, or lack of empirical validation). While attitudes and beliefs do play a significant role in decision-making involving risk, and while a cost benefit analysis does likely occur at some level when engaging in risk-taking, a more comprehensive model incorporating both the biological and attitudinal dimensions of young drivers needs to be developed.

1.5.3. Risk and rationality – the case for a two-fold model of risk-taking

In a monograph published by Reyna and Farley (2006), the theory was put forward that risk decision making could occur under two distinct modalities, and more curiously, that it may be that the increased propensity for young people to engage in risky behaviours might be the product of rational evaluation of the prospective cost and benefit of decision outcomes. Older and more mature individuals might rely more on a gut-instinct, or 'gist' to guide their decision-making when it comes to engaging in risky behaviours. The curious implication of this model is that the rational cost/benefit style of reasoning might predispose young persons to engage in risky behaviour. In the 'fuzzy trace model' proposed by Reyna and Brainerd (2001), there are two distinct processes of decision-making mediated by different brain circuits. Wargo (2007) describes the distinction between these two modalities of decision making:

"One of these modes of thinking is precise and deliberate, and attends to details like numbers and facts. In this category belongs the computational abilities used in mathematics, as well as the deliberate forms of reasoning that scientists and philosophers have historically esteemed as the most advanced, mature, and rational of human mental powers. The other mode of information processing is, in contrast, imprecise and relational or categorical. It tends to ignore details and focuses instead on the overall meaning or gist. This form of thinking is quicker and more intuitive than its more exact and rational counterpart" (pp. 2)

According to fuzzy-trace theory, one neural circuit is highly deliberative and oriented towards a detailed evaluation of verbatim information and beliefs This circuit corresponds to the kind of decision-making described in the classical economic models of risk taking, and involves a logical analysis of benefit and costs (Reyna, Adam, Poirier, LeCroy, & Brainerd, 2005). The alternative circuit is utilized by adults in their decision-making, and involves relying on 'gist'. This is a form of complex intuition that is subjectively experienced (being similar to an emotional response), and tends to direct the decision-making process before an analysis of respective costs and benefits has been performed. Reyna & Lloyd (2006) proposed

this kind of reasoning is employed by experts (such as medical practitioners) in making decisions, and generally leads them to make more correct judgements than their less experienced colleagues (who tended to focus in the details of each case). This may be why adults arrive at decisions more rapidly that young people, and why their decisions tend to be more beneficial. Wargo (2007) goes on to explain these differences:

"Gist-based thinking is actually the more advanced of the two processes and typically leads to better judgments. The forebrain areas that specialize in processing gists mature relatively late in a person's development, usually not until adulthood. As a result, young people are paradoxically more "rational" (that is, deliberative and detail-oriented) than adults, and yet they are also notoriously poor decision makers" (pp. 2)

It is not that rational decision-making is necessarily problematic, but rather is vulnerable to misjudging the significance of different cues, and in doing so is both vulnerable to maligned perceptions as well over-emphasized significance of personal attitudes and beliefs (such as praise from peers).

'Fuzzy trace theory' resounds with the somatic-marker hypothesis proposed by Bechara, Damasio, Damasio, and Anderson (1994). In the somatic-marker hypothesis, people utilise an intuitive 'gut-feeling' to direct decision making, and insensitivity to this gut-feeling reduces the ability to learn from reward or punishment. Bechara and colleagues observed that damage to a particular brain region results in insensitivity to reward and punishment. This region called the ventromedial prefrontal cortex is responsible for incorporating emotional information in higher-level executive processes. Developing upon this, Reyna and Farley (2006) note that the regions of the brain used to quickly assess the 'gist' of a situation are still developing during young-adulthood years, and do not reach maturity until the mid-twenties. The delayed maturation of these brain regions may predispose young persons towards an economic approach, consequentially causing them to be at greater risk of making poor judgements. One immediate application of this theory to research in the field of risk taking is that self-reported assessments may measure the attitudes and beliefs that are related to the economic brain circuits, while measuring less successfully the way in which decisions are actually made. While the assessment of attitudes and beliefs is an essential instrument of driver research, the role in which these measured factors actually influence the propensity to engage in risks may be far more complicated than the classical models of risk taking actually suggest. This opens up the field of research toward exploring how the maturation of the brain is related to the overrepresentation of young and inexperienced drivers in serious crashes; and how training programs can be designed accordingly.

1.5.4. The influence of brain development on the capacity to make risk judgements

Corresponding with the increased accessibility of advanced instrumentation over the past 20 years, there has been a surge of interest in the way in which functional and structural changes in the developing brain might influence the way in which decisions are made between young and older persons. Contemporary research into risk-taking has placed an increased emphasis on the biological substrates of behaviour, in particular the maturation and fine tuning of the prefrontal, temporal, and corticolimbic brain circuitry (Steinberg, 2007). The young-adult brain undergoes a significant remodelling of a variety of structural and functional regions known to regulate emotional and analytical processes – known as executive processes. Many critical brain circuits undergo a gradual maturation that extends through the teenage years concluding within the mid-twenties (Spear, 2000; Steinberg, 2005). Changes in the executive processes and diminished regulation increases the likelihood that young people will engage in either impulsive or reckless behaviours with a certain myopic foresight, or express deficiencies in planned behaviour. Steinberg (2007) writes:

"As a result of this remodeling, dopaminergic activity in the prefrontal cortex increases significantly in early adolescence and is higher during this period than before or after. Because dopamine plays a critical role in the brain's reward circuitry, the increase, reduction, and redistribution of dopamine receptor concentration around puberty, especially in projections from the limbic system to the prefrontal area, may have important implications for sensation-seeking (pp. 84) ...an increase in the sensitivity and efficiency of the dopaminergic system, which, in theory, would make potentially rewarding stimuli experienced as more rewarding and thereby heighten reward salience." (pp. 85)

The literature suggests that during this stage of neural development, the capacity to regulate affect and anticipate consequences for decisions becomes somewhat diminished, and this has a strong influence over young drivers' capacity to anticipate

other road users' actions and detect hazards. Weinberger and colleagues propose that during the maturation of the prefrontal brain structures, the circuitry responsible for forward-planning, sensitivity to reward or punishment, regulation of emotions, attention and memory, impulsivity, and behavioural regulation are all affected (Weinberger, Elvevag, and Giedd, 2005).

These changes help to explain why young adults differ from adults in their ability to assess hazards and perceive risks. Coupled with the maturation executive processes, the disposition toward reckless risk-taking corresponds to Reyna and Farley's (2006) suggestion that young people tend to employ rational analysis in making decisions as opposed to more 'gist' based thinking. The changes during prefrontal maturation also explain in part the increase in searching out of novel stimuli and immediate reward observed during this stage of life, despite the fact that young people have greater ability to undertake rational cognition (Dahl, 2004). As the prefrontal circuitry matures, there is a decline in sensation-seeking and a shift toward more intuitive decision making. Steinberg (2007) proposes how this change occurs:

"The maturation of this cognitive control system during adolescence is likely a primary contributor to the decline in risk-taking seen between adolescence and adulthood. This account is consistent with a growing body of work on structural and functional changes in the prefrontal cortex, which plays a substantial role in self-regulation, and in the maturation of neural connections between the prefrontal cortex and the limbic system, which permits the better coordination of emotion and cognition. These changes permit the individual to put the brakes on impulsive sensationseeking behaviour and to resist the influence of peers, which, together, should diminish risk-taking." (pp. 16)

A number of problem behaviours commonly associated with youth have been proposed to arise from changes in the brain across the span of young-adult development (Spear, 2000), and this would seem to complement the social and attitudinal dimensions of risk-taking as examined under models such as PBT.

Hazard detection and visual tracking are also affected by the maturation of executive processes, and this may predispose young and inexperienced drivers to misjudge road conditions or poorly respond to salient hazards (Chapman, Underwood, and Roberts, 2002; Deery, 1999). Additionally, refinement of the cognitive architecture of the brain also leads to improved attention and awareness, and may explain why inattention frequently precipitates crashes involving young and inexperienced drivers (Underwood, 2007). Keating (2007) writes:

"Potential sources of difficulty for the adolescent driver could lie in the comprehension of important aspects of safety, risk, or long-term consequences of driving behaviour; greater difficulty in learning and applying core driving skills; or greater limitations in terms of cognitive processing capabilities [when driving]" (pp. 150)

In summary, the development of the young-adult brain influences both the willingness to engage in thrill seeking activities, and the ability to detect and respond to road hazards. Young drivers have an increased propensity to engage in risky behaviours to receive reward, while lacking the cognitive processes needed in hazard awareness and executing appropriate avoidance manoeuvres. Both these factors have a significant affect on what speeds young and inexperienced drivers are willing to accept, and how they control a vehicle at speed. The maturation of prefrontal and cortico-limbic circuitry works toward explaining why risk-taking tends to subside during the mid-twenties.

2. The current study

This research will use the validated video speed-choice task by Horswill and McKenna (1999), adapted to different New Zealand road conditions. The speed-choice behaviour of a young and inexperienced group of drivers will be compared to an older and experienced group of drivers. Self-report measures will be also gathered from all participants in regards to their attitudes to risk taking with a special focus on speeding behaviour. There will also be measures on impulse control, confidence levels in their driving and on concerns of having an accident. The main goal of the study was to determine if the self- report measures would reflect the more objective measures of the video speed-choice task.

The specific questions were:

2.1 What differences (if any) do the self-report risk taking measures reveal between the young and inexperienced drivers and the older and more experienced drivers of a New Zealand sample?

The reviewed literature, suggests that younger/inexperienced drivers will hold a more lenient attitudes towards driving related risk-taking (such as speeding), will have greater confidence in their driving skills compared to their peers, and will also report greater impulsivity than older and more experienced drivers.

2.2 i) Do young and inexperienced drivers choose higher speeds than older more experienced drivers? ii) How do different road conditions affect speed choice in these two groups of New Zealand drivers?

The literature review suggested that younger drivers often choose faster speeds than older more experienced Young drivers are often involved in speeding related crashes on rural roads and motorways and therefore it will be interesting to examine if young drivers choose higher speeds on those road environments compared to older more experienced drivers and also to urban and suburban environments with lower speed limits. 2.3. How do the self-report risk taking measures relate to measures from the video speed-choice task in the sample of young and inexperienced and older more experienced drivers?

This research question will determine whether the video speed task reflect the self-reported attitudes of drivers towards speeding and other risky driving behaviours. There is a debate in the literature about the validity of self-reported attitude measures in teenagers (for instance Davey and Freeman, 2006). The laboratory based speed choice measure could be a more objective and valid measure for assessing speeding behaviour in young drivers and it will be interesting to assess which self-reported measures will best predict the video speed-choice measure.

3. Method

3.1. Participants

Thirty six drivers (17 males and 19 females) were recruited to participate in this study. Participants ranged in age from 17 through to 53 years, with a mean age of 28 years (SD = 9.6). The majority of the participants were first year psychology students (N = 27) and received 1.5% course credit as an incentive to participate in the study. There were also a number of drivers (N = 9) who were not students and received a \$10 petrol voucher for their participation.

While the majority of participants classed themselves as New Zealand European (N = 25), there were representatives from other ethnic groups (New Zealand Maori, N = 4, Continental European, N = 4, Asian, N = 2, and Canadian European, N = 1). Participants were required to hold either a current New Zealand restricted, full, or international driver license in order to take part, and to have driven for a period of at least 6 months on New Zealand roads.

A first group (A) labelled as 'Young and Inexperienced drivers' was comprised of 20 drivers (9 male, 11 female) aged between 17 and 24 years with a mean age of 21 years (SD = 2.1, N = 20). Seven of these drivers currently held a restricted license for a mean 3 years since being issued (SD = 2.6, N = 7), and 13 currently held a full license for a mean of 3 years since being issued (SD = 1.9, N = 13).

A second group (B) labelled as 'Older and more experienced drivers' was comprised of 16 drivers (6 male, 10 female) aged between 25 and 53 years with a mean age of 36 years (SD = 8.2, N = 16). These drivers all held a full driver license and had done so for a mean 18 years since being issued (SD = 9.6, N = 16). This clearly indicated that older and more experienced drivers had much greater driving experience than the young and inexperienced drivers.

3.2. Self reported measures

3.2.1. Demographic Questionnaire

The Demographics questionnaire (Appendix 7.2.1.) recorded age, gender, ethnicity, current driver licence (full or restricted vehicle licence) and licence issue date, average kilometres driven in the period of a usual week, and years of driving experience. Participants were required to provide a driver history for the previous 12 months. Participants indicated how many traffic offences resulting in convictions or warnings they had received within the past 12 months. Traffic offence categories included speeding, dangerous overtaking, and driving with a revoked licence, and were grouped by speeding and non-speeding related offences.

3.2.2. Impulsivity (BIS-11)

The Barrett Impulsiveness Scale (BIS-11, Appendix 7.2.2.) used in this experiment was a modified version of the original questionnaire (BIS-11) developed by Barrett (1994). The BIS-11 is a self-report questionnaire designed to measure the motor, attentional, and non-planning aspects of the construct of impulsiveness. While the original version of the BIS-11 is a 30-item questionnaire, two items were omitted from the reproduction utilised in this study, and several items were rephrased (e.g., the original question "*I* "squirm" at plays or lectures" was rephrased as "*I am restless in class/groups*"). Items were scored so that larger values corresponded to higher impulsivity.

Participants were instructed to read through the list of items, selecting the response that best described themselves by indicating on a four-point likert scale (1-4) ranging from '*Rarely/Never*', through '*Occasionally*', '*Often*', and '*Almost Always/Always*' respectively. The summation of the item scores (after reverse scoring for some items) yielded a total score for the BIS-11 ranging from a minimum of 28 through to a maximum of 112, with the greater score indicating a stronger degree of impulsivity for all components. Additionally, three subscales representing the motor, attentional, and non-planning components of impulsivity were obtained by summing

only those items weighting upon each component respectively; and in a like manner to the total score, higher scores in each component indicated greater impulsive tendency along each subscale (Barratt, & Patton, 1983; Patton et al., 1995).

3.2.3. Attitude towards risk-taking questionnaire (AR)

A slightly modified and shorter version of the Attitude towards risk (AR) questionnaire by Franken, Gibson, and Rowland (1992) was used to measure attitudes towards risk-taking behaviour and sensation seeking in general (Appendix 7.2.3.). A selection of 10 questions from the original questionnaire were taken to construct the AR questionnaire, and as with the original, items measured either the risk enjoyment (4 questions; e.g., "*I like the feeling that comes with taking physical risks*", "*I like to do things that almost paralyse me with fear*") or social deviance (6 questions; e.g., "*I often think about doing things that are illegal*", "*I consider myself a risk-taker*") attitudes of risk taking behaviour.

Participants were instructed to read each statement and then select the answer that more appropriately describes themselves, indicating on a five-point likert (1-5) scale ranging from extremes of 1 (*Not like me*) through to 5 (*Like me*). The AR Questionnaire had two subscales. The social deviancy subscale (items 2-4, 8-10) was related to behaviours which society would disapprove of (variable: social deviancy), and the risk enjoyment subscale (items 1, 5-7) was related to the amount of enjoyment experienced while taking risks (variable: risk enjoyment). Summation of the scores for each individual item yielded an overall score, and two subscale scores, as a measure of risk-accepting attitudes, with higher scores indicating a more lenient attitude toward risk-taking.

3.2.4. Accident Concern and Risk Taking questionnaire (AC/RT)

The Accident Concern and Risk-Taking (AC/RT, Appendix 7.2.4.) questionnaire developed by McKenna and Horswill (2006), was composed of four questions related to self-evaluation of personal driving ability (e.g., *"How skilful do you think you are compared with the average driver?"*), accident likelihood (e.g., *"How likely are you*

to be involved in accidents in the future compared with the average driver?"), concern over being involved in an accident (e.g., "I sometimes feel worried that I will be involved in an accident"), and receiving an exhilaration sensation when driving (e.g., "I often get a thrill from driving"). McKenna and Horswill (2006) employed the concern over being involved in an accident (Q1) and self-estimated likelihood (Q3) items as measures of accident concern, and the driving thrill (Q2) and skill (Q4) components as potential indicators of risk-taking behaviour due to the relationship to sensation-seeking and over-confidence.

Participants were instructed to select the most appropriate response from a ninepoint likert scale (1-9), which for each question ranged from 1 (*Strongly Disagree*) through midrange 5 (*Neither Agree/Disagree*) to 9 (*Strongly Agree*).

The third and fourth question measured conceptions of driving accident likelihood and ability (skill). Participants were instructed to indicate the most appropriate answer on an 11-point likert scale, with both questions ranging from 1 (*Much Less Likely/Skilful*) through 11 (*Much More Likely/Skilful*) with a midrange of 6 (*About the Same*). Each item was scored individually. Both the accident likelihood and concern over accident scales were reversed to give more risk-accepting attitudes.

3.2.5. Attitudes towards risky driving questionnaire (DRT)

The Driver Risk Taking questionnaire was adapted from Conner and Lai's (2005) and Reason, Manstead, Stradling, Baxter, and Campbell (1990) questionnaire, and consisted of 24 items measuring attitudes towards various risk-behaviours encountered in driving situations (Appendix 7.2.5.). The questionnaire was constructed to measure risk-taking attitudes towards a number of driving behaviours - though with a particular emphasis on speeding (see Parker et al., 1996) - which included (e.g., "Speeding is one of the main causes of road accidents") (5 items), dangerous overtaking manoeuvres (e.g., "I know exactly what risks I can take when I overtake") (6 items), driving whilst intoxicated (alcohol) (e.g., "It is quite acceptable to drive after only one or two drinks") (6 items), and close following of other vehicles (e.g., "It is quite acceptable to drive close to the car in front than is recommended") (5 items). Additionally, two questions were included regarding the

use of mobile telephones when driving (e.g.,, "It is dangerous to talk on your mobile phone whilst driving"). Responses were given on a 5 point scale ranging from 1 (strongly disagree) to 5 (strongly agree), with a midpoint (3) labelled 'neither agree nor disagree'. Half of the statements were weighted in favour of risk-taking driving behaviour, and the other half weighted against risk-taking driving behaviours. Reversing risk-aversive items yielded total scores and sub-scores with greater scores corresponding to increased risk-acceptance. While attitudes towards speeding, close-following, alcohol use, dangerous overtaking, and mobile phone use while driving were all independently calculated, a total composed score of all these factors was used as well to give an overall measure of a riskier attitude towards driving behaviour.

3.3. Laboratory based speed choice measures

3.3.1. Creating footage for the video speed task

A video speed-choice task (VST) similar to the one developed by Horswill and McKenna (1999) was used to measure risk-acceptance toward speeding. It consisted of participants watching video clips recorded from the drivers' perspective for different traffic scenarios (see example view in Figure 3.1). The task was modified slightly in that participants had to first estimate the vehicle speed (variable: speed estimate) before determining what their ideal preferred speed would be if they were driving.



Figure 3.1: Screenshot of a video used in the VST filmed from the driver's perspective.

The video task was designed to give a realistic impression of the forward view a driver would experience as travelling along a stretch of road. The videos used in the VST were selected according to the criteria established by Horswill & McKenna

(1999), ensuring that (1) reasonably constant vehicle speed was maintained for the duration each video clip, with (2) relatively clear road (approximately 50-100m clear road) ahead to allow for the option of speed increase in risk-estimation. It was also ensured that (3) there were minimal static hazards in the footage (e.g., parked cars), and (4) no external or internal speed cues (e.g., speed signs, or passing vehicles).

3.3.2. Different roads presented in the video speed-choice task

Horswill & McKenna (1999) employed only a limited selection of road types in their study, whereas in the present study the video task was adapted to explore driving behaviour across a number of different road environments commonly encountered by New Zealand motorists. The guidelines for selecting footage for use in the video task remained as consistent as possible with those established by Horswill and McKenna (1999). The land transport safety authority in New Zealand has distinguish between five different varieties of roads that are commonly encountered by drivers based upon the number of lanes present and traffic and hazard density.

- A. Motorways were defined as multiple-lane multiple-direction roads (connecting cities) often separated by intermediate hedging down the centreline. Highways and motorway roads across New Zealand have a speed limit of 100km/h. While the frequency of use changes depending on the day of the week and the time of day, these roads generally presented with a low hazard density. The perceptual characteristics that define these roads include clear markings (including reflective "cats-eyes" on lane centres and borders), edge-curbing pavement, without pedestrian moderate-high illumination, and а moderate/high grading of road aggregate and surfacing to accommodate a high traffic volume.
- B. *Rural* roads were defined as two-lane roads found outside of city-limits with a 100km/h speed limit and low density of hazards, and oncoming traffic in the adjacent lane. Rural roads are usually skirted by pasturelands or forest on

- C. *Semi-Rural* roads were defined as low-intersection arterial roads at the interface between rural and urban zones, where speed limit reduces to between 70-80km/h as traffic volume and number of hazards such as intersections increase. As these roads serve to interface rural and urban environments, they are usually skirted by pasturelands with slightly increasing urban and industrial infrastructure. These roads had markings on both the centre and border, moderate illumination, and developed edge-curbing, as well as a moderate grading of road aggregate/surfacing (NZ Transport Authority, 2005).
- D. *Urban* roads were defined as high-intersection arterial road with a speed limit of 50km/h which connect the hazard-rich sub-urban roads residing within business and housing zones. These roads carry the bulk of traffic volume, and as urban roads are arterial they have a greater traffic volume and number of intersections. Urban roads posses markings both on the centre and border, moderate hazards and more stationary objects (i.e. parked cars), high illumination, and finer grade of surface aggregate and developed curbing and pavement for pedestrians.
- E. *Suburban* roads were defined as 50km/h roads servicing housing developments with a moderate traffic volume and a high density of hazards (i.e. children, drive-ways). These roads are both narrower and have a greater number of static hazards such as parked vehicles. Suburban roads can either connect to other roads (avenues) or terminate in a cul-de-sac. Illumination

Using these accepted categories, video clips for 5 different road environments were produced from the raw video footage (Figure 3.2). Additionally, a night time driving scenario was produced from footage obtained across road environments during night-time.



Motorway

Rural (open)



Semi-rural



Urban

Sub-Urban

Figure 3.2: Sample screenshots of the five different road environments as presented in the video speed task.

To collect footage for the video task, the camera-vehicle was driven on a route covering a number of different road environments located about the Waikato University and surrounding countryside. Footage was recorded along this route during the mid-afternoon over the period of approximately 2 hours. The identical route was again followed after sunset in the early evening to generate night time footage.

Whilst travelling, the camera-vehicle was driven at a variety of speeds ranging at and downward from the road speed limit (Appendix 7.3.1). For instance, on a 100km/h rural road, the footage might have been recorded at camera-vehicle speed of 70km/h (or 30km/h bellow the speed limit). The speed of the camera-vehicle varied from the speed limit in intervals in order to measure the accuracy of driver's ability to estimate how fast they were travelling in the footage. It was reasoned that if the speed of the camera-vehicle remained at approximately the speed limit during filming, participants might be inclined not to make any adjustment. Introducing a mismatch between the camera-vehicle speed in the footage and the road speed limit may incline drivers to select preferred speeds that better correspond with their actual real-world behaviour (i.e., presenting a speed much lower that the speed limit should not be preferred by the majority of drivers). During the time of filming the camera-vehicle speed was kept as constant as possible.

Video footage was recorded using a Sony DCR-TRV25E digital video camera mounted on a specially devised bracket so that the recorded footage would be static-frame and not indicate vibration within the vehicle. The footage obtained presented the drivers view through the front windscreen of the vehicle. A similar system was utilized for filming the front view of traffic scenarios for CD-Drives driver training program (for a more detailed description see: Isler & Cockerton, 2003).

The camera recorded the entirety of footage in compressed digital formatting, allowing for direct transfer onto a desktop computer. The camera was focused automatically to ∞ , and then was locked into that configuration to prevent refocusing under the changing depth-field conditions. This focal-point setting provided maximum density at a distance approximately 20m ahead of the vehicle, which is realistic under normal driving conditions. Exposure settings were set to automatic adjustment with a standard intensity range (ISO100-200), to maintain optimum brightness and contrast.

Footage was transferred digitally to a desktop computer, where editing occurred. According to the criteria set forward by Horswill & McKenna (1999), fifty-seven video clips were selected from the footage (see 3.3.1.), and extracted at mediumresolution (640 by 480 pixels at a bit rate of 704kbs⁻¹) using Windows Movie Maker. From these clips, 30 short video segments (25 day and 5 night) of 15 seconds length were selected based on image clarity and quality, with five videos representing each of the road environments used in the speed task (Appendix 7.3.1.).

3.4. Research design

A mixed, between subjects and repeated measures design was used in this research to examine speed preferences and attitudes of young and inexperienced and older, more experienced drivers (between subjects), and to investigate if their speed preference was influenced by different road environments (repeated measures). All participants, irrespective of driver group, performed the self-report and laboratory measures in an identical manner, completing the self-report measures before performing the video speed choice task.

As described above, the video speed-choice task used footage representing five different New Zealand road environments (plus a night-time scenario), and speed preference and estimate measures were gathered from each participant during a single session. Two sequences of 30 (25 day, and 5 night) video trials were developed (using the same 30 videos pseudo-randomly ordered), and participants were assigned to one of the two sequences. Additionally, for each sequence 3 trials were repeated to provide a measure of internal reliability. For each road environment, video-trials (excluding the 3 repeated trials) were averaged to provide measures of both i) estimated speed, and ii) preferred speed for each of the 5 different road types, and the night-time driving scenario.

3.5. Procedure

After ethics approval was received from the Psychology Department Ethics Committee of the University of Waikato, participants were recruited via posters on the research notice boards of both the Hamilton and Tauranga campuses (Appendix 7.1.1.). Participants were provided with brief information concerning the research goals and experiment (Appendix 7.1.2.). Before participating in the experiment, participants were advised about ethical guidelines, and provided written consent (Appendix 7.1.4.)

The participants were tested individually and self-report measures were administered first in order of Demographics, followed by measures of impulsivity (BIS), attitude toward risk (AR), accident concern and risk taking (AC/RT), and driver risk taking (DRT).

The Video Speed Choice task (VST) was then performed by participants seated at a desk top computer. Initially participants were presented with a clear screen. A mouse-click on a button in the centre of the display started the task, after which a five second countdown was displayed at the centre of the screen. At the end of the countdown, a 15 seconds video clip was shown without sound. For each participant, video clips from the five road environments were presented in a predetermined pseudo-random ordering.

At the completion of the video clip, a screen (Figure 3.3) appeared asking participants to estimate the speed at which the vehicle in the clip had been travelling in kilometres per hour (e.g., "How fast do you think you were going?"). The counter was automatically set to 1km/h at the beginning of the trial, and using the mouse to select the FASTER/SLOWER arrows, participants were able to adjust the counter in increments of 1km/h until the desired speed had been reached. Continually holding down the mouse button accelerated the speed at which the increments increased or decreased.

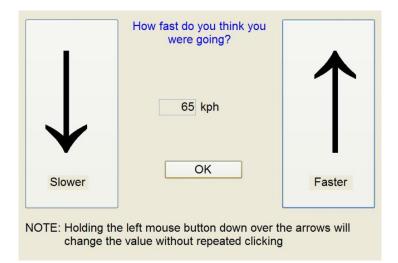


Figure 3.3: The first screen asking participants to enter their vehicle speed estimate.

Selecting OK opened a following screen (Figure 3.4) similar to the screen used for speed estimation (Figure 3.3), except participants were asked to adjust their estimated speed to a speed at which was more appropriate for the conditions presented in the footage (e.g., "What do you think would be the ideal speed for this road condition?"). The counter was set at the speed participants thought the vehicle was travelling. As in the previous trial drivers were able to increase or decrease the counter using the mouse.

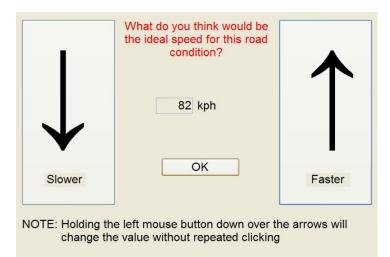


Figure 3.4: The second screen asking participants to adjust their estimate to an ideal speed.

Once participants had adjusted the speed estimate to their preferred speed, selecting OK returned to the initial blank screen. Selecting PLAY would begin the countdown for the next video trial in the sequence. This process was identical for each video trial. Once the entire set of 33 video clips (30 trials, 3 repeated trials) had been completed by the participant, the program exited.

Once all tasks were completed, an informal discussion and debriefing was conducted, in which participants were able to discuss any aspects of the study. Additionally, the experimenter asked if participants had made any observations concerning the estimation of speeds in the VST (e.g., "What did you use to judge speeds in the night-time footage?". Participants were thanked for their time, and given instructions concerning obtaining course-credit and a final dissemination of research findings.

3.6. Data Management and Processing

Demographic and questionnaire responses were entered into a Microsoft Excel spreadsheet. Age and license issue date were calculated from the participants birthday up until the month when testing was performed. The demographic question "How many kilometres do you drive in a usual week?" was excluded due to inconsistent subjective responses, and the question concerning "near misses" was excluded because there was some confusion in interpreting what constituted a near miss.

For each self-report measure, the numerical value for each questionnaire item was entered for each participant. Some questionnaire items were recoded to ensure that greater values reflected higher levels of risk-acceptance. Formulas were written in Microsoft Excel to calculate the total risk-acceptance score for each questionnaire (e.g., total score), and also sub-scales scores measured by certain questionnaires (e.g., the subscale of the DRT measuring attitude toward speeding).

Reliability analysis revealed that the BIS-11 had a poor level of internal reliability. Consequentially the item "I save regularly" was removed to optimize reliability (Cronbach alpha = 0.607). Reliability analysis revealed an acceptable level of internal reliability given by Cronbach's alpha for all other self-report measures (Appendix 7.2.6.)

Two approaches were taken to examine speed choices on different road environments between driver groups. The first approach reflected the methodology employed by Howswill and McKenna (1999) - where the all speed choices were aggregated together to give an overall measure of speed preference. The second approach involved exploring how speed choices differed by driver group across a range of different road environments commonly encountered by New Zealand motorists for both day and night road scenarios. Raw data for the video speed-task was imported into a Microsoft Excel table. Raw data was in a format listing the trial number (corresponding to the video clip), the raw estimate, and the raw speed preference for each video clip.

The accuracy of speed estimation (Estimate Accuracy) was determined by calculating the difference between the camera-vehicle speed and the participants' estimation for each video clip. A positive value for *Estimate Accuracy* corresponded to over-estimation of actual vehicle speed, and negative value corresponded to under-estimation of the actual vehicle speed (this is represented diagrammatically in Figure 3.5).

The *Speed preference* variable was determined by calculating the difference between the preferred speed indicated by the participant and the speed limit of each road. A positive value for *Speed preference* corresponded to a preferred speed greater than that of the road speed limit, and a negative value corresponded to a preferred speed that beneath the speed limit.

During this process, values were constantly matched to a unique participant number to ensure the integrity of data. Video speed results were calculated using formulas on a separate Excel spreadsheet, and the two spreadsheets were merged together using the participant number as a reference and exported for further analysis using SPSS v.12.

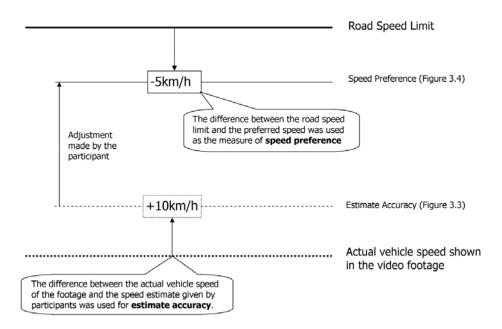


Figure 3.5: Demonstrates how speed estimate accuracy and speed preference were calculated depending upon actual vehicle speed and road speed limit.

Video trials were sorted into the five different road environment categories, and estimate accuracy and speed preference were calculated by averaging the responses participants gave to video trials for each category. For instance, video trials displaying motorway roads were averaged to give mean speed preference and estimate accuracy for the motorway environment for each participant. Additionally, overall speed preference and speed estimate accuracy was calculated for each participant by averaging values for all video trials irrespective of road environment.

Three potential methodological problems were identified at the start of the study: (1) Participants might be selecting speeds randomly; (2) Participants might be inconsistent with their estimation and speed selections across the duration of the task (i.e., they may become bored and be less inclined to adjust estimate speed to their actually preferred speed). To ensure that participants were consistent in their speed estimates and preferences across the span of the video speed task administration, 3 video trials were repeated approximately every 6th video. These repeated video trials were correlated to determine the test-retest reliability. The third (3) problem identified was that the ordering of video trials might influence subsequent trials. To compensate for this potential ordering effect, two randomised sequences of the video trials were produced, such that half the participants would receive one order, and the remaining participants would view the videos in a different order.

Initially, descriptive statistics of the sample demographic were calculated to examine any differences between the driver groups regarding self-reported accident involvement and driving violations.

To examine personality and attitudinal differences between the two driver groups, inferential analyses was conducted on mean overall and subscale scores for each measure using independent t-tests (where normality assumptions were satisfied) with driver group the as independent variable. Shapiro Wilks tests were used to determine if data were normally distributed. Data that did not have a normal distribution were analysed using the Mann-Whitney U test.

Independent t-tests were employed to examine differences in VST measures between the two driver groups. The initial examination focused on differences between drivers' in overall speed preference, and then was focused on the differences between drivers' speed preferences for each of the five different measured road environments. Drivers' ability to estimate accurately the vehicle speed was also examined between groups using independent t-test for each road environment.

Correlations were used to explore relationships between the self-report measures of personality characteristics, attitudes toward risky driving behaviour, and the laboratory measured speed preference. Correlations were performed on all questionnaire composite scores and subscale measures, and the VST measures of overall speed preference and speed preference for the five road environments. As questionnaire items were nominal, Spearman Rho (r_s) was employed.

4. Results and Discussion

The 36 participants who were recruited completed the experimental procedure; however the data from two participants had to be omitted from the analyses owing to computer failure during administration of the video speed-choice test. Therefore, data from 19 young and inexperienced drivers (Group A, 9 male, 10 female) and from the 15 older and more experienced drivers (Group B, 6 male, 9 female) was analysed. The results will be presented in the order of the research questions.

4.1. Self-reported driving history

Initially, the demographic questionnaire revealed background information concerning the participants driving history. The number of convictions or warnings and the number of crashes (regardless of who had been at fault) occurring in the previous 12 month period provided some indication of the two groups real-world driving performance. Several participants reported having had multiple traffic offences and crashes, and 6 of the 9 reported crashes were accompanied by a history of traffic offences. The self-reported traffic offences (i.e., convictions and warnings) and vehicle crashes for both driver groups are presented in Figure 4.1.

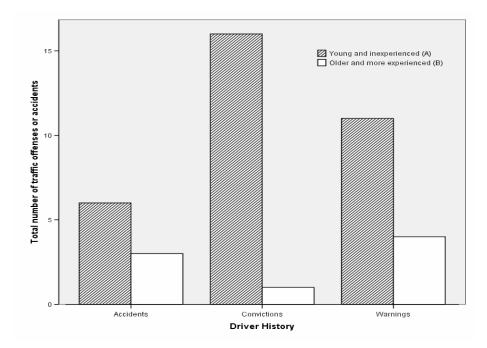


Figure 4.1: The total number of self-reported traffic offences and crashes for both driver groups A (young and inexperienced, N = 19) and B (older and more experienced, N = 15)

The most notable observation was that young and inexperienced drivers (Group A), reported a markedly greater number of traffic offences and accidents than older and more experienced drivers (Group B). Group A reported having been involved in a total of 6 accidents (67% of total), and had been issued 16 convictions (94% of total) and 11 warnings (73% of total). Group B reported having been involved in a total of 3 accidents (33% of total), and had been issued 1 conviction (6% of total) and 4 warnings (27% of total). Clearly this demonstrates that the young and inexperienced drivers in this sample had a higher rate of committing traffic offences or being involved in a crash compared to the older and more experienced drivers.

Speeding convictions and warnings referred to offences where the speed limit had been violated, whereas non-speeding offences referred to violations of other traffic rules (i.e., failing to give way or stop). The number of speeding and non-speeding related offences for both driver groups is presented in Figure 4.2. The young and inexperienced drivers (A) had many more speeding to non-speeding related offences than the older and more experienced drivers (B).

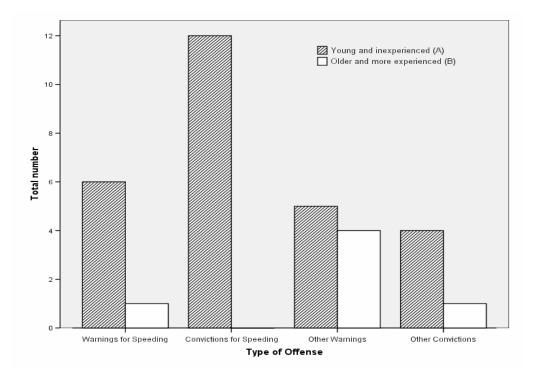


Figure 4.2: The number of speeding and non-speeding related convictions and warnings for both driver groups A (young and inexperienced, N = 19) and B (older and more experienced, N = 15)

Older and more experienced drivers (B) reported having received no convictions for speeding and 1 warning for speeding. Young and inexperienced drivers (A) reported having received 12 speeding convictions (accounting for 75% of Group A convictions) and 6 warnings for speeding. This clearly demonstrated that young and inexperienced drivers (A) were more likely to commit a speeding related traffic offence as opposed to a non-speeding related offence.

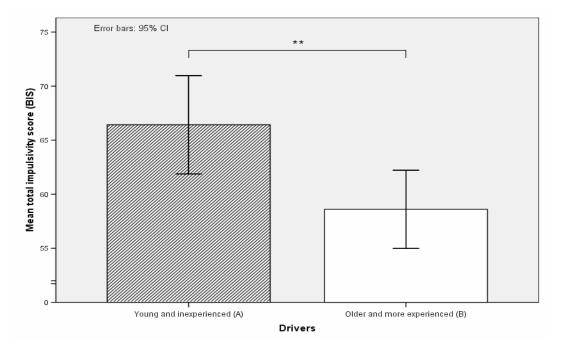
These differences between driver groups are in support of many findings in the reviewed literature, which consistently finds that young drivers are more likely to be charged with a speeding related offence and are more frequently involved in speeding related crashes than older drivers.

4.2. Differences in self-report risk taking measures between the young and inexperienced and older more experienced Drivers in a New Zealand Sample

Self-reported measures of personality characteristics and risk-taking attitudes will be reported in the order that they were introduced in the Method section. The first selfreport questionnaire measured the personality characteristic of impulsivity, followed by the attitude towards risk questionnaire which measured driving attitudes related to sensation-seeking and social deviance. Following these questionnaires, self-rated driving thrill, concern and likelihood of being involved in an accident, and self-rated skill in relation to the average driver are reported. The final self-report questionnaire measured acceptance of different kinds of risky driving behaviour. Self-reported measures were analysed between driver groups.

4.2.1 Impulsivity (BIS)

The Barrett Impulsivity Scale provided an overall score with a higher value corresponding to greater level of impulsivity. The three impulsivity sub-scales (attention, motor, and non-planning) were also analysed. Mean total impulsivity scores for both driver groups are presented in Figure 4.3. The figure reveals that young and inexperienced drivers (Group A) had a greater mean total impulsivity score compared to the older and more experienced drivers (Group B).



<u>*Figure 4.3*</u>: Mean overall impulsivity scores for both driver groups. The bars indicate 95% confidence intervals. (** = p < 0.01).

A Shapiro-Wilk test for normality showed that the distribution of the total impulsivity and sub-scale scores were normal, p > 0.05). T-Tests revealed the difference between the driver groups observed in Figure 4.3 was confirmed to be significant, t(34) = 2.84, p < 0.01. Young and inexperienced drivers (A) had a greater overall impulsivity score (M = 66.4, SD = 9.45) compared to older and more experienced drivers (B) with a lower mean overall impulsivity score (M = 58.6, SD = 6.53). The possible impulsivity scores of the BIS-11 range from a minimum of 28 (extremely low) through to a maximum of 112 (extremely high), indicating that the scores for both driver groups fell within a low to moderate rating of impulsivity. The three impulsivity sub-scales (Attention, Motor, and Non-planning) were examined to identify differences in the type of impulsivity between the driver groups. Figure 4.4 displays the mean total score for each sub-scale for both driver groups. The figure indicates that young and inexperienced drivers (A) had a greater impulsivity score on each sub-scale than older and more experienced drivers (B).

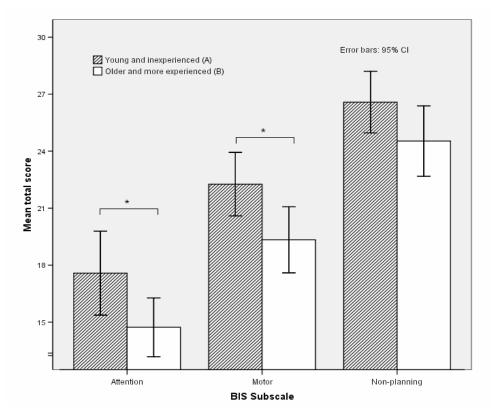


Figure 4.4: The three sub-scales of impulsivity (total scores) for both driver groups. The bars indicate 95% confidence intervals. (* = p < 0.05).

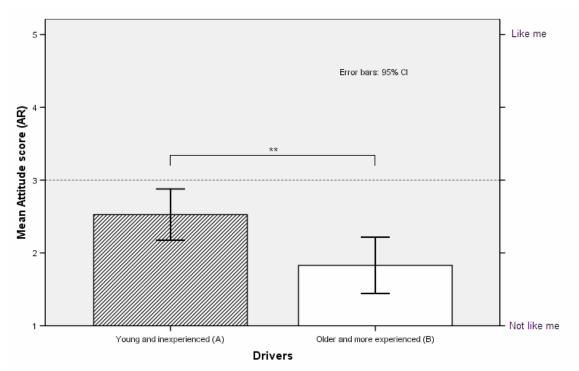
Independent t-tests confirmed the two groups of drivers had significantly different means for two of the three impulsivity sub-scales. The mean total scores for the attention sub-scale were significantly different for the two driver groups, t(34) = 2.2, p < 0.05, with young and more experienced drivers having greater attentional impulsivity (M = 17.5, SD = 4.59) compared to older and more experienced drivers (M = 14.7, SD = 2.78). The mean total scores for the motor sub-scale (average of the 10 questions) were also significantly different between the two driver groups, t(34) = 2.58, p < 0.05. Group A reported greater motor impulsivity (M = 22.2, SD = 3.46) compared to Group B (M = 19.3, SD = 3.13). The mean total score for the non-planning sub-scale was not found to be significantly different between the two driver groups (p = 0.87) with a mean difference between driver group of 2.05 (SE = 1.16).

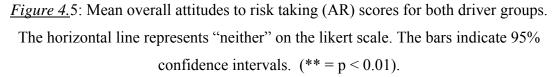
In summary, young and inexperienced drivers had a greater total impulsivity score than older and more experienced drivers. This could indicate that the young and

inexperienced drivers might have less ability to regulate their thoughts and behaviours. The young and inexperienced drivers had significantly higher scores on both the motor and attentional impulsivity sub-scales compared to the older more experienced driver group, and this might indicate that young drivers are more likely to act without thinking and have less ability to maintain attention.

4.2.2. Attitudes towards risk taking (AR)

Higher overall scores of the Attitude towards Risk questionnaire (AR) represented more lenient and risk-accepting attitudes. The mean overall scores for both driver groups are presented in Figure 4.5. The figure clearly showed that young and inexperienced drivers (Group A) had a more lenient attitude toward risk-taking compared to older and more experienced drivers (Group B).

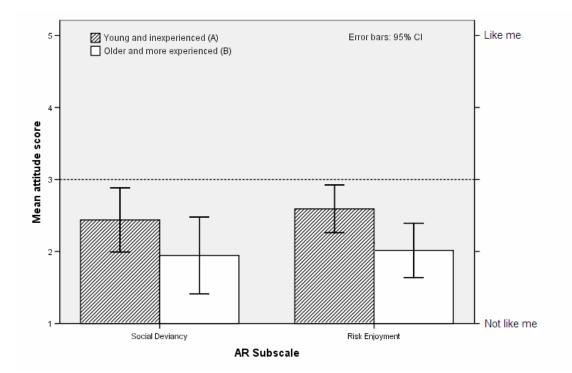


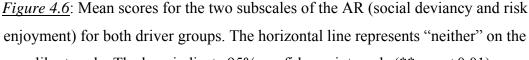


The differences in the mean total score observed between driver groups in Figure 4.5 were confirmed to be significant, t(34) = 2.108, p < 0.05. Young and

inexperienced drivers had a more risk-accepting attitude (M = 2.5, SD = 0.81) compared to older and more experienced drivers (M = 1.8, SD = 0.68).

The mean total scores for each sub-scale (risk enjoyment and social deviancy) of the attitudes to risk taking questionnaire (AR) are shown in Figure 4.6 for both driver groups. The figure shows that young and inexperienced drivers (A) had higher mean total scores for both sub-scales than the older and more experienced drivers (B).





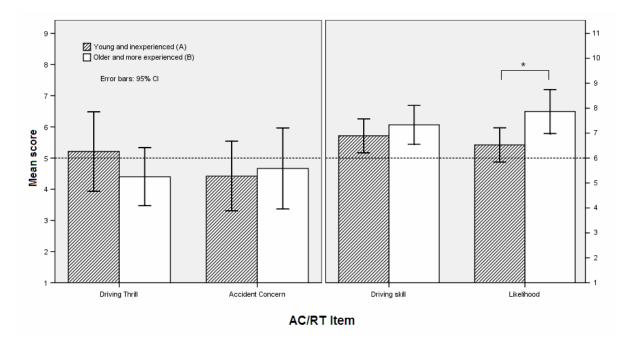
likert scale. The bars indicate 95% confidence intervals (** = p < 0.01).

Independent t-test revealed that the mean total scores for the risk enjoyment subscale were significantly different between the driver groups, t(34) = 2.748, p < 0.01., indicating that Group A received more enjoyment from risk-taking (M = 2.6, SD = 0.69) than Group B (M = 2.0, SD = 0.68). As the risk enjoyment sub-scale measures physical sensation-seeking, this suggests that Group A may experience greater sensation when engaging in risky driving. Analysis of the social deviancy sub-scale using the Mann-Whitney U test did not significantly between the groups (z = -1.478, p > 0.05)

In summary, the differences identified between the two drivers groups suggested greater level of sensation-seeking behaviour in young and inexperienced drivers, who had greater scores on the risk enjoyment sub-scale. This could suggest that young and inexperienced drivers receive a stronger sensation of enjoyment when engaging in personal risk-taking when driving.

4.2.3. Accident Concern and Risk Taking (AC/RT)

The AC/RT questionnaire was composed of four independent questions and provided a measure of self-rated driving ability and accident concern. Figure 4.7 shows the mean score on each item for both driver groups. Higher scores represented greater self-rated skill and thrill, as well as a more lenient attitude (i.e. less worry) toward the concern or perceived likelihood of being involved in an accident. Visual inspection of the figure showed young and inexperienced group (A) rated themselves to have a slightly less worry and self-estimated likelihood of being involved in an accident, and a greater level of thrill perceived from driving compared to the older and more experienced driver group (B). Both groups rated their driving skill and worry over being involved in an accident above that of the "average" driver, although older and more experienced drivers (B) rated themselves to have a slightly greater skilfulness.



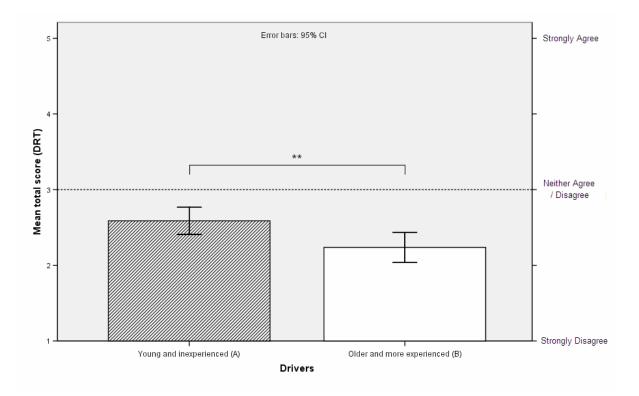
<u>*Figure 4.7*</u>: The mean total score for AC/RT measures for both driver groups. Note that the scale differs for the two sections of the figure. The horizontal line represents 'like the average driver' on the likert scale, and higher scores correspond to riskier self-ratings. The bars indicate 95% confidence intervals (* = p < 0.05).

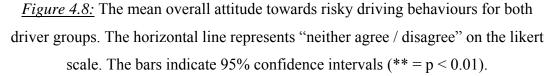
Independent t-test revealed that only the self-rated likelihood of accident involvement was significantly different between the two driver groups, and the non-parametric Mann-Whitney U test confirmed this (z = -2.531, p < 0.05) with a mean rank for Group A of 12.87 and a mean rank of Group B of 21.16. This indicates a lower self-estimated likelihood of being involved in an accident by young and inexperienced drivers (M = 4.1, SD = 1.59) compared to the older and more experienced drivers (M = 5.4, SD = 1.42).

This finding suggests that older and more experienced drivers (B) rate their likelihood of being involved in an accident "about the same" as that of the average driver and greater than young and inexperienced drivers (A) who rate their likelihood of being involved in an accident much less likely than the average driver. Self-rated driving skill was found to be rated above that of the "average driver" for both driver groups, however a non-parametric analysis revealed there was no significant difference between driver groups.

4.2.4. Driver Risk Taking (DRT)

The DRT questionnaire provided indication of risky attitudes towards driving. A higher score represented a more lenient attitude towards risky driving, and each subscale score provided a measure of riskier attitudes toward five different risky driving behaviours. The mean overall attitude scores for both driver groups are shown in Figure 4.8. The figure indicated that young and inexperienced drivers (A) have a more lenient attitude toward risky driving compared to older and more experienced drivers (B)

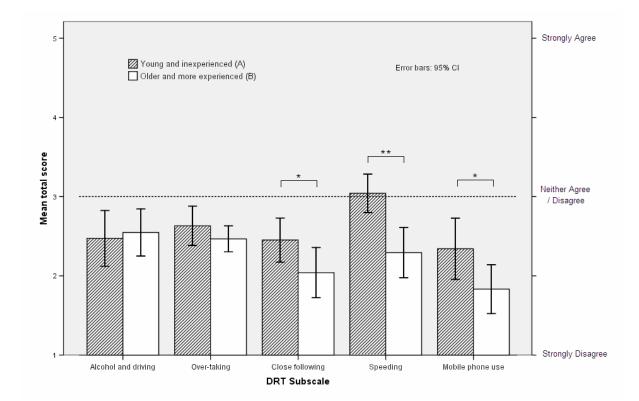


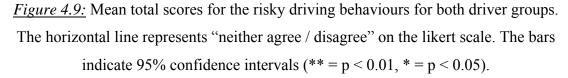


An independent t-test confirmed significantly different mean scores between driver groups, t(34) = 2.78, p < 0.01, with young and inexperienced drivers (A) rating themselves closer to "neither agree/disagree" (M = 2.5, SD = 0.37) than older and

more experienced drivers (B), who rated themselves closer to "disagree" (M = 2.2, SD = 0.36). This indicated that young and inexperienced drivers had a generally more lenient attitude toward risky driving behaviours.

An analysis was performed to examine the different risky behaviours between driver groups. The mean total score for all risky driving behaviours is shown in Figure 4.9 for both driver groups. A visual inspection of the figure clearly shows large differences in attitudes towards speeding and mobile phone use between driver groups. Young and inexperienced drivers had more lenient attitude for speeding, close-following, over-taking, and mobile phone use, whereas older and more experienced drivers indicated more lenient attitudes towards alcohol use and driving.





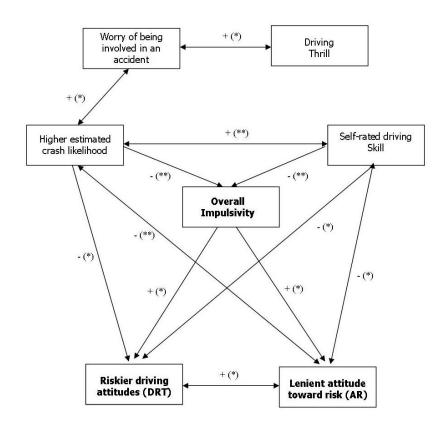
Independent t-test confirmed a significant difference between driver groups for attitudes toward speeding, t(34) = 3.995, p < 0.01, attitudes toward close-following,

t(34) = 2.082, p < 0.05, and attitude towards mobile phone use, t(34) = 2.183, p < 0.05. However, the difference between driver groups was strongest in attitude towards speeding. Young and inexperienced drivers (A) rated their attitude toward speeding more lenient at "neither agree nor disagree" (M = 3.0, SD = 0.50) compared to older more experienced drivers (B) who rated their attitude "disagree" (M = 2.2, SD = 0.57). Group A had a more lenient attitude toward close-following (M = 2.4, SD = 0.57) compared to Group B rating (M = 2.0 (SD = 0.57). Attitude toward using a mobile phone whilst driving (not at the time an illegal practice in New Zealand) was also more lenient for Group A (M = 2.3, SD = 0.80) compared to Group B (M = 1.8, SD = 0.55). Independent t-tests showed that attitudes towards alcohol use (p = 0.748) and dangerous over-taking (p = 0.280) did not differ significantly between the groups.

Overall, it was found that young and inexperienced drivers (A) had riskier attitudes toward various dangerous driving behaviours compared to older and more experienced drivers. Attitudes towards close following, speeding, and dangerous over-taking were found to be more lenient for young and inexperienced drivers.

4.2.5. The relationship between self-report measures of risk-taking

The different self-report measures of risk-taking were correlated to examine the interaction between them. As questionnaire scales were ordinal, non-parametric Spearman produce-moment correlations were employed. Correlations were inclusive of both driver groups. Inter-item correlations revealed that many of these measures were inter-related, and these relationships are represented visually in Figure 4.10.



<u>Figure 4.10</u>: Visual representation of the relationship between different risk measures. Emboldened text represents total scores, and standard text represents subscales. Significance level and direction of correlation is indicated (* = p < 0.05, ** = p < 0.01)

Impulsivity was found to correlate with a number of different measures. Overall impulsivity scores were found to correlate with self-estimated likelihood of being involved in an accident ($r_s = .566$, p < 0.01) and self-rated skilfulness ($r_s = .508$, p <

0.01). This suggests that individuals with higher impulsivity were more likely to underestimate their likelihood of being involved in a crash, and overestimate their ability to control a vehicle. Greater impulsivity scores were also related to a more lenient attitude toward risk-taking (AR: $r_s = .349$, p < 0.05) and accepting of risky driving behaviours (DRT: $r_s = .495$, p < 0.05), indicating that higher impulsivity was related to a riskier attitude towards dangerous driving or risk-taking.

More lenient attitudes towards risk-taking was related to more accepting attitudes towards dangerous driving behaviours as measured by the DRT ($r_s = .450$, p < 0.05). This suggests that greater risk acceptance whilst driving was related significantly to both greater enjoyment of risk taking and socially deviant attitudes. Figure 4.11 demonstrates the relationship between measures of driver risk taking and attitude towards risk.

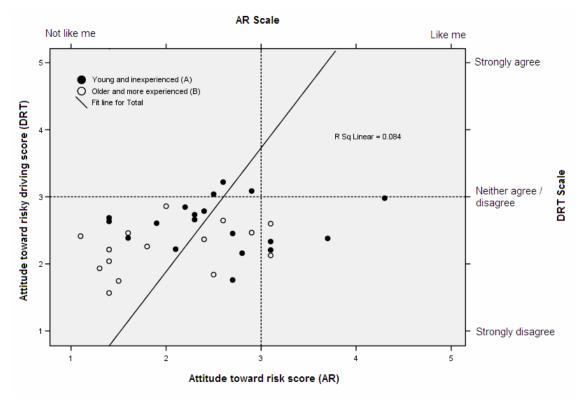


Figure 4.11: The relationship between attitude toward-risk (AR) and driver risk-taking (DRT) measures. The dotted lines represent "neither" on both likert scales.

Lenient attitudes towards risk-taking were also related to under-estimation of the likelihood of accident involvement ($r_s = .469$, p < 0.05) and lower self-rated skill (r_s

= -.347, p < 0.05). This suggested that while individuals within the sample with a lenient attitude towards risk were less likely to expect their involvement in an accident, they were also less likely to view themselves as being skilful drivers. Lenient attitudes were also found to be related to greater impulsivity, as previously discussed. Additionally, the total attitude toward-risk composite score was found to correlate positively with speed related attitudes ($r_s = .434$, p < 0.01) as measured by the driver risk-taking questionnaire.

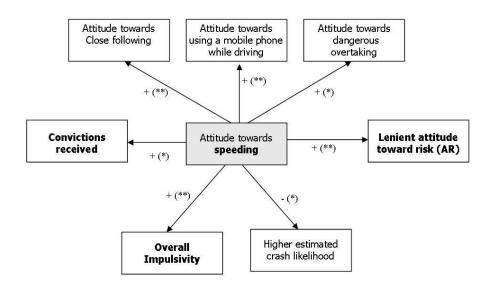
A more accepting attitude towards dangerous driving behaviour correlated with under-estimated likelihood of being involved in an accident ($r_s = .397$, p < 0.05), suggesting that individuals who felt less concern over dangerous driving behaviours were also more likely to expect low chances of being involved in an accident.

Self-rated driving thrill was found to be related to a reduced worry over being involved in an accident ($r_s = .376$, p < 0.05), suggesting that individuals who received greater thrill from driver were also less worried about being involved in accident. Less worry was also found to be related to under-estimated likelihood of being involved in an accident ($r_s = .424$, p < 0.05), which indicated that individuals who were less worried about being involved in an accident tended to underestimate the likelihood that an accident would occur.

An underestimation of the likelihood of being involved in an accident was also related to a reduced self-rating of skilfulness ($r_s = .476$, p < 0.05). While this seemed almost paradoxical, it suggests that more skilful drivers considered that their likelihood of being involved in an accident was greater, and this may be owing to skill increasing with experience which the literature suggests is related to higher riskperceptual and awareness of hazards. Estimated crash likelihood and driving skill have been previously mentioned as being related to impulsivity, driver risk taking, and attitudes toward risk-taking.

4.2.6. Risky attitudes towards speeding

The measure of accepting attitudes toward speeding behaviours was found to correlate with a number of other measures for attitudes towards risk taking and impulsivity. These will be examined further, as the reviewed literature suggests that more lenient attitudes toward speeding are related to faster preferred driving speeds. Significant correlations between risk-taking measures and speeding related attitudes are represented in Figure 4.12.



<u>*Figure 4.12*</u>: Relationship between different risk measures and attitudes toward speeding. Emboldened text represents total scores, and standard text represents subscales. Significance level and direction of correlation is indicated (* = p < 0.05, ** =

p < 0.01)

Impulsivity was found to strongly positively correlate with attitude towards speeding ($r_s = .434$, p < 0.05) suggesting that more impulsive individuals had a more accepting attitude towards speeding. Both higher risk enjoyment ($r_s = .405$, p < 0.05) and social deviancy ($r_s = .395$, p < 0.05) subscale scores from the attitude towards risk questionnaire were found to correlate significantly with a lenient attitude towards

speeding. This indicated that both greater enjoyment in engaging in risky activities and more socially deviant attitudes were associated with speeding.

A higher perceived likelihood of being involved in an accident was found to be related to a more conservative attitude toward speeding ($r_s = -.379$, p < 0.05). This suggested that persons who were though their likelihood of being involved in an accident tended to have less lenient attitudes towards speeding.

A more accepting attitude toward speeding was related to other more accepting attitudes towards close-following ($r_s = .378$, p < 0.05), dangerous over-taking ($r_s = .526$, p < 0.01). The literature suggests that these three behaviours are particularly good predictors of crash involvement. Dangerous overtaking in particular involves an aggressive driving style which is closely related to the desire to drive at excessive speed. Additionally, a more accepting attitude towards using a mobile phone whilst driving was found to correlate with an accepting attitude toward speeding ($r_s = .446$, p < 0.05). While this is a dangerous behaviour, at the time of this research this behaviour was not illegal in New Zealand.

Finally, accepting attitudes toward speeding were rated to a greater number of convictions being received in the previous 12 month period ($r_s = .486$, p < 0.05), and in particular the number of speeding related convictions that had been received ($r_s = .484$, p < 0.01). This relationship was also identified for non-speeding related convictions ($r_s = .360$, p < 0.05). This provides some indication that attitudes toward speeding are related to real-world driving performance, and establishes a certain degree of ecological validity for the speeding attitude measure.

4.3. Do young and inexperienced drivers choose higher speeds than older and more experienced drivers, and how do different road conditions affect speed choice in these two groups of New Zealand drivers?

4.3.1. Overall speed preferences between driver groups

The video speed-choice task provided a measure of speed related risk-taking on different road environments. The VST was tested using two pseudo-random sequences to reduce ordering effects. Comparison of mean speed estimate and preference between these two sequences by independent t-test showed that there was no significant variation between the responding on the two randomised sequences (p < 0.01). Additionally, 3 trials were repeated to provide an indication of the consistency responses. Both repeated speed estimates and preferences were found to have a significant correlation (p < 0.01) indicating a high consistency of responding. This together with test-retest results indicate that participants were consistent with the responses across the duration of the video task and were not likely to be influenced by the ordering of video trials. The night time scenario was excluded from the analysis owing to the poor resolution of the obtained footage.

The first analysis compared the mean overall speed preference between driver groups, (see Figure 4.13). The figure indicates that young and inexperienced drivers (A) preferred faster overall speeds slightly below the road limit, whereas the older more experienced (B) drivers preferred slower overall speeds clearly below the road limit.

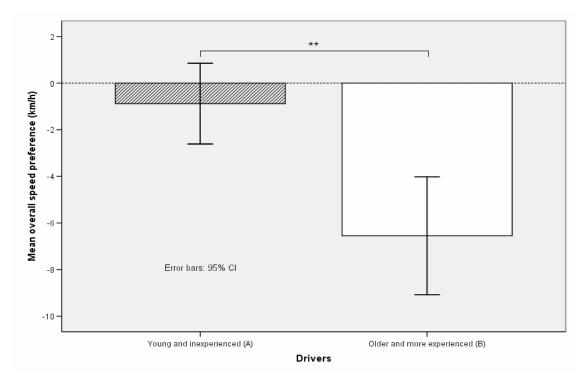


Figure 4.13: Mean overall speed preference below the limit (in km/h) for both driver groups. Speed preference is shown in relation to the road speed limit (0km/h). Negative values indicate preferred speed (in km/h) below the speed limit. The bars indicate 95% confidence intervals (** = p < 0.01).

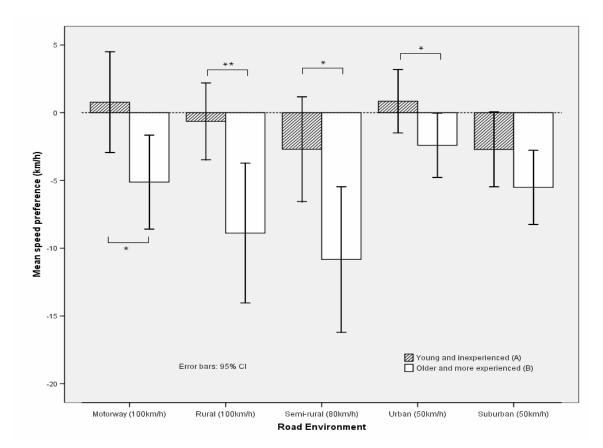
This difference observed between driver groups was found to be significant in an independent t-test, t(34) = 3.952, p < 0.01, with young and inexperienced drivers preferring significantly faster speeds (M = -0.8 km/h, SD = 3.48) compared to older and more experienced drivers (M = -6.5 km/h, SD = 4.55).

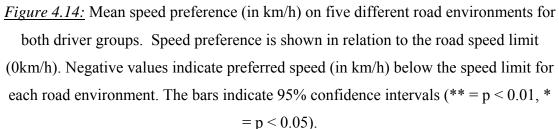
It is worth noting that young and inexperienced drivers (A) were inclined more inclined toward faster speeds which were centred about the road speed limit (Min = -6.0 km/h, Max = 5.2 km/h). Additionally, approximately 40% (N = 7) of young and inexperienced drivers indicated they preferred a overall speed that was greater than the road speed limit, and the majority of these drivers with excess speed were male (5 male, 2 female). Older and more experienced drivers (B) preferred a range of speeds that were slower than the road speed limit, and none of this driver group indicated an over speed greater than the limit (min = -14.5 km/h, max = -0.3 km/h).

One explanation of the differences between driver groups could be that older and more experienced drivers are more able to "read the road" and take road conditions into account when selecting an appropriate speed, whereas young and inexperienced drivers (A) may judge a speed to be appropriate by approximating the speed limit as a target. Additionally, young and inexperienced drivers indicated they were more comfortable with deliberately violating the road speed limit (albeit marginally) and this is supported by the reviewed literature.

4.3.2. Speed preference on different road environments

The next analysis examined if the speed preference differed depending upon the road type. The mean total speed preference for each road environment is displayed in Figure 4.14 for both driver groups. The most notable observation from a visual inspection of the figure was that the young and inexperienced drivers (A) preferred faster speeds that were close to the speed limit irrespective of the road environment, whereas older and more experienced drivers (B) preferred slower speeds which considerably varied from the limit for each road environment.





Independent t-tests were performed on the mean speed preferences between driver groups on all road environments. The results for each road environment are presented bellow.

Motorway roads

Mean total speed preference were revealed to be significantly different between driver groups on motorway roads, t(34) = 2.465, p < 0.05, with a difference in mean total speed preference between groups of 5.8 km/h (SE = 2.39). Young and inexperienced drivers (A) preferred significantly faster speeds (M = 0.7 km/h, SD =

7.48), which ranged from -14km/h to 14km/h about the limit (which translates to actual speed choice ranging between 86 and 114km/h). By comparison older more experienced (B) drivers preferred slower speeds (M = -5.1 km/h, SD = 6.26), ranging from -17km/h to 3km/h about the limit (which translates to actual speed choice ranging between 83 and 103km/h)

Rural roads

Mean total speed preference were revealed to be significantly different between driver groups on rural roads, t(34) = 3.124, p < 0.01, with a difference in mean total speed preference between groups of 8.2 km/h (SE = 2.64). Group A preferred significantly faster speeds (M = -0.6 km/h, SD = 5.69), ranging from -13km/h to 10km/h about the limit (which translates to actual speed choice ranging between 87 and 110km/h). By comparison to the Group B preferred slower speeds (M = -8.8 km/h, SD = 9.3), ranging from -28km/h to 3km/h about the limit (which translates to actual speed choice ranging between 72 and 103km/h).

Semi-rural roads

Mean total speed preference were revealed to be significantly different between driver groups on semi-rural roads, t(34) = 2.679, p< 0.05, with a difference in mean total speed preference between groups of 8.1 km/h (SE = 3.03). Group A preferred significantly faster speeds (M = -2.6 km/h, SD = 5.69) with preferences ranging from -14km/h to 11km/h about the limit (which translates to actual speed choice ranging between 66 and 91km/h). Group B preferred slower speeds (M = -10.8 km/h, SD = 9.69), ranging from -25km/h to 8km/h about the limit (which translates to actual speed choice ranging between 55 and 88km/h).

Urban Roads

Mean total speed preference was found to be significantly different between driver groups on urban roads, t(34) = 2.071, p < 0.05, with difference in mean total speed preference between groups of 3.2 km/h (SE = 1.58). Group A preferred faster speeds (M = 0.8 km/h, SD = 4.72), ranging from -8km/h to 10km/h about the limit

(which translates to actual speed choice ranging between 42 and 60km/h). Group B preferred slower speeds (M = -2.4 km/h, SD = 4.29), ranging from -15km/h to 3km/h about the limit (which translates to actual speed choice ranging between 45 and 53km/h).

Sub-urban roads

Mean total speed preference was not found to be significantly different between driver groups on suburban roads (p = 0.135). Young and inexperienced drivers (A) presented with preferred speed that was slightly below the speed limit (M = -2.7 km/h, SD = 5.56), ranging from -17km/h to 4km/h about the limit (which translates to actual speed choice ranging between 33 and 54 km/h). Group B preferred slower speeds (M = -5.5 km/h, SD = 4.94) ranging from -15 to 0 km/h about the limit (which translates to actual speed choice ranging between 35 and 50 km/h)

Comparison between road environments

Figure 4.13 and supporting inferential statistics revealed that Group A preferred faster speeds than the Group B on both motorway and rural roads (100km/h speed limit). While groups preferred faster speeds on motorway roads in comparison with rural roads, the differences between groups was greater for rural roads. What is interesting is that older drivers drove significantly slower on rural roads when compared to motorways, whereas young and inexperienced drivers preferred similar speeds on both roads. The reviewed literature suggests that young and inexperienced drivers are prone to accepting faster speeds on rural roads as evidenced by their respective crash rates. Group A preferred faster speeds for semi-rural roads (80km/h speed limit), and Group B had considerable more conservative speed preference. Group A preferred faster speeds for both urban and sub-urban roads as well (50km/h speed limit), though had a more conservative speed preference on sub-urban than urban roads. Although the degree of variation between driver groups' speed choice was lower on urban and sub-urban roads (probably due to a smaller margin of choice), Group A indicated preferred speeds at-or-above the speed limit on urban roads, Group B preferred speeds at-or-below the speed limit. Sub-urban roads had

mean total speed preferences bellow the speed limit for both driver groups, and were not found to be significantly different.

The range of speeds preferred by young and inexperienced drivers (A) indicated a greater willingness to exceed the speed limit. The reviewed literature suggests that young drivers are both more likely to prefer faster speeds, and the degree to which this exceeds the speed limit is in keeping with findings that drivers may exceed the limit, but only to the extent where they can avoid receiving a ticket. Although speed limits were not explicitly stated in the video speed task (i.e. there were no speed signs visible in the footage), it can be assumed that participants could be aware or easily predict the road speed limits. Even when this is taken into consideration, young and inexperienced drivers (A) preferred speeds in some instances well in excess of the speed limit (i.e. 60km/h on the 50km/h limit urban road) and perhaps knowledge of the road limits adds additional weight to the decision to exceed the speed limit. It is also notable that both groups did seem to adjust their speed choices based on changes in hazard density, although this seemed to be more exaggerated the older and more experienced drivers.

4.3.3. Accuracy of video based speed estimation

Figure 4.15 showed that both driver groups over-estimated the speed of the vehicle. The most notable observation in Figure 4.3 is that young and inexperienced drivers (A) were fairly consistent in estimate accuracy across all road environments, whereas older and more experienced drivers (B) showed a slightly greater variation in accurately estimating vehicle speed and showed greater variation in accuracy across road environments. Group B had greater estimate accuracy on higher-speed roads when contrasted with lower speed roads.

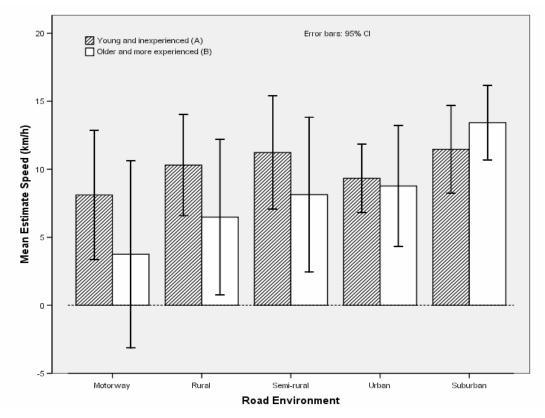


Figure 4.15: Mean total estimate accuracy (in km/h) across road environments for both driver groups. 0 km/h represents the actual vehicle speed, with positive values as the amount over-estimated in km/h. The bars indicate 95% confidence intervals

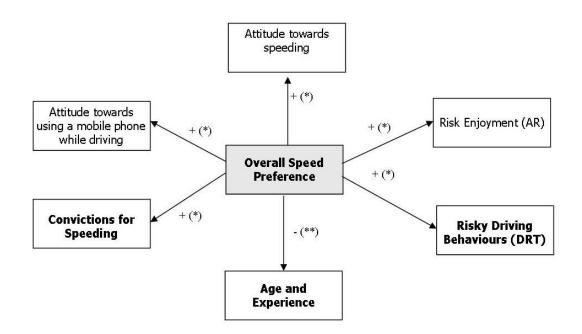
Independent t-tests revealed no significant differences in the mean overall estimate accuracy between driver groups, t(34) = 0.792, p < 0.05. Group A had an overall mean total estimate accuracy of 10.1 km/h (SD = 5.96) and Group B had an overall mean estimate accuracy of 8.1 km/h (SD = 7.98). This suggested that both driver groups were prone to over-estimate the actual speed of the vehicle shown in the video footage.

In summary, it was found that young and less experienced drivers preferred higher speeds than older and more experienced drivers. This was reflected in the speed preferences for different road environment, where young drivers tended towards speeds using the road limit as a target, whereas older drivers preferred speeds lower than the speed limit and with a greater variability across road limits. Speed estimates were not found to differ significantly between driver groups, though both groups over-estimated the speed at which the vehicle was travelling in the video clip.

4.4. How do the self-report risk taking measures compare with the measures from the Video Speed-Choice task?

4.4.1. The relationship between speed preference and self-report measures of driver risk-taking

The overall speed preference from the video task was correlated with selfreported attitudinal and personality measures for both driver groups together. As questionnaire scales were ordinal, the non-parametric Spearman product-moment method was employed. A number of significant correlations were identified, and a summary of the relationship between overall speed preference and drivers' attitudes and personality measures is displayed in Figure 4.16. Only significant correlations will be reported.



<u>*Figure 4.16:*</u> The relationships between overall speed preference and attitudinal and personality measures. Age and experience is also displayed. Emboldened text represents total scores, and standard text represents sub-scales. Significance level and direction of correlation is indicated (* = p < 0.05, ** = p < 0.01)

The figure illustrates that drivers with a riskier or more lenient attitude toward risky driving behaviours or enjoyment of risk-taking are related to a faster preferred speed. Notably, age and experience correlated with speed preference with the most significance, and this may suggest that age and experience are better predictors of speed than attitudinal measures

The most noticeable finding was that there was a significant correlation between attitudes towards speeding and overall speed as measured by the video task ($r_s = .371$, p < 0.05). This relationship is displayed in Figure 4.17.

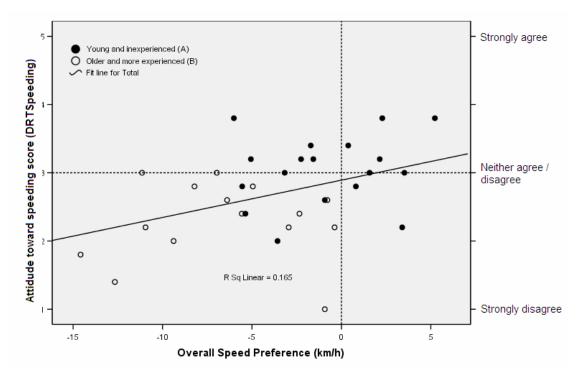


Figure 4.17: Relationship between overall speed preference and attitudes relating to speeding behaviour (DRTSpeeding). The horizontal dotted line represents "neither" on the likert scale, and the vertical dotted line represents the road speed limit (0km/h).

This suggested that drivers with a more lenient attitude towards speeding behaviour are also more likely to prefer faster speeds. Young and inexperienced drivers (A) had both faster overall speed preferences and more lenient attitudes toward speeding behaviour, and this was evidenced in by a second correlation between overall speed and speeding attitude when Group B was excluded ($r_s = .348$, p < 0.05). The relationship between speed preference and driver attitudes was the strongest for attitudes towards speeding in particular, and this is supported by the reviewed literature, which finds that drivers with a more lenient attitude toward speeding are also more inclined to drive at faster speeds.

The risk enjoyment sub-scale of the attitude towards risk questionnaire was also found to significantly correlate with total speed preference ($r_s = .386$, p < 0.05). The relationship is displayed in Figure 4.18.

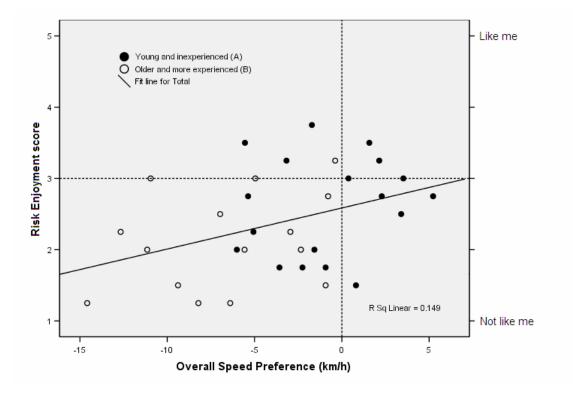
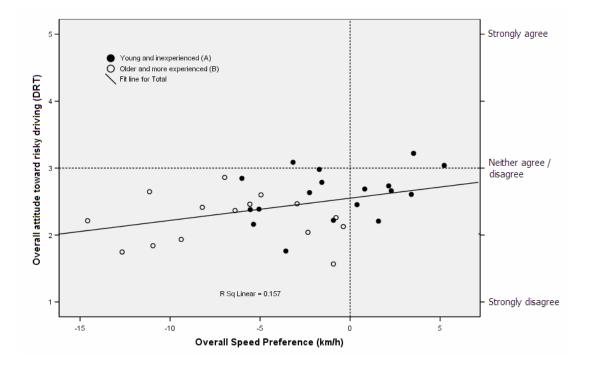
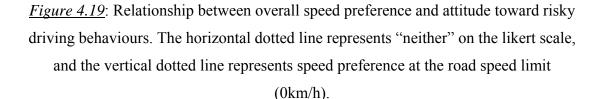


Figure 4.18: Relationship between overall speed preference and risk enjoyment. The horizontal dotted line represents "neither" on the likert scale, and the vertical dotted line represents the road speed limit (0km/h).

This relationship between risk enjoyment and speed preference suggested that drivers who prefer faster speeds also receive greater enjoyment of the physical sensations that came with taking risks. This relationship was suggested in the reviewed literature, which finds that sensation-seeking is related to drivers enjoying travelling at greater speeds.





The overall score for driver risk taking was found to positively correlate with overall speed preference ($r_s = 0.380$, p < 0.05), and this is displayed in Figure 4.19. This relationship suggests that drivers with a riskier attitude towards dangerous driving behaviours in general are more likely to prefer faster speeds, and is supported by findings in the reviewed literature. Further analysis into which attitudes towards driving were related to faster preferred speeds revealed the only other sub-scale apart from speeding that correlated with total speed preference was the use of a mobile phone whist driving ($r_s = 0.353$, p < 0.05).

4.4.2. Relationship between self-report attitudes and speed preference over road environments

Drivers attitude towards speeding behaviour was found to significantly correlate with speed preferences for motorway ($r_s = .348$, p < 0.05), rural ($r_s = .364$, p < 0.05), and semi-rural ($r_s = .390$, p < 0.05) roads, but no significant correlations were found for either urban or suburban roads. This suggests that a lenient attitude toward speeding might have more influence over driving behaviour on these faster roads, but not influence driving behaviour on slower roads.

Drivers attitude towards dangerous overtaking was found to correlate with speed preferences on both motorway ($r_s = .442$, p < 0.05) and urban roads ($r_s = .416$, p < 0.05). This suggested that a riskier attitude towards over-taking was related to faster preferred speeds for motorway and urban environments. Additionally, a correlation was found between drivers attitude towards close-following and overall speed preference on motorway roads ($r_s = .349$, p < 0.05).

Drivers enjoyment of risk-taking was found to positively correlate with speed preference on rural roads ($r_s = .377$, p < 0.05), and this suggests that drivers who prefer faster speeds on rural roads may enjoy the sensations that came with taking risks in this road environment. This relationship between risk enjoyment and speed preference was not found for the other road environments.

Scores of attentional impulsivity were found to correlate with speed preference on suburban roads ($r_s = .349$, p < 0.05). However, neither composite scores for impulsivity nor the other impulsivity sub-scales were found to correlate with environment speed preferences. Self-ratings of skill, thrill, were not found to correlate with speed preferences on any road.

4.4.3. Traffic offences, accidents, and attitudes of speed-choice violators

Self-reported accidents and convictions were found to positively correlate with speed preference from several road environments. The number of accidents that participants reported having been involved in over the previous 12 months was found to correlate with speed preference on semi-rural roads ($r_s = .384$, p < 0.05),

suggesting that higher speed preference in this environment was related to the number of accidents that a participant had been involved in.

Self-reported convictions for speeding was also found to correlate with overall speed preference ($r_s = 0.348$, p < 0.05). This suggested that drivers preferring faster speeds were also more likely to have received a speeding related conviction in the past 12 months. It was found that self-report convictions was related to rural road speed preference ($r_s = .364$, p < 0.05), and in particular the number of convictions for speeding ($r_s = .403$, p < 0.05). While it is uncertain as to whether these convictions were issued on rural roads (which unfortunately was not a variable measured by the demographics), this suggests that there is some relationship between greater overall speed preference and the likelihood of being issued a driving conviction.

5. Discussion

The general purpose of this research was to examine how young and inexperienced drivers and older and more experienced drivers differ in their preferred speeds in different driving conditions measured by a video speed-choice task, and how this is related to attitudes and beliefs, and personality characteristics. In the sample of New Zealand drivers, significant differences were identified between driver groups both in self-reported attitudinal and personality measures, and speed preferences under different road conditions. The video speed-choice measures appeared to be related to attitudes toward speeding, as well as a number of other self-report measures of risky driving behaviours.

As anticipated from the reviewed literature, young and inexperienced drivers obtained higher self-report scores on measures of impulsivity and sensation seeking, and also indicated more lenient attitudes toward a range of unsafe driving behaviors including speeding. This group rated their likelihood of being involved in an accident less than that of the average driver, and rated themselves to have similar driving skill as older and more experienced drivers.

In the current study it was found that young and inexperienced drivers preferred faster speeds in the video speed-choice task, and this was in keeping with the reviewed literature. Young and inexperienced drivers tended to select speeds closer to the road speed limit compared to older and more experienced drivers, who had more conservative speed preferences. Young and inexperienced drivers also displayed less variation from the speed limit across the different road environments, whereas older and more experienced drivers showed a greater variation from the speed limit across environments. The finding that young and inexperienced drivers did not appear to adapt speed preferences to different road conditions is of particular interest and concern.

A number of the self-reported attitudinal and personality measures were identified to be related to faster speed preference - and these will be discussed in greater detail – though this seems to indicate that the speed choice task provided a valid measure of assessing risky driving attitudes in addition to the self-report questionnaires. The video speed-choice task might be particularly useful in examining how drivers choose appropriate speeds in different driving conditions.

The remainder of this section will discuss the findings of the current study in greater detail and put this in the context of the reviewed literature. The discussion will be structured so that the research questions and hypotheses raised at the end of the introduction section are addressed in the order they were presented.

5.1. Discussion of research questions

5.1.1. What differences (if any) do the self-report risk taking measures reveal between the young and inexperienced and older more experienced drivers of a New Zealand sample?

The initial examination of driving history for the sample revealed that young and inexperienced drivers had a much larger proportion of traffic offences and crashes compared to older and more experienced drivers. This was particularly evident in the number of speeding related offences reported. These findings were in agreement with the general consensus of the literature, suggesting that speeding offences are more frequently perpetrated by young drivers (Rajanlin, 1994; Cooper, 1997; Clark et al., 2002). Young and inexperienced drivers as a group reported having been involved in twice as many crashes as older and more experienced drivers, and this is especially interesting considering that many reported crashes often accompanied a self-reported history of convictions or warnings. This concurs with Janke and colleagues (2003) finding that a history of traffic offences often accompanies an elevated risk of crash involvement, and Williamson (2000) noted that young and inexperienced drivers are at a particularly high likelihood of crashing, and this is reflected in the self-reported crash history of this sample.

Self-rated attitudinal and personality measures were also found to be generally "riskier" for young and inexperienced drivers compared to the older and more experienced group. In relating these findings to the reviewed literature, young and inexperienced drivers had higher impulsivity scores, more lenient attitudes towards risk-taking, and greater enjoyment of taking risks (Stradling, Meadows, and Beatty, 2000), and an under-estimated likelihood of being involved in an accident (McKenna and Horswill, 2006).

The overall, motor, and attentional impulsivity scores were considerably higher for young and inexperienced drivers when compared to the scores of older and more experienced drivers. This may indicate that young drivers are more prone to act before thinking, and have greater difficulty in regulating their attention or maintaining focus. However, it should be noted that although there were statistically significant differences in impulsivity scores, both groups were within the low to moderate region of the BIS scale.

Young and inexperienced drivers were found to have more lenient attitudes toward risk enjoyment compared with older and more experienced drivers, suggesting that they may be more disposed towards motivations such as sensation-seeking when engaging in risky behaviour. Impulsivity was found to be related to both risk enjoyment (i.e., sensation seeking) and social deviancy measures. The differences between drivers' impulsivity and sensation-seeking was anticipated from the reviewed literature which indicates that both personality traits peek during adolescence and slowly diminish over the course of young-adult maturation (Spear, 2001; Stradling et al., 2000). Although both groups had non-significant differences in social deviancy scores, drivers who rated higher socially deviant attitudes were also found to hold more lenient attitudes towards speeding, and this relationship has been identified in the literature by Elliot (2001) in regard of intention to speed, and Cauzard and Quimby (2000) who found that young drivers were more prone toward being opposed to speed limitations and other driving restrictions. Notably, a number of items in the driver risk taking questionnaire were worded in such a way as to be related to the social acceptability of speeding, and so it is not surprising that a relationship was identified between speeding attitudes and social deviancy as measured by the attitude toward risk questionnaire.

While the literature suggested that both measures of impulsivity or sensation seeking are predictive of drivers' history of crashes or traffic offences (Jonah, 1997; Cherpitel and Tam, 2000), this relationship was not found in the current study. This may be owing to that both driver groups scoring low to moderate levels on both

personality measure scales, the relatively small sample size and sample demographic, or the accuracy of the crash offence data provided by the drivers.

Both higher impulsivity and sensation-seeking scores were related to riskier overall attitudes toward dangerous driving behaviours, which echoes Conner and Lai's (2005) study where elevated sensation-seeking was related to riskier driving attitudes. According to the literature, both sensation-seeking and impulsivity are related to increased engagement in dangerous driving and overconfidence (Franklen et al., 1992; Mayer and Treat, 1977), in the current study it was found that young and inexperienced drivers had a lower self-perception of being involved in an accident compared to older and more experienced drivers.

In the current study higher self-rated skill was related to lower levels of sensation seeking and impulsivity. While it was anticipated the young and inexperienced drivers would have indicated higher impulsivity, thrill from driving, and greater skill, it is worth noting that both driver groups viewed themselves to be more skilful than the 'average driver', and this corresponds with the similar finding made by Matthews and Moran (1986) that young drivers rated themselves being as skilful as their older contemporaries.

Young drivers perceived their likelihood of being involved in an accident to be lower than older and more experienced drivers and this was related to a reduced concern or worry about accident involvement. This agrees with the findings made by McKenna and Horswill (2006), which indicate that young and inexperienced drivers are generally less concerned about driving consequences, and believe themselves to be less likely to be involved in an accident.

Young and inexperienced drivers' had riskier attitudes overall toward dangerous driving behaviours, including speeding, overtaking, and close-following, and these attitudes were related to impulsivity, under-estimation of crash likelihood, and this is supported by the literature which indicates these attitudes are particularly common and interrelated amongst young and inexperienced drivers (Parker et al., 1996; Reason et al., 1990), and are influenced by personality characteristics (Parker, et al., 1998; dePelsmacker et al., 2007)

Young and inexperienced drivers had a much more accepting attitude towards speeding than older and more experienced drivers, and attitudes toward speeding were strongly related to a number of measures such as impulsivity, risk enjoyment, under-estimated likelihood of being involved in a crash. Corbett (2001) found that lenient attitudes toward speeding was related to drivers' over-confidence (such as reduced likelihood of being involved in an accident), and sensation seeking has been implicated in risky driving, of which speeding is characteristic (Arnett et al., 1997; Deffenbacher et al, 2001; Stradling et al., 2001). Lenient attitudes toward speeding were also found to reflect higher number of convictions in general, and speeding related convictions in particular, and this is what both Iverson (2004) and Harrison et al., (1998) identified. This indicated that the self-report measure of speeding had some degree of external validity.

Overall, self-rated measures of both personality and attitudinal characteristics significantly differed between the two driver groups, and were largely consistent with the consensus of the reviewed literature – that young and inexperienced drivers tend to be more prone to impulsivity and sensation seeking, hold more lenient attitudes toward risky driving, and are more likely to be implicated in speeding convictions and accidents more so than older and more experienced drivers.

5.1.2. Do young and inexperienced drivers choose higher speeds than older and more experienced drivers, and how do different road conditions affect speed choice in these two groups of New Zealand drivers?

The results from the video speed-choice task revealed that young and inexperienced drivers preferred a significantly faster overall speed compared to older and more experienced drivers. This result was anticipated from the reviewed literature, which suggested that young drivers are more likely to prefer driving at faster speeds (Kloeden et al., 1997; MacDonald, 1994b).

In addition to this, Renge (1998) found that greater accumulated driving experience was related to slower speed preferences, and the results of this study seemed to confirm this finding. Resistance to speed adjustments is likely to be attributable to lack of driving experience and in this study young and inexperienced drivers seemed to adjust their speed preferences less across the different road conditions. However, deliberate violations in exceeding limits might reflect more attitudinally directed speeding behaviour. In the current study, it was noted that some young and inexperienced drivers indicated a preferred speed well in excess of the road speed limit. Exceeding the speed limit was not observed for older and more experienced drivers. Campbell and Stradling (2003) found in their study that young drivers were more likely than older drivers to deliberately violate the speed limit, and this was evidenced in the current study with young and inexperienced drivers indicated an "ideal" speed above the national speed limit on both motorway and urban roads.

McKnight and Resnick (1993) suggest that deliberate speed limit violations are often motivated by personal reasons such as sensation or thrill seeking, or peer approval (McKnight and Resnick, 1993). However, given that speed selections were not excessively greater than the speed limit (i.e., under a speed that would result in penalties such as traffic conviction), this may be more owing to drivers not viewing the limits as credible or perhaps as "elastic" as is proposed by Goldenbeld and van Schagen (2007) and Corbett (2001).

When the individual road environments were explored in greater detail, it was found that young and inexperienced drivers preferred significantly greater speeds on all but the suburban road environments when contrasted with older more experienced drivers. This may follow the findings of the study conducted by SARTRE (2004) which suggested that most drivers are in favour of speed restrictions on urbanised roads, but less so for open and motorway roads, although some young drivers were still more likely to be resistant to speed restrictions regardless. The findings of the current study indicate that both driver groups had more conservative speed preferences on the dense sub-urban roads.

An important finding was that young and inexperienced drivers often preferred speeds cantered about the road speed limit, whereas older drivers preferred slower speeds well below the limit. One example was that older and more experienced drivers preferred significantly slower speeds on rural roads when compared to their preferred speed on motorways, whereas young and inexperienced drivers preferred only slightly slower speeds on road environments when compared to their preferred speed on motorways. This is an important finding considering that travelling at faster speeds on rural roads is considerably more risky than travelling at the same speed on motorway roads.

The variation observed between driver groups across road environments might indicate that young and inexperienced drivers were using the speed limit as either a target or indication of appropriate speed. Literature suggests that young and inexperienced are less flexible in adjusting their driving behaviour to the road conditions. Experience seems to play a significant role in drivers' ability to "read the road" and select an appropriate speed, and this might explain the observed differences between driver groups (Renge, 1998). Making appropriate speed judgements based on road conditions is an essential issue for driver safety, and young drivers may not be as adept at determining a speed appropriate to the conditions as older and more experienced drivers. From the findings of this study, it is possible that young drivers do not adapt to the road conditions as easily as older and more experienced drivers, and this seems evident especially when comparing the speed preferences made on rural and motorway roads.

The reviewed literature suggests that loss of control from inappropriate vehicle speed is a strong determinant of severe crashes on rural roads (Liu, Chen, Subramanian, and Utter, 2005; Whelen et al., 2009; Mosedale and Purdy, 2004) as opposed to urban or motorway roads, where excessive speed is likely to be a stronger contributing factor. The findings of the current study suggest that young and inexperienced drivers make similar speed judgements between rural and motorway roads and this might explain why young drivers have a much higher representation of rural crashes (Ministry of Transport, 2009; MacDonald, 1994a). Additionally, young and inexperienced drivers preferred a speed slightly in excess of both motorway and urban road environments, and this may additionally indicate that they are at a higher risk of crashes involving excess speed.

Both driver groups were prone to over-estimate the speed of the vehicle shown in the footage. Although older and more experienced drivers were more accurate in estimating vehicle speed on the faster roads compared to young and inexperienced drivers, though there were no statistically significant differences between driver groups. The tendency to over-estimate speed may be due to the lack of acoustic feedback. McKenna and Horswill (2006) found that the presence of auditory cues had an influence over drivers' ability to accurately estimate speeds. While it has been proposed that most drivers do not consult their speedometer regularly, they may become accustomed to depending upon the "feel" of the vehicle in make speed estimates. Considering that the video speed-choice task used in this study lacked audio cues, the absence of sound may have made accurately judging speeds difficult. Additionally, visual information has been identified as the major component of making speed judgements. As the perspective shown in the video speed-choice task was absent of motion in the drivers' periphery, this perhaps may have reduced drivers' ability to accuracy estimates vehicle speed.

5.1.3. How do the self-report risk taking measures compare with the measures from the Video Speed-Choice task in the sample of young and inexperienced and older more experienced drivers?

Faster overall speed preferences in the video speed-choice task were found to be related to greater levels of risk enjoyment (sensation seeking), a generally risky attitude toward dangerous driving behaviours, and riskier attitudes toward speeding in particular. Overall speed preference was also found to be related to the number of convictions for speeding that had been received. This might indicate that the video speed-choice task had a degree of ecological validity, as was surmised by Horswill and McKenna (1999).

The reviewed literature indicated that higher speeds and traffic convictions are frequently related (Harrison et al., 1998), and that higher speeds are also related to more lenient attitudes towards speeding. Additionally, McKnight and McKnight (2003) who found crashes are often associated with a lack of adjusting driving behaviour to the road conditions, and while speed preference did not provide a significant predictor of drivers' crash history, it was observed that young and inexperienced drivers showed less speed adjustment across road environments and had a higher number of crashes.

In the current study, a relationship was identified between higher speed preferences and more lenient attitudes toward speeding as well as risky driving behaviours in general. This seems to be in agreement with the findings of both Harrison and colleagues (1998) as well as a number of other studies (Stradling et al., 2001; Parker et al., 1996) which suggest that drivers willing to speed have more accepting attitudes toward speeding.

In the current study, lenient attitudes toward speeding were related to faster speed preferences for motorway, rural, and semi-rural roads, but not for urban or sub-urban roads. Considering that in the current study, attitudes toward speeding did not have a uniform relationship with preferred speeds across all road environments, this finding may suggest that more lenient attitudes toward speeding might have an effect on higher-speed roads, but other factors might play a stronger role in determining drivers speeds in urbanized areas. The finding that attitudes toward speeding and faster preferred speeds in the video speed-choice task is in agreement with the findings made by Horswill and McKenna (1999). They suggested that the speed task might be an effective instrument in measuring drivers' riskiness in relation to speeding as opposed to other driving behaviours.

DeJoy (1992) found that low perception of risk was related to faster speeds, and a relationship was identified in this study between self-estimated likelihood of being involved in an accident and higher speed preferences. In the current study, drivers who rated their likelihood of being involved in an accident lower were more inclined to prefer faster speeds (Parker et al., 1998; Harrison et al., 1998), perhaps because these drivers view the world as less threatening. Horswill and McKenna (2006) found that concern and self-estimated likelihood over accident was the lowest predictor of speed preference, rather finding that skill and thrill were more strongly predictive. Unlike Horswill and McKenna's (2006) findings, neither self-ratings of driving skill or thrill were found to be related to speed preferences. However, in supporting the findings of this study, Ullberg and Rumdmo (2003) found that lower ratings of concern or likelihood of accident involvement were related to an increased tendency to engage in dangerous driving. What Horswill and McKenna (2006) proposed was that faster drivers were less concerned over health damaging consequences than receiving the gratification that comes from taking risks. In this regard, greater enjoyment in taking risks was found in the current study to be related to faster speed preferences. Walton (1999) found that greater sensation-seeking and risk enjoyment was related to a tendency to engage in dangerous speeding behaviour, and in the current study enjoyment of taking risks was found to be related to faster speed preferences on rural roads.

5.2. Limitations of the current study

A number of issues were identified in the current study. The first was the reliability of the self-report measures, and particularly those concerning the number of traffic offences and crashes that had occurred in the previous 12 months.

Some participants might have been inclined to give a response to self-report questionnaire items which they deemed to be more socially acceptable, rather than answering the questions honestly or naturally. Unfortunately, no measures of social desirability or bias were included in the test battery, so it remains speculative as to the influence over the findings of this study. Additionally, as several measures were highly subjective (i.e., what constituted a crash or warning). The rates of reported crashes and traffic offences was somewhat greater than had been anticipated from a sample of this size, and so there is some doubt as to whether the driver history can be viewed as reliable.

The second issue concerned the relatively small sample size. While significant effects have been found - implying large effect sizes – there was large variability in many risk measures, indicating that some drivers in both groups are at a higher crash risk than their similarly aged peers. Although for the purpose of this study drivers' had to be treated as if they were a homogenous group, even though there is strong evidence in the reviewed literature that some individuals are at a significantly higher risk than their similarly aged peers (for instance, young males are at a greater risk of crashing than young females). Additionally, the sample was composed mostly of students who may have characteristics which may distinguish them from the general population in propensity to engage in unfavourable levels of risk-taking. Expanding the sample size and diversifying the method of recruitment to a more general population might alleviate this issue.

The technique of data acquisition and analysis for the video speed-choice task was closely modelled on the work of Horswill and McKenna (1999), however several limitations were identified. The quality of footage might have had an influence over both estimating speed and selecting a preference speed. Visual cues were somewhat diminished in the obtained footage, and enhancing the resolution with newer camera technology might create a more realistic driving feel. Additionally, the camera angle did not provide much peripheral information, and literature suggests this has an influence on how drivers make speed judgments. No information about the road speed limit or vehicle speed was provided in the selected video footage, and so it was be assumed that drivers would be reasonably familiar with the road speed limits when selecting a preferred speed. However, this may actually be an advantage, as it allowed the task to measure what drivers' perceived to be an appropriate speed rather than defaulting to posted limits.

As video footage was collected from roads about the Waikato University where the majority of participants were recruited, there is a good chance that some participants might have been familiar with the road more than others, and this may have had an influence on how ideal speed preferences were made. However, as this would be true of both driver groups, it is unlikely that the influence would be significant. Finally, adjusting the software to allow participants to adjust speed in intervals of 5km/h rather than 1km/h may make selecting speed both more convenient and reliable indications of drivers actual preferences.

The last issue identified concerns the method used for data analysis. Unfortunately, the only successful methodology identified was to use mean speed preferences for participants, and due to the research design, independent t-tests proved to be the most suitable approach to analysis. Despite this limitation, this was in keeping with the methodology employed by Horswill and McKenna (1999) in their analysis of their VST data. Additionally, the current study expanded the number of road environments to encompass a broader variety of road conditions rather than only using all speed preferences together as a measure of risk-taking. This revealed that drivers did have different speed preferences for different environments, and may suggest limitation to the original video speed task design.

5.3. Conclusions and future research

The findings of this study suggest that young and inexperienced drivers not only preferred higher speeds in the video speed-choice task, but their speeds preferences were related to more lenient attitudes toward speeding, and greater enjoyment when taking risks. Speeding related convictions were found to be related to faster speed preferences, and this offers some validation to the speed-choice task as an ecologically valid measure for the New Zealand driver sample.

One notable finding was that young and inexperienced seemed to be more reluctant in adapting their speed preference to different environmental conditions, and appeared to be using the road speed limit as a target rather than adjusting their speeds to what might be more appropriate. As the literature clearly indicated, both excessive and inappropriate speeds play a significant role in determining crash risk, and the sample of young and inexperienced drivers both indicated a more elastic concept of speed limits and adjusted their speed less across differing road environments than older and more experienced drivers.

Hazard perception training for different road conditions might be a valuable addition to the current driver training regime in New Zealand, especially focusing on drivers becoming competent in making appropriate speed adjustments. Additionally, incorporating the contemporary risk-taking research by Reyna and Lloyd (2001) in developing such training initiative is warranted. This may involve more "hands on" approached to learning to adapt to conditions rather than verbatim information which may prove less effective. Encouraging young drivers to develop a "gist" of safe speed adaptation, rather than stressing the importance of speed limits, may prove fruitful in reducing the number of deaths per year owing to inappropriate speed.

The video-speed choice task appeared to be an ecologically valid and easily deployed method of investigating how drivers choose ideal speeds in different road environments, and while much more research is required in expanding upon the findings of the current study, there is potential for using a speed-choice task in a number of different settings. Speed choice tasks may be useful firstly in evaluating the effectiveness of driver training programs in influencing speeding behaviour. Additionally, the speed choice task may be helpful in determining how the public view posted speed limits (in an expansion of Goldenbelds et al., 2007 methodology). The task may be useful in understanding both what makes speed limits realistic to drivers, and how appropriate limits might be established under differing road conditions. Video speed-choice tasks have already been employed in a number of settings to study both hazard detection and risk-acceptance. Further research may expand on the current study to examine different scenarios such as night time driving, or broader road conditions such as limited visibility, rain and ice, different road markings and roadside characteristics. Such research may be particularly useful when considering countermeasures to influence drivers' speeds.

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7. Appendices

Appendix 7.1.1. Participant Advertisements

Taking Risks?

Why do young people take more risks? Do emotions affect our risk-taking decisions?



Volunteers Needed!

Hi, my name is Steve Cantwell. I am looking for volunteers who

currently hold either a full or restricted driving license (and have done so for at least the past 6 months)

to take part in a study exploring risk-taking behavior, age and gender, emotional influences on risk-decisions, with a particular emphasis on speeding and dangerous driving.

This study employs several computer-based experiments to measure different aspects of risk-taking and risk-acceptance behaviours. 1st year psychology students will receive 1% p/h to their final G&E grade upon experiment completion.

For more information feel free to contact me (sjc29@waikato.ac.nz) or view the research folder located at the Psychology Department Office.

(supervised by Dr Robert Isler & Dr Nicola Starkey)

Appendix 7.1.2. Participant Correspondence Letters

Many thanks for getting in contact with me, and showing your interest in my research. As you have probably gathered from what was posted, I am looking into Adolescent Risk-taking both in general and regard to driving (speeding) behaviour. Much of this is supported through what researchers have uncovered in recent years involving the maturation of the prefrontal brain regions – which continue to develop and mature until mid-twenties - and how these regions are related to executive functions, such as memory, decision-making processes, and to some extent personality traits.

I am focusing particularly into the way in which decision-making involving risk-behaviours (general and driving risk-taking) is controlled largely through the regulation of affect (emotion), and the way this process changes across the maturation of the prefrontal cortex (age). Although much ground work has been established in these areas, I hope this research will enhance and add insight into these important psychological avenues.

Measuring these different aspects of risk-taking and decision-making will require a crosssection of tests. These tests have been designed to measure specific aspects of risk-behaviour and emotion-based decision-making. I will be utilising computer-based multiple-choice style questionnaires which measure driving-risk behaviour, and a video-simulation of driver speed to gauge speeding risk-taking. To measure decision-making a computerised card game will be used. Emotion will be measured by a short questionnaire which scores depression and anxiety. Demographic information (such as age and gender) will also be recorded. As instructions and questionnaires are presented in English, it is valuable that this is either a first language or, if not, participants are competent in their understanding and comprehension of the English language. More information and specific instructions will be provided before and during the experiment.

As participants, you are under no obligation to complete the tests, and are free to withdraw from the experiment at any stage. You do not have to give a reason if you do wish to withdraw, and you may request any data destroyed. No names or information which can identify any participant will be recorded, for data processing you will be identified by a number. For course credit (1% per hour for PSYC103 students), your consent forms (name and student ID) will be used to accredit your grade, however, this information will in no way associate you with any measures or test scores, and will not be used (other than for accrediting course credit) or made available to anyone. I stress that participation is voluntary, obligation free, and anonymity will be preserved at all times. If you do have any queries on these matters, please feel free to contact me.

Once again, many thanks for getting in contact with me. I hope this information has been helpful in answering some of your questions. Please feel free to contact me with any further questions (though unfortunately I can't give too much away as to preserve the reliability of the test measures). I look forward to you being in contact.

Appendix 7.1.3. Experiment Instructions

Experiment Instructions

Welcome to the experiment. I greatly appreciate you taking the time to participate in my research. This experiment involves three major components, which have been outlined below. The entire experiment should take approximately 1 to 1.5 hour(s) to complete, though please allow more time should you require it. Feel free to reschedule to another time if you have upcoming appointments within the next few hours.

Please let me know if you have previously performed any of these tasks, as this may affect results.

Before you sign the consent form attached, please ensure that you are familiar with what is involved in this experiment and your rights as a participant:

- Your involvement is voluntary and entirely free from any obligation.
- You are free to withdraw from the experiment at any stage, and do not need to give a reason. You may also request any data that has been collected to be destroyed.
- Anonymity means that there is no way of connecting your personal identity to this experiment. You will not be asked at any stage to provide details which could identify you personally, and an arbitrary number has been assigned to keep track your responses.

Please feel free to ask me if you have any questions. I hope you enjoy this experiment, and many thanks for taking part.

1. Questionnaires

At the beginning of this experiment you will be asked to complete a series of questionnaires. Please carefully read the instructions included at the top of each questionnaire page. Answer each of the questions honestly. Try to avoid spending too much time thinking about your answer.

2. Video Speed Task

In this task, you will be shown an assortment of 15 second video clips, which were taken from various locations around Hamilton. Each video shows from the drivers perspective what is seen as the vehicle travels along the stretch of road.

After watching each video, a screen will appear where you will be asked to make a speed estimate, which is your impression of how fast the vehicle was **actually travelling** as shown in the video. It is best for you to use the impression of speed you gathered while watching the video. You can enter your estimate by clicking on the FASTER / SLOWER arrow buttons located on the screen until you reach your desired speed estimate, indicated in the counter. Holding down the left mouse key on the arrow buttons will accelerate through the numbers shown in the counter. Once you have reached the value of your estimate, press the OK Button to continue.

Another screen will appear, asking you what ideal speed you would feel most comfortable at driving at on the road presented in the video. Base your decision upon what you would naturally do when driving in the conditions presented in the video clip. The previous speed estimate you made of the actual vehicle speed is shown in the counter. If you feel that speed given in the estimate would be your preferred speed, the select OK. If you feel that you would be most comfortable travelling at a different speed, then use the arrow buttons in the same way as before to enter your preferred speed. Click OK once you have made your selection to continue to the next video clip.

Appendix 7.1.4. Ethics Approval Form

University of Waikato Psychology Department CONSENT FORM

PARTICIPANT'S COPY

Research Project: Multi-apparatus assessment of adolescent risk-taking behaviour in a driver speed task

Name of Researcher: Stephen J. Cantwell

Name of Supervisor (if applicable): Robert Isler

I have received an information sheet about this research project or the researcher has explained the study to me. I have had the chance to ask any questions and discuss my participation with other people. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact the convenor of the Research and Ethics Committee (Dr Robert Isler, phone: 838 4466 ext. 8401, e-mail r.isler@waikato.ac.nz)

Participant's Ivanie. Date.	Participant's Name:	Signature:	Date:
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University of Waikato Psychology Department CONSENT FORM

RESEARCHER'S COPY

Research Project: Multi-apparatus assessment of adolescent risk-taking behaviour in a driver speed task

Name of Researcher: Stephen J. Cantwell

Name of Supervisor (if applicable): Robert Isler

I have received an information sheet about this research project or the researcher has explained the study to me. I have had the chance to ask any questions and discuss my participation with other people. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact the convenor of the Research and Ethics Committee (Dr Robert Isler, phone: 838 4466 ext. 8401, e-mail r.isler@waikato.ac.nz)

Participant's Name:	Signature:	Date:

Appendix 7.2.1. Demographics Questionnaire

Driving Project
Instructions Please provide the following information by typing your response in the appropriate boxes
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?
<pre>restricted for car full for car</pre>
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?

Instructions

Almost every driver becomes involved in an adverse traffic event (accident or near-hit) 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 <u>accident</u> is any collision that occurred <u>on the public roads</u> (but not private property), <u>while you were the driver of the vehicle</u> and <u>irrespective of who was at fault</u>.

accidents

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

near hits

Instructions

Nearly all drivers commit traffic offences and we would like to estimate how often these happen. 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.

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		
Racing		
Reckless driving		
Drinking or drug related e.g. driving under the influence		
Dangerous overtaking e.g. overtaking with limited visibility		
Following too close		
Roundabout offences e.g. using the wrong lane, 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	
Taking a vehicle without consent	
Driver Licence offense e.g. driving whilst disqualified, outside of license restrictions	
Driving without a warrant of fitness	
Driving without registration	

Other, please provide a detailed list

Appendix 7.2.2. Barrett Impulsivity Scale (BIS-11)

	ly/Never Occasionally ys/always	Often			Almo
	1 2	3			4
27. 1.	I am reatless in dass/groups	1	2	3	4
28. 2.	I Blathingshithbutthinking	ł	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

Driving Project

Appendix 7.2.3. Attitude towards risk-taking (AR) Questionnaire

Driving Project
Instructions Indicate using a 5 point scale the degree to which each of the following statements describes you. Select 1 to indicate it does not describe you at all (not like me) and select 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.

Not Like Me

Like Me

5

1	2	3	4

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	З	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

Appendix 7.2.4. Accident Concern and Risk Taking (AC/RT) Questionnaire

Driving Project

Instructions

Please rate how strongly you agree or disagree with the following statement by clicking 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					About					Much
less					the					more
likely					same					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					About					Much
less					the					more
skilful					same					skilful

Appendix 7.2.5. Driver Risk Taking (DRT) Questionnaire

Driving Project

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 **click** 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 taken when I overtake	1	2	3	4	5
12.	Random breath testing of drivers should be introduced	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	1	2	3	4	5

	overtaking					
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

Appendix 7.2.6. Variable names and reliability

Measure Convictions Warnings Crashes WarningNon WarningSpeed ConvictNon ConvictSpeed	Group A N = 16 N = 11 N = 6 N = 5 N = 6 N = 4 N = 12	Group B N = 1 N = 4 N = 3 N = 4 N = 1 N = 1 N = 0	Cronbach's Alpha - - - - - - -		
BISOverall BISAttention BISMotor BISNon-planning	66.4 (9.45) 17.5 (4.59) 22.2 (3.46) 26.6 (3.37)	58.6 (6.53) 14.7 (2.78) 19.3 (3.13) 25.5 (3.33)	0.607 0.612 0.601 0.648		
AROverall AREnjoyment ARSocDeviancy	2.5 (0.81) 2.6 (0.69)	1.8 (0.68) 2.06 (0.68)	0.847 0.737 0.753		
ACSkill ACConcern ACLikelihood ACThrill	6.9 (1.41) 4.4 (2.32) 4.1 (1.59) 5.2 (2.64)	7.3 (1.39) 4.6 (2.35) 5.4 (1.42) 4.4 (1.68)	- - -		
DRTOverall DRTAlcohol DRTOvertaking DRTClosefollowing DRTSpeeding DRTPhone	2.5 (0.37) 2.5 (0.73) 2.6 (0.51) 2.4 (0.57) 3.0 (0.50) 2.3 (0.80)	2.2 (0.36) 2.6 (0.53) 2.5 (0.29) 2.0 (0.57) 2.2 (0.57) 1.8 (0.55)	0.771 0.689 0.619 0.673 0.701 0.602		
Convictions	The number of convictions (i.e. previous 12 months.	tickets) issued by ar	officer in the		
Warnings	The number of warnings for illegal driving issued by an officer in the previous 12 months.				
Crashes	The number of crashes that had regardless of who was at fault.	occurred in the prev	ious 12 months		
WarningsNon	The number of non-speeding rel (other than speeding) issued by a	•			

WarningsSpeed The number of speeding related warnings for illegal speeds issued by an officer in the previous 12 months.

ConvictNon	The number of non-speeding related convictions (i.e. tickets) for illegal driving (other than speeding) issued by an officer in the previous 12 months.
ConvictSpeed	The number of speeding related convictions (i.e. tickets) for illegal speeds issued by an officer in the previous 12 months.
BISOverall	The totals score for the BIS. The questionnaire was composed of 28 items, and the scale ranged from 28-112
BISAttention	The attentional subscale of the BIS. The subscale was composed of 7 items, and the scale ranged from 7-28
BISNonplanning	The non-planning scale for the BIS. The subscale was composed of 11 items, and the scale ranged from 11-44
BISMotor	The motor sub-scale of the BIS. The subscale was composed of 10 items, and the scale ranged from 10-40
AROverall	The overall attitude score for the Attitude toward risk (AR) questionnaire. The questionnaire was composed of 10 items, and the scale ranged from 1-5
AREnjoyment	The risk enjoyment subscale of the AR. The subscale was composed of 4 items, and the scale ranged from 1-5.
ARDeviancy	The social deviancy subscale of the AR. The subscale was composed of 6 items, and the scale ranged from 1-5.
ACConcern	The self-rated concern of being involved in an accident measures by the AC/RT Questionnaire. Scale ranged from 1-9
ACSkill	The self-rated level of driving skill measure in the AC/RT Questionnaire. Scale ranged from 1-9
ACThrill	The self-perceived thrill received from driving measured by the AC/RT questionnaire. Scale ranged from 1-11.
ACLikelihood	The self-rated likelihood of being involved in an accident measured by the AC/RT questionnaire. The scale ranged from 1-11.
DRTAlcohol	The attitude towards driving under the influence of alcohol measured by the DRT questionnaire. The subscale was composed of 6 items and scores ranged from 1-5.
DRTOvertaking	The attitude toward risky overtaking measured by the DRT questionnaire. The subscale was composed of 6 items and scores ranged from 1-5.

DRTClosefollowing	The attitude towards following a vehicle too closely measured by the DRT questionnaire. The subscale was composed of 5 items and scores ranged from 1-5.
DRTSpeeding	The attitude towards speeding measured by the DRT questionnaire. The subscale was composed of 5 items and scores ranged from 1-5.
DRTPhone	The attitude towards using a mobile phone while driving measured by the DRT questionnaire. The subscale was composed of 2 items and scores ranged from 1-5.
DRTOverall	The overall attitude towards dangerous driving behaviours measured by the DRT questionnaire. The questionnaire was composed of 24 items and scores ranged from 1-5.

Road Environment	Road name	Speed limit	Camera vehicle speed	Difference from speed limit
Motorway	Cambridge 100.100a	100	100	0
	Cambridge 100.100b	100	100	0
	Cambridge 100.80	100	80	-20
	Cambridge 100.50	100	50	-50
	Cambridge 100.30	100	30	-70
Rural	Holland 100.100a	100	100	0
	Holland 100.100b	100	100	0
	Holland 100.80	100	80	-20
	Holland 100.50	100	50	-50
	Holland 100.30	100	30	-70
Semirural	Ruakura 80.80	80	80	0
	Morinsville 80.80	80	80	0
	Ruakura 80.50	80	50	-30
	Morinsville 80.50	80	50	-30
	Ruakura 80.30	80	30	-50
Urban	Silverdale 50.50a	50	50	0
	Silverdale 50.50b	50	50	0
	Silverdale 50.30	50	30	-20
	Silverdale 50.20	50	20	-30
	Silverdale 50.10	50	10	-40
Suburban	Cameron 50.50a	50	50	0
	Cameron 50.50b	50	50	0
	Cameron 50.30	50	30	-20
	Cameron 50.20	50	20	-30
	Cameron 50.10	50	10	-40

Appendix 7.3.1. Road names, limit, and classification