THE EFFECT OF AGE AND EXPERIENCE ON HAZARD PERCEPTION AND SPEED CHOICE IN MALE DRIVERS

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by

REBEKAH JANE CROSSWELL

Abstract

There are many deaths on New Zealand roads each year, due to speeding related incidents. Teenage drivers (aged 15 to 24 years) are excessively represented in crash statistics. Young drivers seem to have poor hazard perception abilities compared to that of Older Experienced drivers, and may have problems choosing the appropriate speed for the road conditions.

While speeding is difficult to measure in real world situations, the use of a laboratory speed choice task in the current study allowed for speed choice to be studied in a controlled laboratory setting, in an objective way. The current experiment investigated hazard perception and speed choice in males (with higher crash statistics compared to females) using four groups, Young Novice, Advanced Novice, Young Experienced and Older Experienced drivers. Independent variables included age (ranging from 15 to 60 years), experience (Young Novice, Advanced Novice, Young Experienced and Older Experienced) and differing weather conditions (dry and wet) on rural roads and day and night conditions on urban roads. Participants were given a hazard perception dual task as per where they had a primary task of detecting immediate hazards, as well as performing a secondary task of keeping a small dot within a small square, stimulating the steering in real driving. For the Video Speed Choice Task (VST), participants were shown the video clips and asked "how fast do you think you were travelling?" And "what would be the ideal speed appropriate for the road conditions?" The results showed that younger drivers were more likely to select slower speeds, closer to the speed limit, whereas Older Experienced drivers chose greater speeds. Slower speeds were chosen during night-time conditions, and wet

conditions. These unexpected results may be for a number of reasons, to be discussed in the following thesis. They will be examined in terms of the current literature on hazard perception, speed choice and driver safety in New Zealand and overseas. Implications of the current study and future research will also be discussed.

Acknowledgements

I would first like to thank my supervisors, Dr. Robert Isler and Dr. Nicola Starkey, for their constant support, feedback, and guidance throughout the entire research process. It has been both an honour and a pleasure to work with such renowned researchers. Your advice and suggestions have been extremely valuable to me.

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Thanks and appreciation must be given for scholarships and financial assistance which have enabled this research project to come to fruition. Financial support was given by The University of Waikato, The Faculty of Arts and Social Sciences, The Faculty of Science and Engineering, The Waikato Police and The Federation of Graduate Women. Thank you to all voluntary research participants - without your time, enthusiasm and effort, this research would not have been possible.

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This thesis process has taught me many things. I have had my mind opened up to the wide world of research and academia - an exciting, diverse, and dynamic area. This past year has taught me to have perseverance, patience, to problem solve, broaden my academic writing skills, and the ability to effectively interact with participants, fellow researchers and supervisors alike. This thesis has given me a taste of what the wide world of research entails, and I am eager to start putting all the knowledge and experience I have gained at The University of Waikato into practice.

Dedication

I would like to dedicate my thesis to my Grandparents – Nana Crosswell, and to those who have passed – Grandad Crosswell, Nanny and Poppy Storer, who always gave me neverending support to achieve my hopes and dreams. I am sure they have watched over me throughout my academic journey.

Ethical Information

Ethical approval for this research was obtained through the School of Psychology Research and Ethics committee. Participants took part with the assurance that the data will be kept confidential and that they have the right of anonymity and the right to withdraw at any time. They were briefed and provided with the opportunity to ask questions and discuss any issues which arose during the course of the experiment. A consent form was provided and they were promised a written summary of the results.

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Preface

"On the evening of July 12th, 2009, 18 year old Nathan Laurenson and his friend, 18 year old Udo Fourie took a ride in a modified racing Subaru Impreza driven by a 22 year old male. Minutes later, on Greys road near Plimmerton travelling at more than 100 km/hr, in an 80 km/hr zone, the driver lost control of the car in the wet conditions, crossed the centre line and crashed into an oncoming vehicle. The force of the impact flipped the Impreza on its roof and into the Pauatahaunui Inlet. Nathan died at the scene. Udo died later in hospital when his life support was switched off. A young mother (19) in the other car suffered a broken spine and severe head injuries. She spent the next 73 days in a coma, but survived. Her daughter (2) and one other person in the car were injured. The driver of the Impreza was eventually charged with three counts of dangerous driving causing injury and two counts of dangerous driving causing death".

Source:

The Ripple Effect, DVD, Educational Resource

1. Scope and aims of thesis

1.1. The Young Driver Problem and Risky Driving

Many deaths and injuries result from motor vehicle crashes involving teenage drivers such as the one described in the preface. Drivers aged between 15 to 24 years are grossly overrepresented in crash statistics (see Figure 1.1) and while teenagers comprise only 15% of the driving population, they are involved in nearly 30% of all the total road deaths in New Zealand (Ministry of Transport, 2011), and this is known as the 'Young Driver Problem'. The social cost of crashes involving young drivers in New Zealand is approximately $1 billion dollars per year (Ministry of Transport, 2010). Similar rates are found in Australia, where young drivers are involved in 35% of fatalities and in countries such as the United States and Canada (Deery, 1999), making this a global health issue.

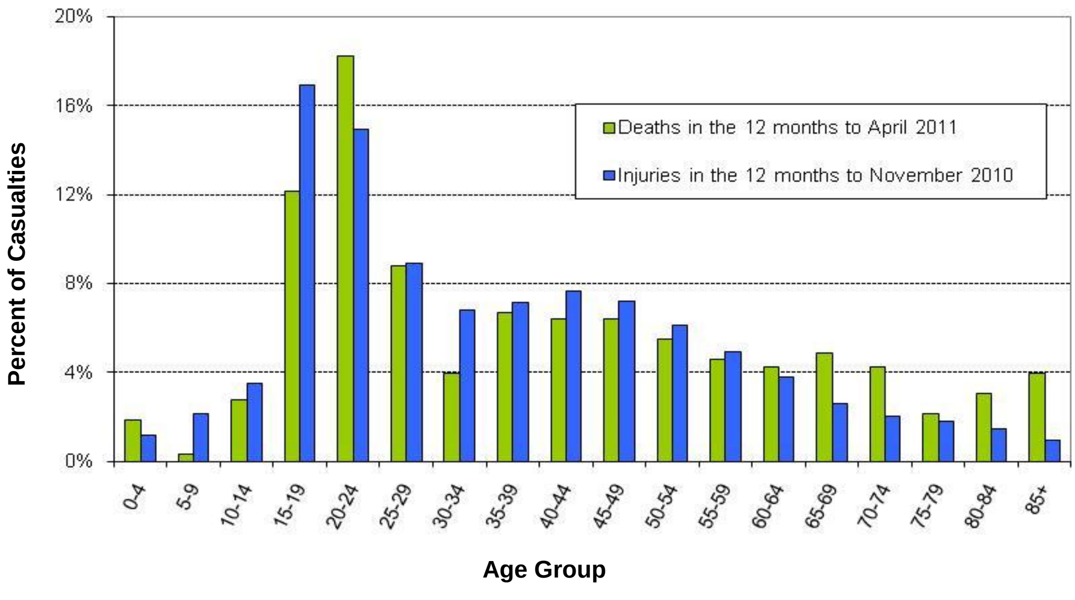


Figure 1.1: Drivers involved in fatal/injury crashes in New Zealand (Source: Ministry of Transport, 2011)

Young drivers often engage in risky driving, with speeding being the most dangerous driving behaviour. Speeding, defined as travelling at speeds which are above the legal set limits for that particular road, can result in loss of control of the vehicle. This accounted for over 40% of the fatalities among young drivers aged 15 to 24 years between 2006 and 2008 (Ministry of Transport, 2009). While speeding may be a safety issue for drivers in many age groups, it is certainly a significant crash risk for younger drivers, who are more than two and a half times more likely to speed than drivers over the age of 25 years (Ministry of Transport, 2009).

1.2. Factors Contributing to the 'Young Driver Problem'

The road safety literature identifies three main factors contributing to the 'Young Driver Problem': (1) teen drivers lack maturity (2), they have a high exposure to dangerous traffic conditions (e.g., Reyna & Farley, 2006), and (3) they lack driving experience. In addition, young male drivers seem to be more at risk than young female drivers (Figure 1.1) possibly because they engage in more risky driving behaviours (Laberge-Nadeau, Maag, & Bourbeau, 1992).

Age disappears as a risk factor regardless of driving experience when a driver reaches 25 years, which clearly points to a developmental issue (Mayhew, Simpson, & Pak, 2003). However, driving experience seems to be an even stronger predictor for crashes than age, and lack of experience and poor driving skills are evident in adolescence (Isler, Starkey, & Williamson, 2009; Sagberg & Bjornskau, 2006). Younger drivers also seem to lack efficient visual search behaviour, and they typically have less situation awareness than more experienced drivers (Horswill & McKenna, 2004). They also have not experienced as broad a range of traffic scenarios as Older Experienced drivers and one particular skill which seems to improve with driving experience is hazard perception (Isler et al., 2009).

Young Inexperienced drivers lack critical hazard perception skills, which are directly related to crash risk (Isler et al., 2009). Interestingly, McKenna, Alexander, and Horswill (2006) found that those skills can be easily trained to the level of experienced drivers and that such training also decreases the level of risky driving (such as speeding behaviour). They used three separate experiments to investigate if anticipation training affected drivers' risk taking in terms of speed choice (McKenna et al., 2006). Results showed that participants who undertook anticipation training, responded significantly faster to the hazards than the untrained group. In addition, it was found that the participants also took significanlty less risk regarding the violations, speed and the gap acceptance measure.

Due to hazard perception being a skill that can clearly be trained, and risk taking being easily measured through experiments such as that described above, there became a viable reason to investigate the relationship between hazard perception and risky behaviours. This leads us onto the next section, a description of the thesis and research questions.

1.3 Scope of the thesis

There is a lack of research examining the important relationship between hazard perception skills and speed choice behaviour in teenage drivers, and in particular male drivers. To address this, the aims of the thesis carried out in male drivers, were to examine: a) the relationship between age and experience and hazard perception ability; b) the influence of age and experience on speed choice; and c) the relationship between hazard perception and speed choice.

2. Literature Review

2.1. Speeding as a Risky Driving Behaviour

Speeding, or loss of control of the vehicle is the primary cause of many motor vehicle accidents in New Zealand (ACC & LTSA, 2000) and as mentioned previously, the main cause of crashes among 15 – 24 year olds is driving too fast for the conditions (Figure 2.1) (Ministry of Transport, 2010a), while too slow for the conditions is more often observed in older, senior drivers (Fildes, Rumbold, & Leening, 1991).

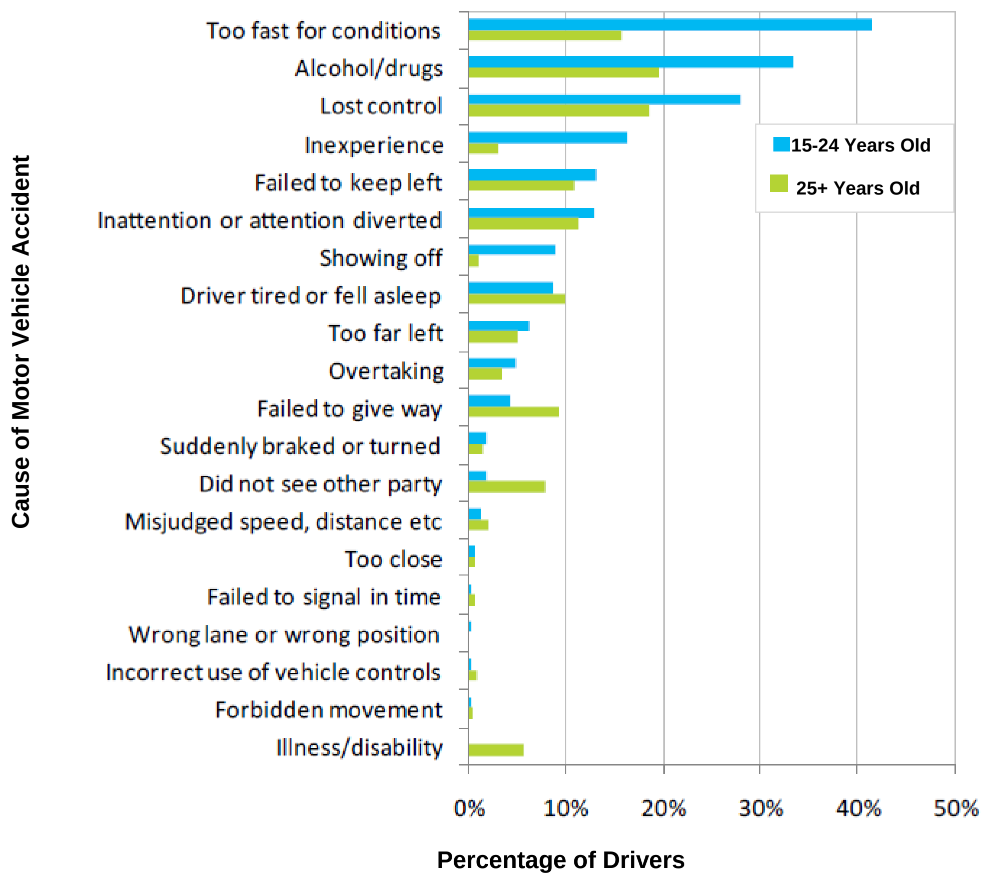


Figure 2.1: Causes of Motor Vehicle Accidents in New Zealand (Source: Ministry of Transport, 2009)

While there are many extraneous variables the driver cannot control, such as weather conditions, speed is something the driver can control. By changing speed over a journey, crash risk can be either increased or decreased (ACC & LTSA, 2000). In New Zealand from 2007 to 2009, driver speed was a factor in 31% of fatal crashes, 20% of serious injury crashes, and 15% of minor injury crashes (Ministry of Transport, 2010a). Other behaviours that may result in risky and dangerous driving include inexperience, inattention, failing to adhere to road rules, overtaking, and being overtired or falling asleep (Figure 2.1). However, due to the majority of crashes resulting from driving too fast for the conditions, speed choice behaviour is undoubtedly a road safety area where additional research is required. Further, even when speed is not necessarily a contributing factor in a road crash, it is significant in influencing the severity of injuries as a result of the crash (ACC & LTSA, 2000).

2.2. Adolescence

This section will involve a discussion about adolescents, to provide the foundations for the explanations of why they partake in risky decision making, such as speeding. Initially, adolescence will be explained in relation to behavioural, social and emotional processes occurring during this time.

To understand decision making behaviours that occur during adolescence, and driver behaviour, it is imperative to define adolescence, understanding that it is a period of risks and opportunities which occur in terms of neural and social development. Steinberg (2005) defines adolescence as a "critical developmental period" and a period of "heightened vulnerability" (p.73), with many risks and opportunities. Heightened vulnerability refers to the susceptibility of teenagers to engage in risky behaviours, such as risky sexual behaviour, alcohol and drug use, speeding and dangerous driving. This vulnerability is produced by the disparity between emotional, cognitive and behavioural systems which develop at differing rates (Steinberg, 2005). Studies into neural and social maturation propose that adolescent and frontal lobe development of the brain continues well into adulthood, with maturation of the frontal lobe complete at 25 years (Sim, 2008) (Dahl, 2004; Keating, 2007; Lenroot & Giedd, 2006). Consequently, those aged between 16 to 25 years are the focus of young driver behaviour research, which coincides with the age where an individual is able to obtain a learner's licence in New Zealand.

When fully developed, the frontal lobe enables regulatory competence (Dahl, 2004; Johnson, Sudhinaraset, & Blum, 2010; Sim, 2008; Spear, 2000; Steinberg, 2005) and is responsible for decision making and other important functions. These include visual searching, impulse control and attention, self monitoring and planning. Lesions, or an immature frontal lobe can result in numerous problems; such as apathy and difficulties in emotion regulation, problems in anticipation, planning, monitoring, adapting and inappropriate stopping behaviour, and abstract reasoning (Hawkins & Trobst, 2000).

Dahl (2004) suggests that in order to understand adolescence, the complex processes between brain, behaviour and social context interactions must be studied. Therefore the discussion of emotion as well as risky decision making and behaviour, which are highly prevalent during adolescence, are important in understanding this developmental time period**.** Before risk taking and risky decision making can be understood, underlying emotions which act as precursors for such behaviour must be explained. The adolescent period accepted in most cultures and outlined by the World Health Organisation (WHO), is defined by the onset of puberty (Sim, 2008; Spear, 2000), linked with the motivation to experience highly emotive feelings; intensity, excitement and arousal (Dahl, 2004; Spear, 2000). Individuals may make irrational decisions while experiencing strong emotions, impacting on decision making processes. Teenagers make decisions under hot and cold cognitive processes (Steinberg, 2005); cold referring to decision making under low levels of emotional stimulation, and hot referring to decision making in moments of high stimulation. High emotional stimulation results in difficulties with response inhibition, referred to as the regulation of risk, reward and emotion (Steinberg, 2005). Low levels of response inhibition may manifest in an inability to effectively control desires or to judge risk levels.

While adolescence has been described as a period of vulnerability, with emotions influencing behaviour, it is also a period of increased risk taking. Johnson et al. (2010) states that the majority of teenagers undertake risky behaviours and sensation seeking. Risk taking occurs as teenagers may act in a way that capitalizes on instantaneous satisfaction (Reyna & Farley, 2006; Sim, 2008; Spear, 2000), and this satisfaction acts as a reward. This results in stimulation of the reward centers in the brain, and an increase in the frequency of performance of the behavior, due to reinforcement (Reyna & Farley, 2006). Teenagers have a greater propensity to participate in risky behaviours, such as drinking, dangerous driving, drug use, smoking and risky sexual behaviour than any other developmental age group, causing 200% morbidity and injury compared to younger developmental stages (Steinberg, 2005, Sim, 2008, Spear, 2000, Dahl, 2004). While risk taking and risky decisions are common and viewed as necessary for evolution into adulthood, they can result in imprudent choices such as inappropriate speed choice, resulting in death and injury (Spear, 2000). Risk based behavioural influences are multifactorial; including personality, disposition, opportunity, genes, social context, environmental stressors, and speed and timing of maturation. Other factors which affect adolescent risk taking behaviours include: Peer influences, low parental monitoring, poor parental role models, cultural influences and substance use (Husted et al., 2006). To further understand how people manage risk, various models of risk taking have been developed and will be discussed further.

There are several models of risk taking that are applicable to driving, including the 'Task Capability Interface' model, the 'Illusion of Control', and 'Optimistic bias'. While these models are all distinct, they share similarities in that they can all be discussed in relation to hazard perception and speed choice.

The 'Task Capability Interface' model involves risk being managed by the driver altering their behavior, so the task demands are kept within an acceptable level, dependent on personal differences. Risk taking is evident in this model, outlined by Fuller (2005) cited in Kuiken and Twisk (2001) which demonstrates that task demands may change over time, and the driver must respond appropriately. This relates to hazard perception and speed choice, as in order to accurately detect hazards and choose appropriate speeds, a driver must be 'self aware'. As driving is a 'self paced' task, a driver can reduce the task demands, for example by slowing down, which makes the task easier (Fuller, 2005). Increases in task demands require evasive action to ensure that the task demands remain at a level safe for the driver. Drivers must compare task demands to their own skill level, referred to as calibration (de Craen, Twisk, HageNew Zealandieker, Elffers, &

Brookhuis, 2006, 2008; Kuiken & Twisk, 2001). Calibration is an important skill for a driver to have in order to detect hazards appropriately, choose appropriate speeds and respond to hazardous situations accordingly (Kuiken & Twisk, 2001). Miscalibration can lead to aggressive driving, too smaller following distances, excess speed and the performance of dangerous maneuvers; therefore, is highly relevant in the areas of hazard perception and speed choice (Kuiken & Twisk, 2001). Kuiken and Twisk (2001) suggest that feedback is important for safe calibration, which is in alignment with the 'Self Regulation Theory', where the driver is able to regulate their skills in the context of traffic environments. However, in order to accurately assess the task demands in a situation, the driver has to have an accurate perspective of their own driving skills, which relates directly to the 'Optimistic Bias' (de Craen et al., 2006).

The 'Optimistic Bias' involves drivers' judging themselves as better than the average driver and is highly prevalent among young drivers (De Craen, et al., 2006, 2008) . It has been found that Young Novice drivers, particularly males, are more often confident than Older Experienced drivers (Mynttinen et al., 2009). The ability to overestimate ones skill has lead to the high crash rate in novice drivers (Mynttinen et al., 2009). This model leads to the 'Self Enhancement Bias'; to view oneself as superior in comparison to others (Dogan, Steg, Delhomme, & Rothengatter, 2012). It can also be viewed in terms of the 'negative other', where the average driver is viewed with negative connotations (worse than one's self) (Sundstrom, 2008). In driver behaviour, the skill of the driver is generally measured in terms of self reports, hence why an accurate perception of one's skill is important (Sundstrom, 2008). Drivers may not develop an accurate point of view of their own driving behaviour for several reasons, such as lack of feedback, attributing mistakes to other causes, lack of understanding of why the mistake occurred and not receiving self corrective information (Dogan et al., 2012). As a result, failure of negative consequences arising from their behaviour reinforces driver's overconfident behaviour in the future (Dogan et al., 2012). In addition, if a driver is poor in estimating their own skills, it is highly likely that they will be poor in assessing traffic risks, which can lead to the high crash rate (Gregersen & Bjurulf, 1996: Sundstrom, 2008). If one perceives the risks in traffic scenarios as low, they cannot take evasive action when it is needed; for example, they may be speeding, however, it may be an area which requires slow driving due to children crossing. In the event that a driver is speeding, this leaves less time for slowing down in hazardous situations, hence the probability of negative consequences, such as crashing are high (Dogan et al., 2012). This misperception of risks leads to dangerous driving and poor decision making in driving situations, with behaviours such as speeding being highly prevalent, as the driver is overconfident. An accurate point of view of the drivers' skills is therefore extremely important, as safe driving necessitates that the driver can alter their behaviour depending on the demands of the task (de Craen et al., 2006). This theory is significant in hazard perception and speed choice, as when a driver is overconfident, this leads to a reduction in their assessment of risk (such as hazards) and poor decision making (such as speeding).

Another risk taking model in relation to driving is the 'Illusion of Control'. This model involves the level of control, in this instance, control whilst driving being perceived as greater than it realistically is (Hammond & Horswill, 2002). This model is significant in hazard perception because if the driver does not have a realistic view of their ability to control the vehicle, they will not be in a position to detect hazards as accurately as those that do have a realistic idea of control. Consequently, this model also relates to speed choice, as those that are in greater control may choose faster speeds according to Hammond and Horswill (2002) who suggest greater perceived personal control over a situation may lead to taking greater risks, such as choosing higher speeds (Kuiken & Twisk, 2001; Sundstrom, 2008). In a study by Horswill and McKenna (1999) participants were told to either imagine they were driving or that they were passengers of a vehicle. Results showed that those who believed they were driving the vehicle chose greater speeds than those who were passengers, emphasizing the fact that greater control results in greater speeds. This model is an illusion, as the driver believes they have control over the situation, whereas in reality other factors are at play on the road and in road accidents, such as chance (Hammond & Horswill, 2002).

These three models, the 'Task Capability Model', the 'Optimistic Bias' and the 'Illusion of Control' are all relevant in understanding driver behaviour and in particular hazard perception and speed choice. This is because each model acts as an explanation of the behaviours which lead to failing to detect hazards or choosing inappropriate speeds. Overall this section has highlighted why risky behaviour is so high during adolescence and has discussed factors that influence decision making in relation to risk management, and included models of risk taking. Risk taking has important relevance to driver behaviour as speeding is a risky behaviour, and while prevalent, is not exclusive to younger drivers. Due to risky decision making, inappropriate speed choice and poor hazard perception affecting a wide range of age groups, it is important to then go on to examine the impact of age and driving experience and crash risk.

2.3. The Effect of Age and Driving Experience on Crash Risk

While adolescence is a significant developmental period associated with an increase in crash rates, it is important to focus on age and experience, two predominant factors related to driving behaviour. Speeding and poor hazard perception are not limited to young drivers alone, therefore, the following section on age and experience will also include older drivers. As highlighted previously, young drivers have crash rates that far exceed those of Older Experienced drivers (Mayhew et al., 2003), although the rate declines dramatically during the first six months of driving (Mayhew et al., 2003). These crash rates remain low throughout middle age, but increase again among senior drivers (those over 70) to a lower crash rate level than the youngest drivers (Hornberry et al., 2004). Changes in crash rates with age may be due to experience (increase in skill), maturation (declining influence of lifestyle factors such as sensation seeking), age related factors (such as cognitive decline) or a combination of these factors.

2.3.1. The Effect of Age

Young drivers are prone to risky decision making, such as speeding, due to contributing developmental factors, such as lack of maturity and an increase in sensation seeking, seen in conjunction with the transition into adulthood (Zuckerman, 1994). Speeding has been shown to be the biggest cause of vehicle crashes for those under 25 years (Zuckerman, 1994). As age increases, the number of deaths from fatal crashes due to speeding decreases (Figure 2.1). Age disappears as a risk factor regardless of driving experience when a driver reaches 25 years (Ministry of Transport, 2010a). It is an arduous task to separate the effects of age and experience, as age confounds experience and experience confounds age.

Mayhew et al., (2003) examined the effect of age on crash rates by separating age and experience as confounding factors and investigated crash rates for novices who had similar experience, but different age. Results for those aged 16 to 19, and 20 and older, clearly showed the effect of age, particularly in the first few months of solo driving. Young Novices (16 – 19 years) had higher crash rates that were twice that of Advanced Novice drivers (20 years and older), a 45% difference, despite 24 months of exposure, demonstrating a vivid example of the 'age effect'.

The effect of age on driver crashes was further evidenced by Lewis-Evans, (2010) who controlled experience by using participants of different ages, with similar levels of experience, for example, full licence drivers for the same time period, yet different in age. Lewis-Evans (2010) demonstrated higher crash rates for young drivers, particularly males. In the time period between receiving learners licences to graduating with restricted licences, those aged 15.5 to 16.5 years, had 7.4 times increase in crash rate compared to all other groups (except those aged 18.5 - 19.5 years). Those that gained their restricted licence aged 16.5 to 17.5 had a higher crash rate than those aged 17.5 to 18.5, and those aged 19.5 to 20.5, highlighting the significant role age plays in car crashes.

Goldenbeld and van Schagen (2007) showed additional evidence for the 'age effect' indicating that younger car drivers (18 to 25 year olds) preferred a higher safe speed than older car drivers (Goldenbeld & van Schagen, 2007). The 40 to 55 year old drivers had the highest preferred speed, compared to the slowest age group 56+ (safest preferred speed). The age effect is also supported by other research such as Laberge-Nadeau et al., (1992), Hornberry et al., (2004) and

Fildes et al., (1991), Quimby, Maycock, Palmer, and Buttress, (1999) and Lawton, Parker, Stradling, and Manstead,(1997).

2.3.2. The Effect of Experience

Experience is vital for driving, and as drivers accumulate more experience, their hazard perception and speed choice improve (Gregersen & Bjurulf, 1996). Drivers that are more experienced have an increased level of skill, and are less likely to be involved in a crash, shown by their decreased number of crashes (Mayhew et al., 2003). Inexperience can be evident in teenage years as young drivers have not experienced as broad a range of traffic scenarios (Isler et al., 2009; Sagberg & Bjornskau, 2006). With longer distances travelled, younger drivers increase in their level of experience and may reduce preferred speeds and improve hazard perception (Isler et al., 2009).

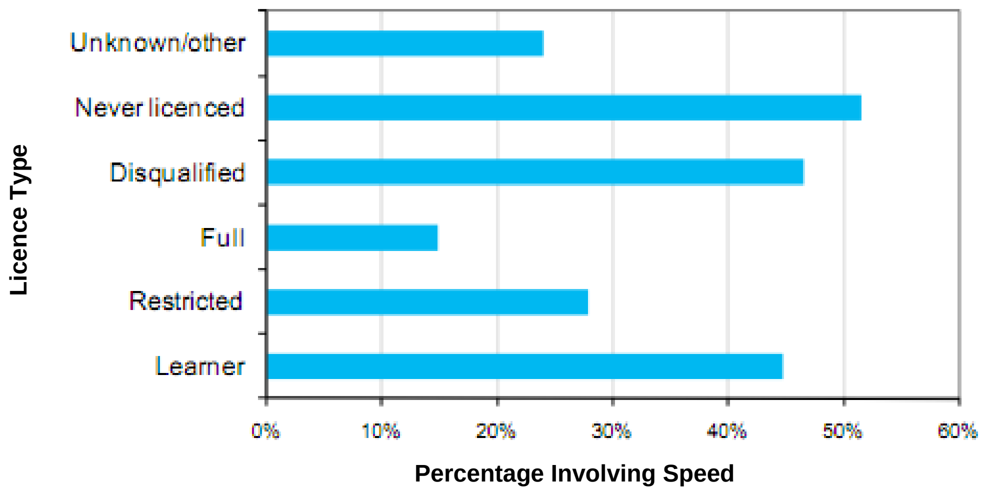


Figure 2.2: Percentage of drivers in fatal crashes who were speeding, categorized by licence type (Source: Ministry of Transport, 2010).

Research into experience while driving, such as The Ministry of Transport speeding report (2010a) suggests that drivers with learners or restricted licences are more likely to be involved in speeding related crashes, at approximately 45% and 28% respectively, compared to 15% of those who hold a full licence (Figure

2.2). This demonstrates that experience plays a role in speeding related accidents, with individuals on their learner and restricted licences most at risk. However, as Lewis-Evans (2010) described, those that are on their learner licences have a decreased level of risk in comparison to restricted solo driving. Supervision of learner drivers by a more experienced other acts to slow them down, to ensure they are driving safely (Figure 2.2). The majority of those involved in fatal crashes either had their learner licence, were never licenced or were disqualified from driving, showing that a lack of experience may lead to speeding related fatalities (Figure 2.2) (Ministry of Transport, 2010).

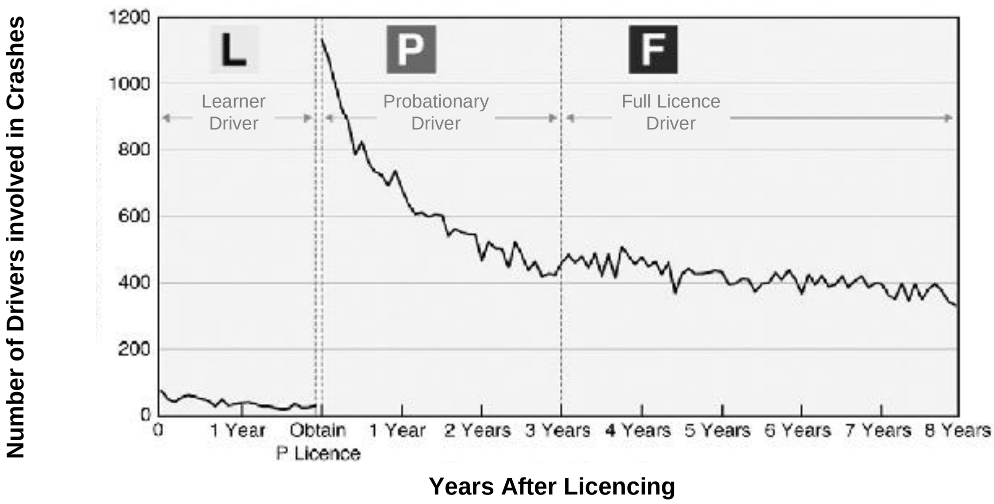


Figure 2.3: Number of Drivers Involved in Crashes in terms of licencing stages showing the large increase in crash rates at the restricted level. (Source: Lewis-Evans, 2010)

When studying the impact of experience on crash rates, Mayhews et al.'s., (2003) analysis of driving experience on a monthly basis, showed that learners crash rates are extremely low due to supervision while driving, consistent with experience effects identified elsewhere. For novice drivers, the crash rate was very high in the first month after receiving their licence and first undertaking solo driving however this rate dropped consistently after seven months of driving. Despite the confounding effects of age and experience, when studied separately; the decline in crash rate is most likely due to “experience effects” as it is unlikely that any major lifestyle changes, such as increases in physical and intellectual capabilities which could affect driving, did not occur within a seven month time frame. Dingus et al., (1997), and Tarko (2009) further support Mayhew et al.,(2003). Dingus et al., (1997) investigated speed choice in relation to age, experience and navigation techniques. Findings revealed that increased experience allowed drivers to drive with greater degrees of safety and obey the speed limits.

Research outlined in this section described the ‘age effect’ and ‘experience effect’ when studying driver behaviour. While some literature suggests either age or experience as more important, (such as Gregersen & Bjurulf, 1996) findings from the current literature review highlight they are equally critical factors when studying driver behaviour. Another factor is gender, which is briefly discussed in the next section.

2.4. The Effect of Gender on Risky Behaviour

There is a clear gender bias in the statistics, with males overly represented; for example, Figure 2.4, shows that more males than females have been killed in car crashes in the Waikato region (Clark, Ward, Truman, & Bartle, 2006; Fernandes, Job, & Hatfield, 2007). Research into speed choice has shown males to be more persistent speeders than females (Ministry of Transport 2009, 2010 & 2011; Laberge-Nadeau, et al., 1992; Rienstra & Rietveld, 1996; Stradling, 2007; Elvik, 2010). In 2010, 54% of those injured were male and 73% of those killed were male, all due to speeding related offences (Ministry of Transport, 2011). Further, males in the 15 to 19 age category are 11 and a half times more likely to crash than male drivers in the lowest risk age group, 55 to 59 years (Ministry of Transport, 2010a). In comparison, females of the same age have a lower risk than males, although are eight times more likely to crash than females of the lowest crash risk age group 55 to 59 (Ministry of Transport, 2010a). Due to this gender bias in the statistics, males were the gender focused on for the current research.

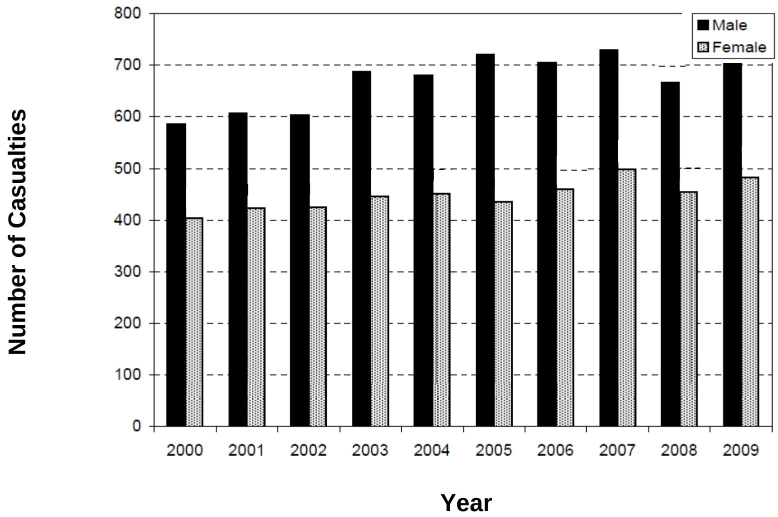


Figure 2.4: Male and Female casualties in rural Waikato regions 2000 – 2009 (Source: NZTA, 2010)

2.5. Skill Deficits in Younger Drivers Which May Lead to the High Crash Rate

While age, experience and gender are important for studying driver behaviour, it is also important to examine driver skills because these contribute to drivers being able to drive competently and make correct and informed decisions while on the road. If the correct skills are not taught during the learning process, this could raise many safety issues later on. Therefore, skill deficits in young drivers are to be discussed further in this section.

Driving is a complex process, which requires higher order skills to drive at appropriate speeds, while detecting hazards. Young drivers learn car handling skills and traffic laws quickly, some have suggested in as little as 15 hours, however, they require much longer to obtain complex higher order skills such as hazard perception, visual search and attention, and calibration to safely interact with the driving environment (Deery, 1999; Isler et al., 2009). This section will examine mental workload, eye scanning, attentional control and hazard perception.

To begin describing skill deficits, it is important to first examine how driving skills are processed in the brain, in terms of mental models and mental workloads. A mental model is “information stored in long term memory on which to base a decision on” a depiction of the relationship between the person and their environment, (Ashcraft, 1994, p. 561). In comparison to Older Experienced drivers, young drivers have a simple set of scripts or mental models, obtained by being the passenger in the car (Underwood, 2007).

Mental workload in a driving context depends on the amount of “resources” that are available; the less resources a task needs, the easier it is to combine it with other tasks (Gregersen & Bjurulf, 1996). Driving requires a large amount of cognitive resources, therefore novice drivers have a higher mental workload compared to experienced drivers, as they pay attention to different tasks concurrently (de Craen, et al., 2008). Novice drivers use more mental resources to manage basic vehicle control skills not already automated (Horswill & McKenna, 2004). While still learning vehicle control skills, such as steering, gear changing and speed control, the task of driving has not yet been transferred into procedural (automatic) memory, such as that found in experienced drivers (de Craen, et al., 2008; Isler, et al., 2009; Sagberg & Bjornskau, 2006). Therefore, at this stage, the young driver must allow a greater amount of attentional resources to be allocated to the driving task. Mental workload is significant, as it represents part of the higher order skills necessary for safe driving, and may explain why the crash rate in young drivers is so high.

While mental models and mental workloads are important for obtaining the skills required to become a proficient driver, a skill which is equally important is eye scanning and related behaviours. Eye scanning is another higher order skill which can be used to help understand and explain the high crash rate in younger drivers. With expert eye scanning behaviours, this contributes to a greater situation awareness on the road (Deery, 1999). Novice drivers use less advanced information gathering techniques, however with experience, visual searching strategies improve (Deery, 1999). Less saccidic eye movements are undertaken by novice drivers who are not searching as efficiently as Older Experienced drivers who have experience identifiying hazards and superior situation awareness (Isler, et al., 2009). Younger drivers check mirrors less regularly, focus their eyes closer to the front of the vehicle, and use peripheral vision less efficiently (Deery, 1999). Experienced drivers perceive driving scenarios more holistically, whereas novices perceive a scene as a number of parts, independent of the situation (Deery, 1999). Borrowsky, Shinar, and Oron-Gilad (2010) believe Young Inexperienced drivers focus straight ahead, whereas experienced drivers searched in the periphery. Inefficient search patterns, could impact on hazard perception, as the driver is unable to identify and respond to hazards in a timely manner. In turn, they cannot slow their speeds accordingly if they do not classify the situation as hazardous, which can be dangerous for all road users.

While eye scanning is a significant factor in acquiring the skills to become a competent driver, it also increases situation awareness on the road, also referred to as hazard perception. Hazard perception refers to the “ability to read the road” and good situation awareness of every traffic environment (Kuiken & Twisk, 2001). As with any skill, it is assumed that this ability should improve with practice (Horswill & McKenna, 2004). As accident involvement decreases noteably during the first few years of driving, researchers suggest this may be due to improvements in hazard perception (Horswill & McKenna, 2004). Grayson & Sexton (2002) cited in Horswill and McKenna (2004), found that Learner drivers had slower response times to hazards, compared to novice drivers (less than two years experience), who were in turn slower than experienced drivers (ten years of experience). Experienced drivers were also found to detect a greater number of hazards than novices (Horswill & McKenna, 2004). As is evidenced from research, hazard perception is relevant to the current study as differing levels of hazard perception skills may result in inappropriate speed choice, poor hazard perception and crashes, ultimately resulting in injury and death. This is particularly evident in Young Novice drivers; and therefore will be investigated in the current experiment.

This section has examined mental workload, eye scanning, attentional control and hazard perception, which are all higher order skills required in the driving process. These skills are vitally important, as it is higher order skills which separate Young Inexperienced drivers from Older, Experienced drivers, who have had more time on the road to develop these skills. Therefore any difficulties with these higher order skills, results in crashes, and in particular the high crash rate among young drivers, as they have not had the chance to further develop and enhance these skills.

2.6. Previous Research on Hazard Perception and Speed Choice

While many factors contribute to the young driver problem, road crash statistics indicate that inappropriate speed and poor hazard perception skills are significant factors. Current research investigating speeding behaviours relies heavily on self-report measures (Dahlen, Martin, Ragan, & Kuhlman, 2005), however these represent a methodological limitation as they can lead to bias and/or inaccurate reporting of information; that is, self-report measures are subject to cognitive, affective and self-presentational biases (Elliot, Armitage, & Baughan, 2005).

Determining potential deficits in hazard perception ability and why drivers choose inappropriate speeds would be difficult in a naturalistic setting as there are many extraneous variables to be accounted for. Controlled laboratory based settings provide external ecological validity, as outlined by Horswill & McKenna, (1999) however, there is still little research using laboratory based assessment. Using laboratory tasks allows greater ease of control of extraneous variables encountered in real world driving. The speed choice task and hazard perception tasks conducted in the laboratory, as in the current study, provides a way of objectively measuring speed choice and hazard perception, in a situation which aims to reflect driving behaviour in real world situations.

The relationship between hazard perception and crash risk has been investigated in a dual task paradigm by Isler, et al. (2009). They examined the hazard perception skills of younger drivers compared to experienced, middle-aged drivers to investigate if hazard perception skills can be improved through training. This involved participants identifying immediate hazards, verbally and by clicking the mouse button. Immediate hazards required the driver to take evasive action. A secondary task aimed to stimulate steering, which involved participants keeping track of a circular motion 'target dot' within a smaller square whose position was controlled using the mouse. Results revealed that younger drivers detected fewer hazards than experienced drivers, and had longer reaction times. However, younger drivers performed better on the secondary tracking task, with fewer tracking errors. Road commentary training was given to both groups to identify whether hazard perception can be trained. It was established that the younger drivers' hazard perception skills improved to that of the experienced drivers. When compared to a group of comparable age and driving skills level, the younger drivers made significant improvements. This research is pivotal as it provides a validated task that demonstrates that hazard perception can be trained.

Studies using a laboratory based objective measure of speed choice have been carried out by Horswill & McKenna (1999) and Cantwell (2010). These studies have laid the foundation for future speed choice studies, and have provided the basis for the current video speed choice task (VST).

The VST in Horswill & McKenna's (1999) study involved investigating the relationship between the speed choice task, and prediction of accidents and risky behaviour (Horswill & McKenna, 1999). The purpose was to consider whether the VST could predict the number of accidents that drivers would be involved in due to driving too fast, while comparing the VST with traditional measures of driver speeding behaviour, such as interviews and self reports. Participants viewed scenes to consider whether they would be driving faster/slower than the vehicle in the scene and recorded speeds they would drive in the real world; for example, 10mph faster. Results showed that the participants' responses on the VST were directly related to speed related accidents, supporting external validity. Speeds chosen by drivers involved in an accident were 5.95mph faster than the video car and 5.12mph faster when not involved in accidents. Overall the relationship found was those that selected higher speeds were more likely to be involved in accidents.

Following McKenna's research, Cantwell (2010) conducted a study using the VST as a measure of speed choice. Participants were asked to watch a video of particular traffic scenarios and were instructed to estimate the speed they believe they were travelling, followed by the speed appropriate to travel on that particular road (Cantwell, 2010). Participants adjusted the speed on the screen using arrows. While Horswill and McKenna (1999) presented a limited number of road types, Cantwell (2010) expanded the range to include urban, suburban, semi urban rural, semi rural, and motorways. In each of these categories, video clips were recorded across differing road environments, including night-time video clips.

Cantwell (2010) found that Young Inexperienced drivers preferred significantly faster speeds than Older Experienced drivers (Cantwell, 2010). Young Inexperienced drivers chose faster speeds and 40% preferred speeds that were greater than the road limit, with the majority being male. Older Experienced drivers preferred speeds that were below the speed limit, and both groups overestimated the speed at which the vehicle was travelling on the video (Cantwell, 2010).

The video based experiments carried out into hazard perception by Isler, et al., (2009) and speed choice investigated by Horswill and McKenna (1999) described in this chapter, have been sucessfully validated in their respective areas, thus are reputable studies to be utilised as the foundation for this thesis. Research in hazard perception and speed choice has indicated there may be a link between the two, which is to be further discussed.

Hazard perception, as discussed previously, involves the ability to interpret a traffic situation and respond appropriately, and is highly correlated with crash rate (Wallis & Horswill, 2007). Like other aspects of driving, hazard perception may be impaired when speed is involved (due to less time to react). Despite experienced drivers being more adept at hazard perception than novices, the distance required for a car to stop when travelling at high speeds is the same for any driver, regardless of their skill level (ACC & LTSA, 2000). Therefore, hazard perception skills decrease as speeds increase, due to less time to detect and respond to hazards, placing them at great risk of crashing and increasing the crashes severity (ACC & LTSA, 2000).

Speed choice and hazard perception involve an interlinked relationship. Naturally, the faster a driver travels, the less able they are to detect potential hazards that arise (ACC & LTSA, 2000). Several studies have examined the link between hazard perception and risky driving behaviours (in particular, speed choice). McKenna et al. (2006) aimed to investigate if there was an effect of anticipation training on hazard perception ability. Their first experiment showed that anticipation training resulted in a decrease in risk taking. In their second experiment, McKenna, et al., (2006) showed that an increase in driving skills training may result in an increase in hazard perception, and decrease in risk taking in particular speed choice. Those who were trained had the ability to detect and identify hazards, and produced reductions in their speed choice in relation to the presence of hazards. In Experiment 3, McKenna, et al., (2006) established the tests in an ecologically valid environment, police training, which validated results.

2.7. Current Research

The reviewed literature suggests that there could be a link between hazard perception and speed choice. However, further research is needed to elucidate this relationship and provide insights into possible targets for driver education interventions. This is of importance as hazard perception and speed choice/s highly influence crash rate; therefore, this link could be used to allow drivers to become competent, safe drivers who are more aware of potential hazards, and who undertake safer speeds. The proposed research will investigate speed choice and hazard perception in a controlled laboratory based setting using the VST outlined by McKenna and Horswill (1997), and hazard perception task by Isler, et al., (2009). Laboratory based tasks allow greater ease of control of extraneous variables encountered in real world driving. The speed choice task in the current study provides an objective method for measuring speed choice, reflecting driving behaviour in real world situations. As the validated speed choice task has external, ecological validity, the current research will add to the present research on speed choice, in a reliable and objective way.

The aims of the current study were to:

1. Examine the effect of age, driving experience on hazard perception ability
2. Examine the effect of age and experience have an impact on speed choice
3. Examine whether there is a relationship between hazard perception and speed choice

Based on the reviewed literature, it was hypothesized that:

1. Younger Inexperienced drivers will detect a smaller number of immediate hazards than Older Experienced drivers
2. Younger Inexperienced drivers will focus more on the secondary tracking task of the hazard perception dual task, therefore having more tracking errors than Older Experienced drivers
3. Younger Inexperienced drivers will prefer to travel at faster speeds than Older Experienced drivers. Increased age and experience will result in slower chosen speeds
4. There will be a relationship between hazard perception and speed choice, increased hazard perception ability will result in a decrease in speed choice

3. Methods

This research was part of a larger study carried out by five graduate psychology students examining different aspects of hazard perception skills and speed choice behaviour of drivers. The larger study recruited over 96 participants, consisting of both males and females. The current research focused on the male drivers, who seem to experience a higher crash risk than female drivers.

3.1. Participants and Experimental Groups

Forty-eight male drivers who held current, valid New Zealand Drivers Licences were recruited, mostly from Waikato University student and staff population. Many participants were first year Psychology students or recruited from the local boy's high school. Some participants were recruited via a regional newspaper article describing the project and asking for volunteer drivers, posters put up around the university, or advertisements on social networking sites such as Facebook or the university online learning tool (Moodle).

The majority of participants (n = 35, 76.1%) were of New Zealand European / Pakeha descent, 5 (8.3%) of Maori descent, 3 (6.5%) were African, Kurdish, Guyanese or other, 2 (4.3%) participants were of other European heritage, and 1 (2.2%) was of Asian descent.

The participants were assigned to four groups (A, B, C, D) with 12 drivers in each group. Group A ('Young Novice') consisted of drivers on their learner licence, ranging between 15 and 20 years with a mean age of 16.0 years (SD= 1.6). Group B ('Advanced Novice') consisted of drivers who were on their restricted licence with a mean age of 17.5 years (SD= 1.5) ranging between 15 and 20 years. Group C (‘Young Experienced’) comprised those on their full licence that were between 20 and 25 years, with a mean age of 21.8 years (SD= 1.5). Group D (‘Older Experienced’) involved those with their full licence aged between 25 and 60 years, with a mean age of 38.3 years SD= 9.5).

3.2. Apparatus and Experimental Setup

The experiment took place in a windowless research lab of the School of Psychology. The lab contained an arm chair, approximately 1m away from a television monitor (Panasonic TH-L42U30Z 42" Full High Definition LCD TV 42inch), which was used to display the video-based traffic simulations for the hazard perception dual task and the speed choice task (see Figure 3.1.), with a visual angle of approximately 54 degrees (measured horizontally). The simulation was displayed via a Dell computer on the television monitor (resolution1080dpi = 1920X1080), with a frame rate of 60Hz. Participants had access to a computer mouse for responding during the hazard perception and video speed choice tasks.

Figure 3.1: A participant is undertaking the hazard perception dual task in the laboratory

3.3. Experimental Tasks and Measures

3.3.1. Demographics and Driving History Questionnaires

The demographics questionnaire and driving history questionnaires (see Appendix E) with questions relating to age, ethnicity, gender, relationship status, driver licence type (i.e., learner, restricted, full), driving experience in years and months, estimated mileage driven over a week (in kms), and any crashes or near misses that they have been involved in the last 12 months. Crashes were defined as collisions that occurred on a public road (not private property) while the participant was the driver of the vehicle, irrespective of who was at fault. A near miss was defined as narrowly avoiding a crash on a public road (not private property).

3.3.2. Hazard Perception Dual task

For the hazard perception dual task, the participants were required to search for immediate hazards in video-based traffic scenarios and to use the computer mouse to click on them (primary task), while tracking a randomly moving dot (secondary task). The traffic scenarios were based on real-world driving situations viewed from the driver's perspective. Immediate hazards were defined as those that were directly going to cause the driver to take evasive action to avoid an accident, such as braking to avoid collision. Participants were required to identify the hazards by clicking the left mouse button while concurrently verbally identifying the hazard, for example "pedestrian to my left". Participants took part in up to 3 practice trials depending on their level of understanding the task. The participants' verbal responses were recorded using a digital audio recording device, as well as audio recording software on the computer. When participants clicked on the mouse to identify a hazard, a "beeping" sound followed to prompt for a verbal identification. Each mouse click reaction time was recorded in milliseconds by the computer, from the start of a trial to when the clicking occurred. The dependent variables in each trial were the number of detected and identified hazards and the time it took for them to respond to the hazards (reaction time). If a participant missed a hazard, the total time the hazard was visible was used to replace the missing reaction time data. The values for the variables were automatically stored for each trial and participant on an excel file for further analysis.

The aim of the secondary tracking task was to simulate the steering in real driving (Isler et al., 2009). It involved a video-based stationary rectangle (130 x 80 mm), as seen in Figure 3.2 that was digitally superimposed in the central area of the driving scenario at the location on the road ahead. Participants needed to keep a randomly moving dot (5 mm, speed approximately 10 mm/s) within a square (30 x 30 mm) using the mouse to control the position of the square. The square was maintained in place within the large outer rectangle, with the moving dot bouncing off the sides somewhat like balls in arcade games. Each time the dot was mistracked, the participant was alerted with a low pitched "beeping" sound and the frame around the square changed colour from blue to purple for 500 milliseconds. The dependent variables for the secondary task were the number of times the participants mistracked the dot, and the length of time the dot was mistracked.

Figure 3.2: Sample screen shot of a video traffic simulation for the hazard perception dual task with the virtual dashboard and the secondary task (see text for detailed description of the task)

There were nine video-based traffic scenarios including one practice trial, each between four and 75 seconds long. Each participant performed the traffic simulation trials in the same order. They were all displaying urban or suburban traffic scenarios and showed a variety of hazards, such as road workers and primary schools, children, cyclists and pedestrians.

3.3.3. Video Speed Choice task (VST)

The Video Speed Choice task (VST) was adapted from previous research by Horswill and McKenna (1999), and Cantwell (2010). Participants were required to view video clips filmed from the driver's perspective, simulating driving on urban and rural roads in different weather conditions (wet and dry), and during the day and at night.

The computer screen was initially blank, before the videos were presented. The video clips were presented in a predetermined pseudo-random order to minimise confounds and improve the validity (Aron & Aron, 2003). After viewing each video clip a new screen was presented, in which participants were required to use the mouse to answer two questions: a) how fast do you think you were going? And b) what do you think would be the most appropriate speed for this road condition?

The participant answered each question by changing the speedometer on the screen. Once the participants had selected their desired speed using the speedometer, they then selected START VIDEO on a new screen, which initiated the three second countdown to the next video clip. This process was used across all trials of the VST. Following each video clip, a mouse click signalled progression to the next video clip.

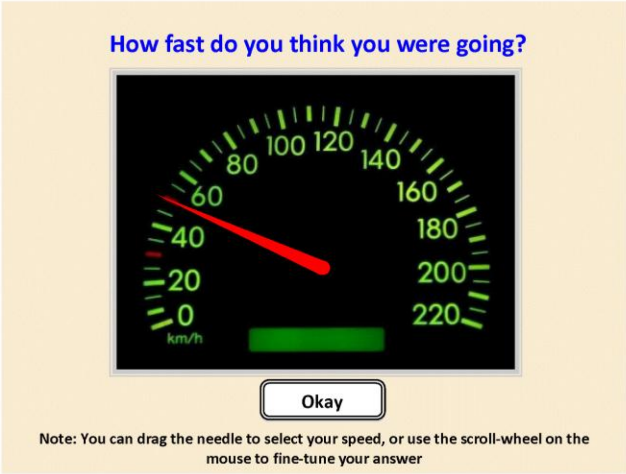


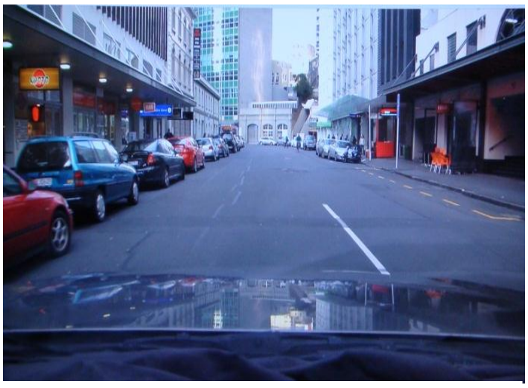
Figure 3.3: Computer screen as viewed for questions on the speed choice task

3.3.4. Footage Collection

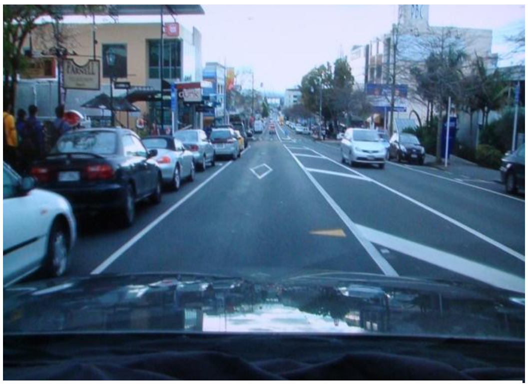
Video clips of rural and urban roads were used. Urban areas involve major roads, e.g. arterials, minor roads and housing areas, comprising of speed limits between 50 – 60km/hr, and around schools this limit drops down to 40km/h (at certain times) (ACC & LTSA, 2000). Urban roads are high intersection arterial roads which join onto hazardous roads in commercial and housing areas (Cantwell, 2010). These roads consist of traffic flow (8,000 to 20,000 vehicles per day) and a larger amount of intersections compared to rural roads. An urban road typically has road markings on both the centre and shoulder of the road (Cantwell, 2010; Davin & Olsen, 2011).

Rural roads are those with low density housing, two laned open roads and often run through farming areas, being set to speeds between 70 - 100km/h (ACC & LTSA, 2000). Rural roads are found outside commercial areas, where there are few hazards present. These areas consist of lesser traffic flow (1,000 to 5,000 vehicles per day) and a low density of hazards (e.g., moving cars). These roads have markings on the centre of the road, but not always on the shoulders.

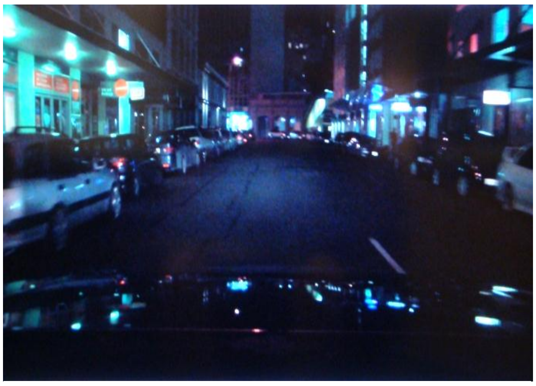
Eight different road conditions were filmed in affordance with the definitions described above. The two urban roads (with and without shoulder lines) had a speed limit of 50km/h while the two rural roads (with or without shoulder lines) had a speed limit of 100km/h. Urban roads were filmed during the day and night, and the rural road conditions were filmed during dry and wet conditions (see Figure 3.4).



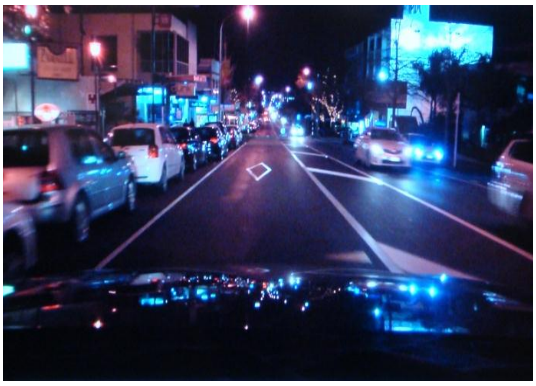
Urban day (no shoulder lines)



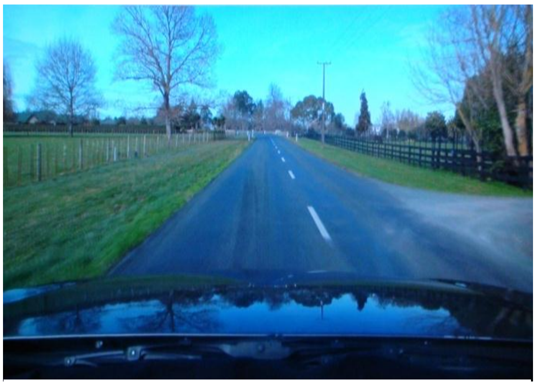
Urban day (shoulder lines)



Urban night (no shoulder lines)



Urban night (shoulder lines)



Rural dry (no shoulder lines)

Rural dry (shoulder lines)

Rural wet (no shoulder lines)

Rural wet (shoulder lines)

Figure 3.4: Video Speed Choice Task sample screenshots of the eight different road conditions used.

3.3.5 Procedure of Video Footage Collection

The video footage was collected with a camera-vehicle driven on selected routes in the rural areas of Hamilton and the urban areas of Auckland. Afternoon footage was taken at 3pm for the day-time video clips and night-time at around 10pm. Recordings for wet and dry conditions were taken at approximately the same time during the afternoon on differing days.

The footage was recorded using a digital video camera mounted on a special bracket within a vehicle, so that the footage would be static frame and no vibration of the vehicle would be apparent. Footage was obtained from the driver's perspective through the windscreen of the vehicle. It was recorded in high definition (HD) to make it as accurate to the real-world as possible for the viewer; the camera focus was set on infinity (∞).

The speed limit for the rural roads were 100km/h and the video clips were filmed at three different speeds; 100km/h, 70km/h and 30km/h for both the wet and dry conditions. The speed limit for the urban roads were 50km/h with the video clips filmed at three differing speeds; 50km/h, 30km/h and 10km/h for both the day and night conditions. Once the footage was collected, it was transferred onto a Dell desktop computer and edited. Video clips were selected according to Horswill and McKenna (1999). There were 24 video clips, of about six seconds each in length. Four clips were repeated and selected at random to check for consistency and two practice trials were also included to make sure the participant understood the task at hand, bringing the total to 30 video clips.

3.4 Procedure

Ethical approval was obtained from School of Psychology Ethics Committee prior to commencement of the experiment. Participants were recruited through advertising posters on the notice boards around The University of Waikato's, Hamilton campus, a local boy's High School and through word of mouth. All participants were recruited and tested within an eight week period. Participants that volunteered for the experiment were contacted via email and arrangements were made for them to attend the laboratory for the 1.5 hour experimental session (See Appendix B). Participants filled in a consent form after it was explained to them the procedure of the experiment, that it was completely anonymous and they could pull out of the experiment at any time. Participants were assigned a number and this determined the order in which they completed the tasks. Half the participants began with the demographic and psychometric questionnaire, followed by the hazard perception test and the speed choice task. The remaining participants began the hazard perception test and speed choice tasks first, followed by the psychometric testing. The questionnaire required participants to fill out the Demographics form, which recorded information, such as age and gender. All participants completed the questionnaires, the hazard perception test and the speed choice task in an identical manner as described in the measures section.

After debriefing, the Hazard Perception Dual task was performed by participants seated in the lazy boy chair in front of the television screen (seen in Figure 3.1). The task was explained to the participant and a practice trial was presented. This trial could be repeated until the experimenter was satisfied with their performance. After the practice trial, eight video clips were shown to the participant where they had to identify all hazards by clicking the mouse button and verbally identifying the hazards, while concurrently carrying out the secondary tracking task.

The Video Speed Choice task was then carried out in the same chair and television screen (Figure 3.1). Participants were told how to carry out the task and they then completed two practice trials to ensure their comprehension of the task was satisfactory. After two trials, 28 video clips of six seconds each were shown to the participant, and after each one they had to answer the two questions (Figure 3.3) using the computer mouse. Between the two video clips, there was a three second countdown to help prepare the participant for the subsequent trial. The process was identical for all trials.

At the conclusion of the experiment, participants were given an informal questionnaire by the researcher, which consisted of a list of specific questions, along with impromptu questions regarding the participants own experience. They were able to mention any issues encountered while participating. Examples of questions include those such as “do you think that the tasks represented real world driving experience”, “are there any changes you believe we could make to the current experiment in the future”. Participants were thanked for their time and effort in taking part. They were given a 2% course credit form if they were a first year psychology student or a $10 MTA voucher if they were not a student. Participants were told that they would be debriefed at a later date when a summary of the research findings could be emailed to them if they wished to find out more about the outcome of the experiment.

4. Results

All 48 participants in the four groups (Young Novice, Advanced Novice, Young Experienced and Older Experienced) completed all parts of the experiment and provided complete sets of data for all tests and questionnaires.

4.1 Driving History

As expected, the Older Experienced group had greater driving experience than any of the other groups (see Table 1). The older the group (with more driving experience) was, the greater distance they travelled each week. The lowest number of kilometers was driven by the Young Novice driver group. Advanced Novice group were driving more kilometers than the Young Experienced drivers, and the greatest distance travelled was revealed by the Older Experienced drivers. Consistent with previous research, was the finding that the Advanced Novice drivers experienced the highest crash involvement, which supported the fact that 'solo driving', seems to be the most vulnerable time period for these drivers. The Young Experienced and Older Experienced drivers experienced crashes at the same rate. The Young Novice drivers had very few, if any near misses which is consistent with not having had any crashes, as well as the fact that they drove very little compared to all the other age groups (Table 1). The Advanced Novice group had a moderate number of near misses, which again could due to the vulnerable solo period of driving, in that they no longer are required to have a supervisor present. The Young Experienced drivers showed a smaller number of near misses compared to the Advanced Novice; however, the Older Experienced drivers had the highest number of total near misses altogether.

Table 1

Driving History

Driver Group	Driving Experience (Years)		Distance Travelled Each Week (km)		Crash Involvement in the Last 12 months		Total Near Misses in the Last 12 months	
	Mean (M)	Standard Deviation (SD)	M	SD	M	SD	M	SD
Young Novice	0.17	0.58	22.75	31.11	0	0	0.25	0.62
Advanced Novice	1.71	1.05	123.33	125.58	0.33	0.49	2.23	2.52
Young Experienced	6.42	1.73	115.0	125.64	0.25	0.45	1.42	1.51
Older Experienced	22.5	9.41	148.33	124.54	0.25	0.62	6.25	11.94

4.2. The Effect of Driver Age/Experience on Hazard Perception Ability

Figure 4.1 shows the mean total number of hazards detected for each of the four driver groups. The figure reveals that age/driving experience had a clear effect on the number of hazards the drivers detected with the greatest number of hazards detected by the Older Experienced group and the least number of hazards detected by the Young Novice group. A one-way ANOVA performed for the four groups on the total number of hazards detected revealed a statistically significant result, $F(3,44)= 3.376$, $p>0.5$. Bonferroni post-hoc tests revealed that the difference in regard to the number of hazards detected lay between the Young Novice and the Older Experienced groups.

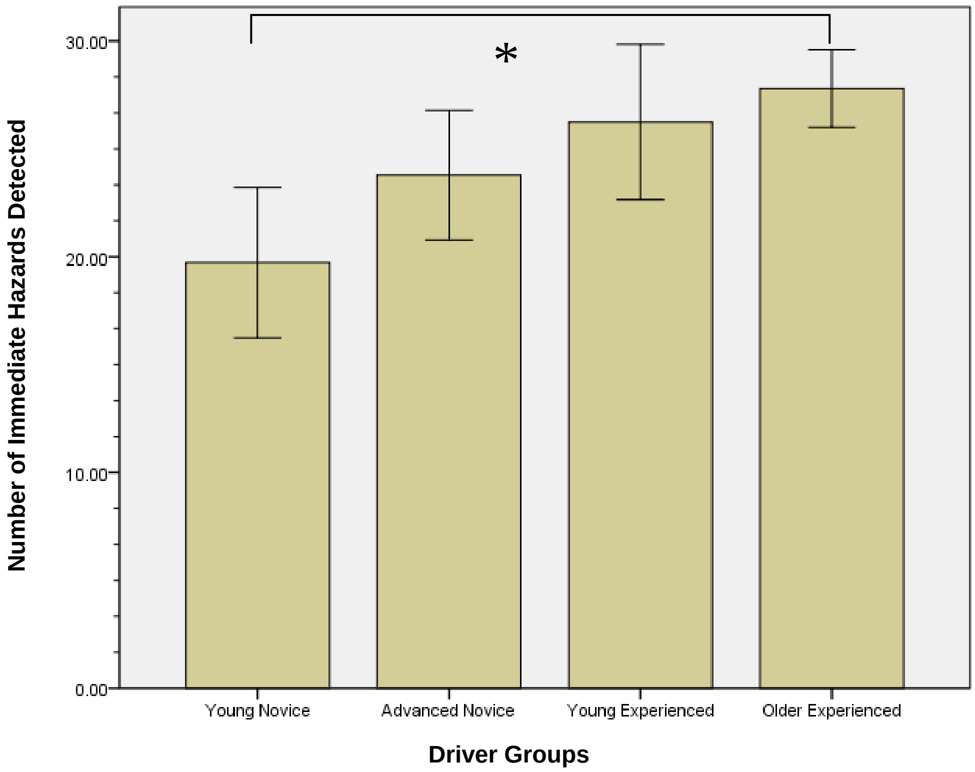


Figure 4. 1: Mean total Number of Immediate Hazards detected, by driver groups, the error bars denote 95 % confidence intervals, *= p<0.05

Figure 4.2 shows the effect of age/driving experience on the hazard perception reaction time. The figure reveals that the least experienced drivers, the Young Novice group, took the longest to identify the hazards, followed by the Advanced Novice, Young Experienced and finally the Older Experienced, who had the fastest hazard perception times. A further one-way ANOVA on the hazard perception time confirmed that there were statistically significant differences between the four driving groups, $F(3,44)= 3.38$, $p<0.05$, with Bonferroni Post-Hoc Tests revealing that these differences were between Young Novice and Experienced Novice groups, ($p<0.05$), and the Young Novice and Older Experienced driver groups, ($p<0.01$). This shows that experienced drivers had faster hazard perception times than less experienced drivers.

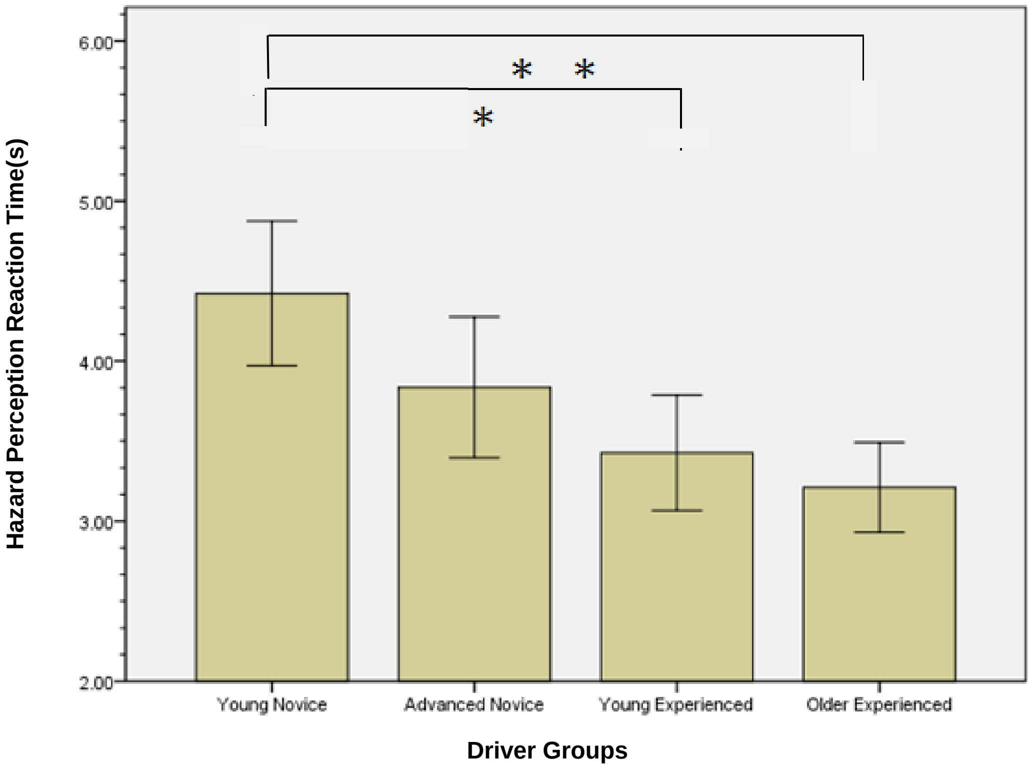


Figure 4.2: Mean Hazard Perception Time, by driver groups, error bars denote 95 % confidence intervals, *= p<0.05, **= p<0.01

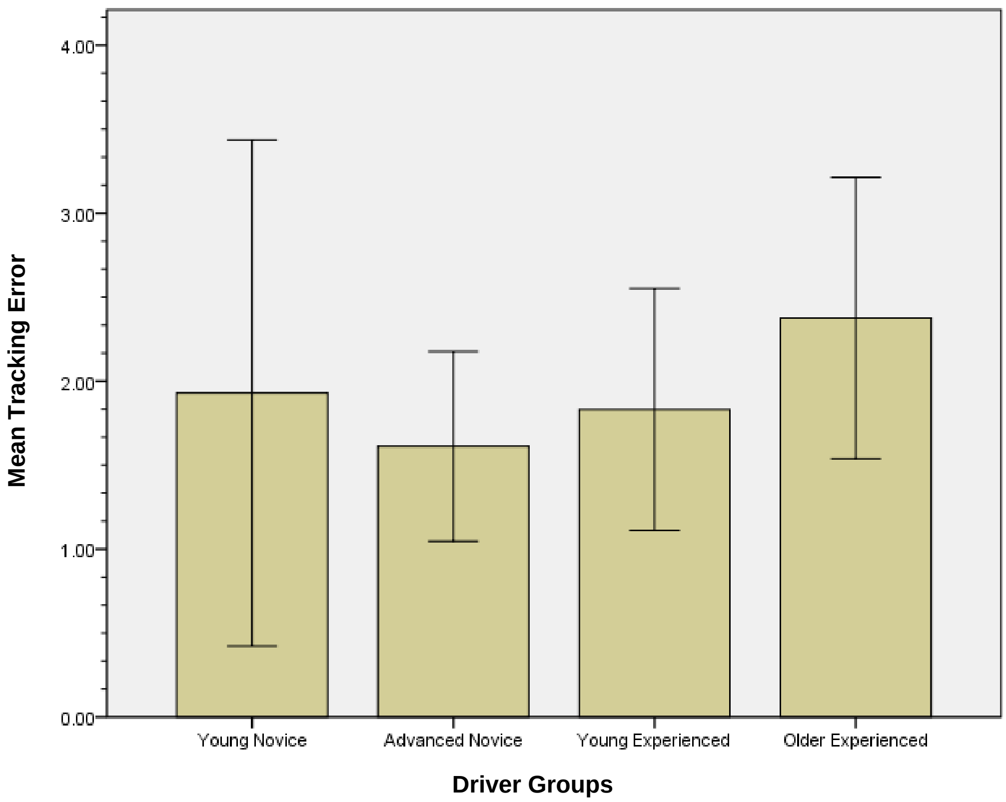


Figure 4.3: Mean total Number of Tracking Errors, by driver groups, error bars denote 95 % confidence intervals

The graph for the mean number of tracking errors f (see Figure 4.3) shows that the Older Experienced drivers produced the greatest number of tracking errors, followed by the Young Novice drivers. However, the Young Novice drivers produced a lot of variability the data, with large 95% confidence intervals. The Advanced Novice and Young Experienced drivers produced the least tracking errors. There were no significant differences in tracking errors between the groups, $F(3,44)= 2.11$, $p>0.05$), and no further post hoc tests were performed.

4.3 The Effect of Driver Age/Experience on Speed Choice

The Video Speed Choice task (VST) provided a laboratory-based speed choice measure for driving on different road conditions (rural and urban, wet and dry, and day and night). Some of the speed choice trials were repeated and these trials showed a high consistency of speed choices.

4.3.1. Speed Estimations for Urban Roads in Day and Night Conditions

The speed estimation data was analysed first for the urban roads during day and night driving conditions. As can be seen in Figure 4.9, all driver groups overestimated the driven speeds on the urban road for both day and night driving conditions. The Young Novice drivers estimated the speeds at night to be at the speed limit. Speeds in general were estimated to be higher at night than during the day (Figure 4.9). This is seen to be the case for all age groups and the speeds were all overestimated. When comparing the speed estimates for each level of driver experience, it is obvious that for both day and night conditions, the greater the level of experience of the drivers, the higher the estimated speed. The speed estimates for the three groups during the day condition were analysed using a one-way ANOVA, which was significant, $F(3,44)= 4.84$, $p<0.05$), with Bonferroni post hoc-tests revealing a difference between the Young Novice and Older

Experienced groups (p<0.05). The corresponding speed estimates during the night conditions were analysed using another one-way ANOVA which was also significant, ($F(3,44)= 6.663$, $p>0.05$), with Bonferronni post-hoc tests indicating differences between Young Novice and Young Experienced drivers ($p<0.05$), as well as between Young Novice and Older Experienced drivers ($p<0.01$).

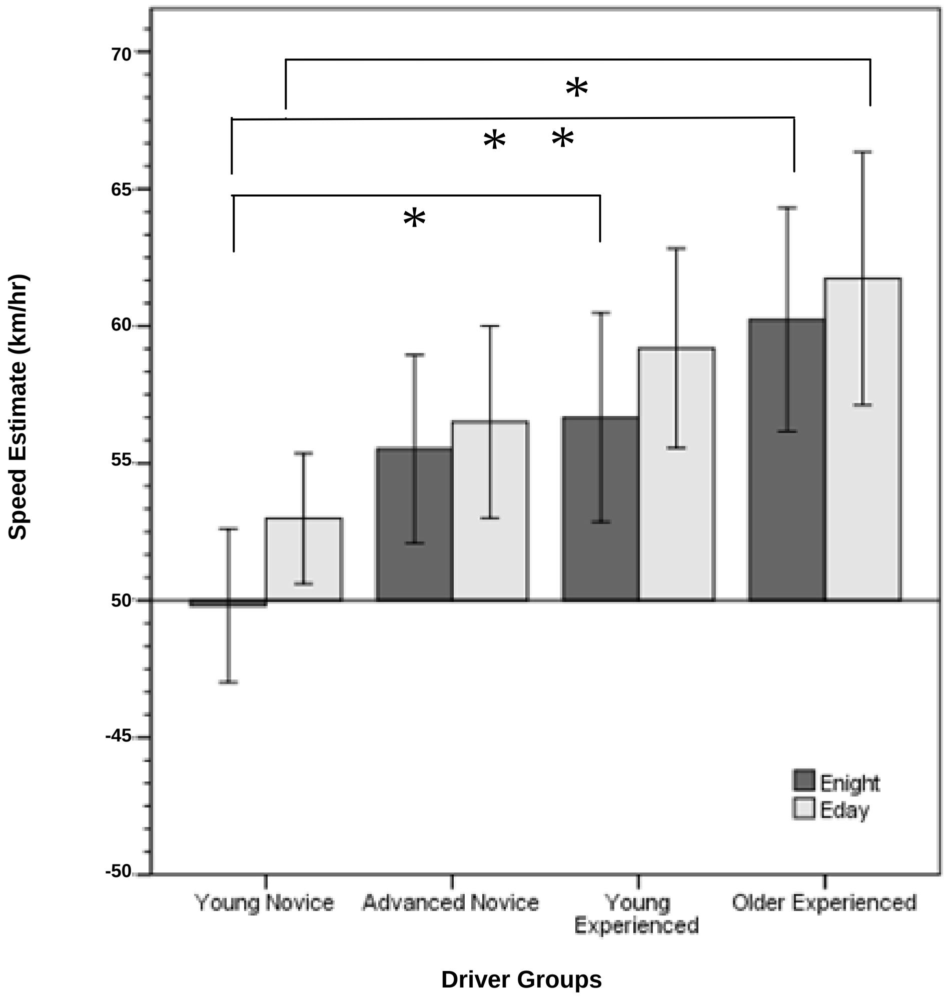


Figure 4.4: Mean Speed Estimates for the urban roads during day and night driving in relation to the speed limit (50 km/h) by driver groups, the error bars denote 95 % Confidence intervals, *=p< 0.05, **=p< 0.01.

4.3.2. Speed Estimates for Rural Roads in Wet and Dry Conditions

For the wet and dry conditions on rural roads, the Older Experienced drivers tended to overestimate the speeds, whereas Young Novice drivers tended to underestimate their speed choice (Figure 4.4). The Young Novice drivers underestimated the speed, while all other age groups overestimated the speed for both dry and wet conditions. Advanced Novice and Young Experienced drivers overestimated their speed estimates in both conditions. For the dry condition, the speed estimates of the three groups were further analysed using a one-way ANOVA, which was significant, $F(3,44) = 5.92$, $p<0.05$. Bonferonni tests displayed significant differences between Young Novice and Older Experienced, $p<0.05$, as well as between Young Experienced and Older Experienced, ($p<0.05$) for dry conditions. The corresponding speed estimates for the wet condition were analysed using a further one-way ANOVA, $F(3,44) = 2.39$, $p>0.05$, showing no significance ($p>0.05$).

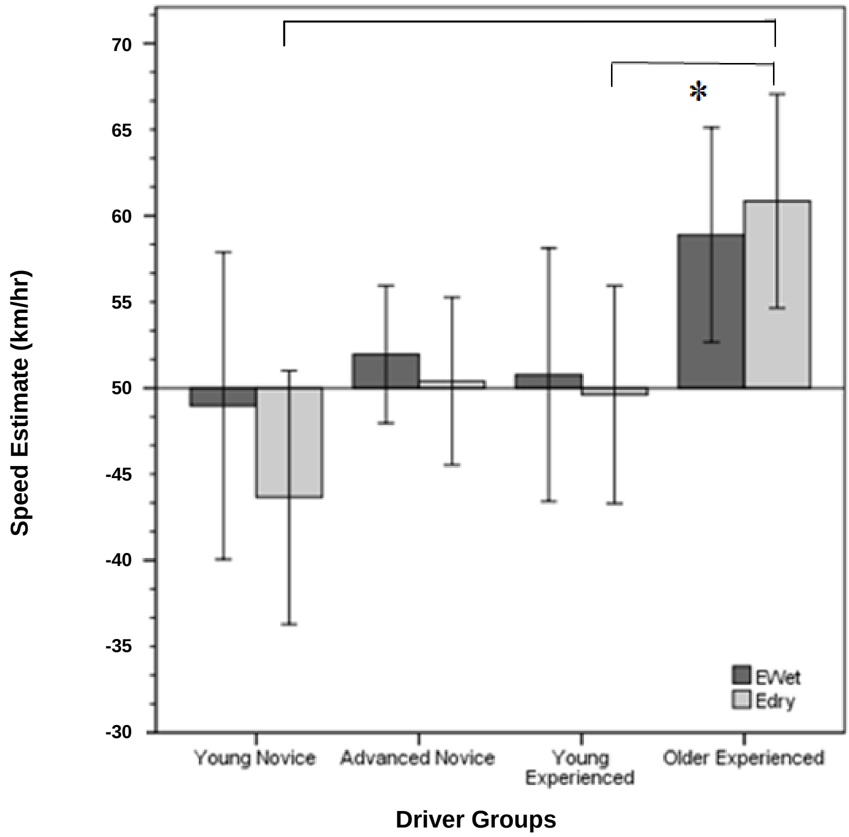


Figure 4.5: Mean Speed Estimates in relation to the speed limit, for the rural roads during wet and dry conditions, by driver groups, error bars denote 95% confidence intervals, *=p<0.05.

4.3.3. Speed Preferences for Urban Roads in Day and Night Conditions

From Figure 4.6, it can be seen that all drivers have chosen slower speeds for the night driving condition compared to the day driving condition. When comparing the speeds chosen for each level of driving experience, the Young Novice drivers chose slower speeds than the Advanced Novice drivers. The Advanced Novice group chose lower preferred speeds than the Young Experienced group, who chose lower preferred speeds than the Older Experienced group. Day-time speeds for the four groups were further analysed using a one-way ANOVA, which was significant, $F(3,44)= 3.45$, $p<0.05$. Post-Hoc Bonferroni tests revealed that the significant speed choice difference was between the Young Novice and Young

Experienced drivers (p<0.05). Corresponding night-time speeds were analysed for the driving groups, using another one-way ANOVA, showing no significance, F(3,44)= 3.99, p>0.05.

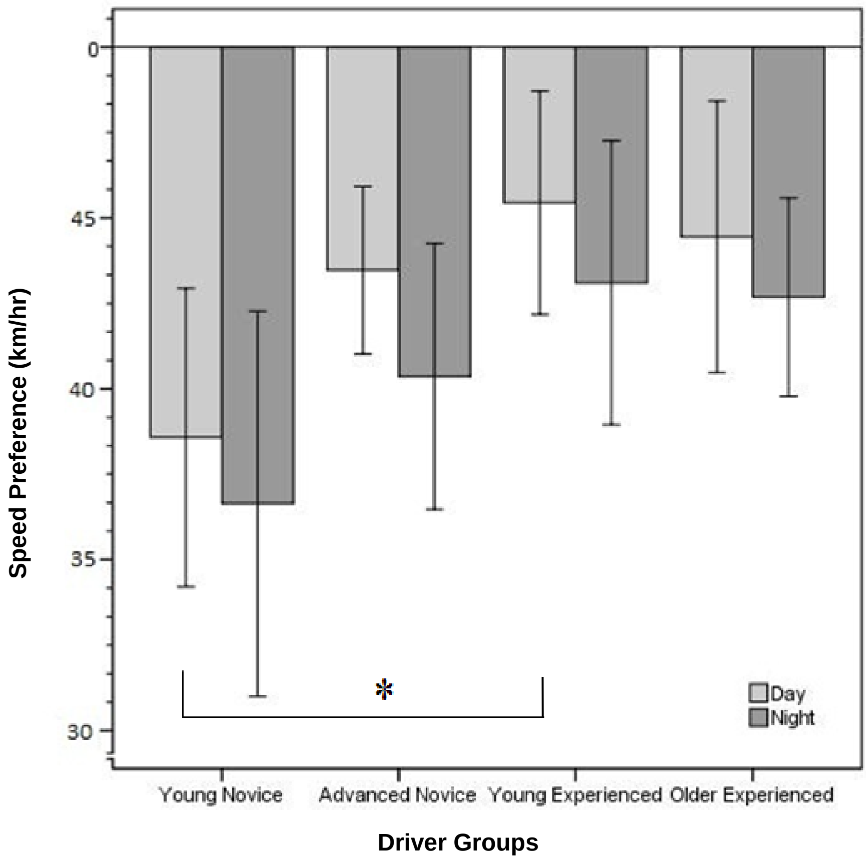


Figure 4.6: Mean Speed Estimates in relation to the speed limit 50km, for the urban roads during day and night conditions, by driver groups, error bars denote 95% confidence intervals, *=p<0.05.

4.3.4. Speed Preferences for Rural Roads in Wet and Dry Conditions

From Figure 4.7, it can be seen that all drivers have chosen slower speeds for the wet driving condition compared to the dry condition. When comparing the speeds chosen for each level of driving experience, the Young Novice drivers again chose slower speeds than the Advanced Novice drivers. The Older Experienced group chose the faster speeds during the wet and dry conditions; however, none of these differences were supported by two separate one-way ANOVAs, first for the wet condition, $F(3,44)= 2.53$, $p>0.05$ and then for the dry condition, $F(3,44)= 5.26$, $p>0.05$.

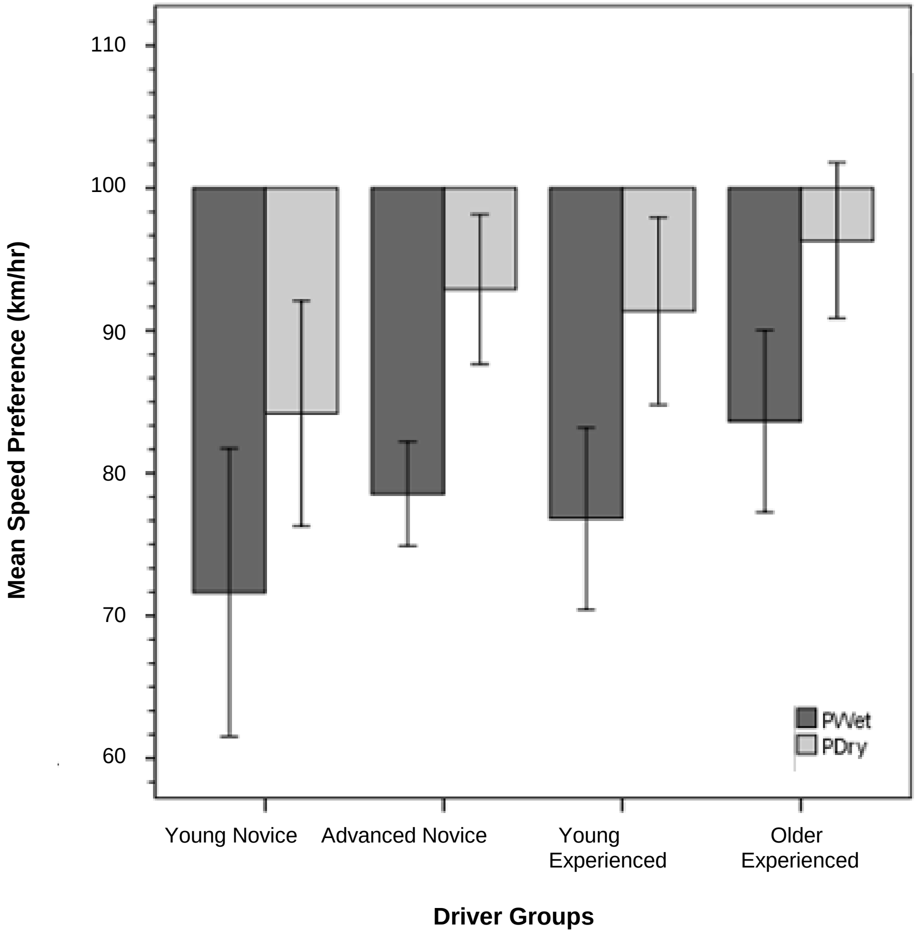


Figure 4.7 Mean Speed Preferences in relation to the speed limit (100km), for the urban roads during day and night conditions, by driver groups, error bars denote 95% confidence intervals.

4.4 The relationship between hazard perception and speed choice

In order to examine whether there is a link between the number of hazards the drivers in the four groups detected and their speed choice, all speed choice preference data (urban night and day) and rural (wet and dry) were converted into Z-scores. The total Z-scores were then plotted against the number of immediate hazards detected (Figure 4.7). The graph shows that the majority scores of the Older Experienced drivers are on the right hand side of the graph, indicating that they identified a greater number of hazards (than any of the other groups).

Whereas the scores of the Young Novice drivers are mainly on the left hand side, indicating that they identified fewer hazards. The scores of the other two driver groups seem to be distributed randomly throughout the scatterplot. The Pearson product-moment correlation coefficient revealed no statistically significant relationship between the two performance variables, the number of immediate hazards detected the speed choices (r= 0.201, n= 48, p>0.05).

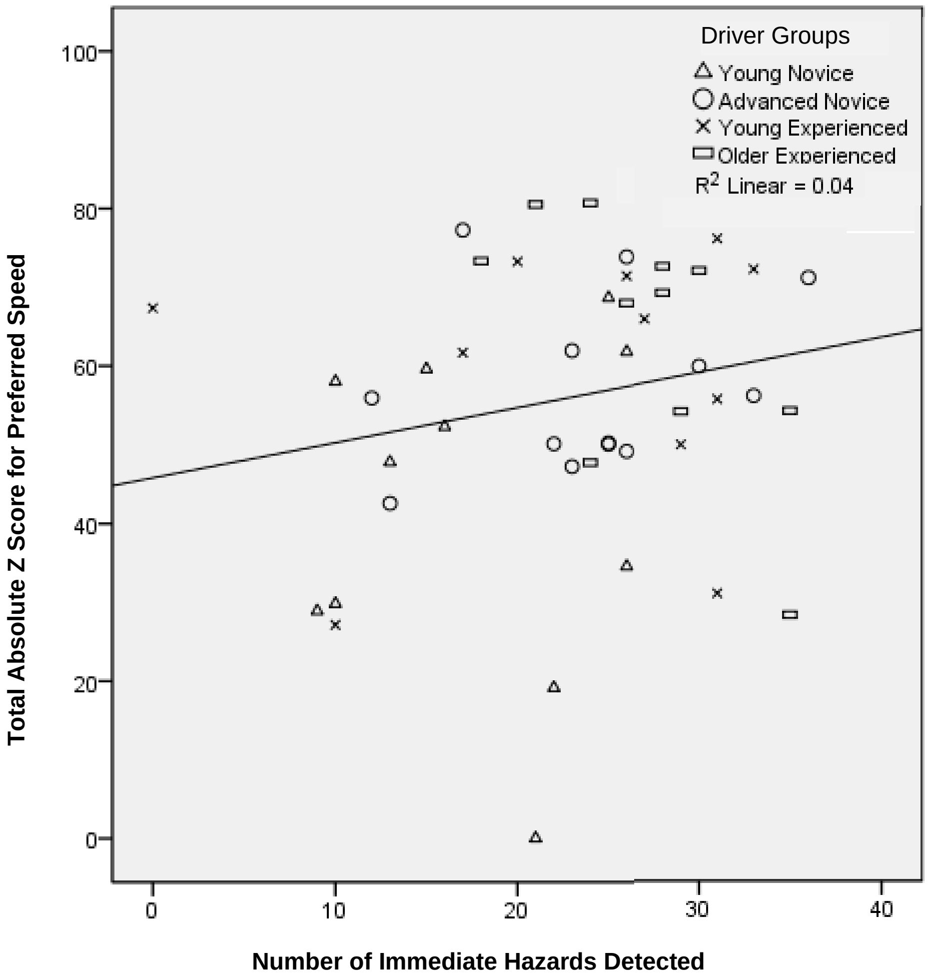


Figure 4.8: Scatterplot of Total Absolute Z scores for Preferred Speed and Total Number of Immediate Hazards detected for all drivers in the four driver groups, error bars denote 95 % confidence interval, *=p<0.05.

5. Discussion

The first question investigated was whether age and experience play a role in hazard perception. There was clear evidence to suggest that Older Experienced drivers are more advanced with their hazard perception techniques compared to Young Novice, Advanced Novice and Young Experienced drivers. The second research question investigated the influence of age and experience on speed choice. This influence was evident through the examination of speed estimation and speed preference in numerous conditions, including day and night, wet and dry, and rural and urban roads. It was hypothesised that Older Experienced drivers would select more appropriate, slower speeds, and that their selection would generally be lower than the younger drivers, who would most likely choose higher, inappropriate speeds. However, this was not the case for estimated or preferred speeds, with higher speeds being preferred by Older Experienced drivers compared to Young Experienced drivers. In addition, Older Experienced drivers were said to overestimate their speeds, while Young Novice drivers underestimated driving speeds, believing they were travelling slower. The third and final question investigated the relationship between hazard perception and speed choice, where no relationship was found.

5.1. Discussion of Research Questions

Findings from the current study revealed that Younger Novice drivers had slower average hazard perception reaction times and detected fewer immediate hazards compared to Older Experienced drivers, while Advanced Novice and Young Experienced drivers' performance lay between these two. Tracking errors and tracking error time(s) did not reach statistical significance; however, there was a clear trend indicating that the greatest number of tracking errors was among the

Older Experienced group, followed by the Young Novice group. These results support the concept that age and experience play a crucial role in hazard perception, consistent with prior literature, such as Mayhew et al., (2003) and Lewis-Evans (2010). Those that are younger (between 15 and 25 years) and in the Young Novice, Advanced Novice, Young Experienced are not as adept at hazard perception as drivers that are older (ranging between 26 and 60 years old) in the Older Experienced age group. These findings are also in keeping with Grayson and Sexton (2002), Horswill and McKenna (2004) and Matthews and Moran (1986).

According to Horswill and McKenna (2004), differences between Novice (Young and Advanced) and Experienced (Young Experienced and Older Experienced) drivers may occur not only due to novice driver's poor hazard perception skills, but also their being less willing to label situations as hazardous than the experienced drivers (Horswill & McKenna, 2004; Isler, et al., 2009). Drivers who are more likely to label situations as hazardous are often safer drivers, independent of their skill level (Horswill & McKenna, 2004).

Several theories have been developed to explain poorer hazard perception skills in younger drivers. Keating (2007) suggests that differences between novice and experienced drivers are not the result of misclassification of hazards, rather that novices are only responding to the most hazardous of situations. They found that novices respond more slowly to less hazardous scenes because they only notice the hazards when anticipatory cues become more conspicuous. Novices are slower to build up evidence of potential danger; therefore, as seen in the current experiment, their reaction times are slower, with Young Novice and Advanced

Novice drivers having the slowest average response times. Thus, they can interpret hazardous situations the same as Experienced drivers, but are less willing to label situations as hazardous, as mentioned previously (Isler, et al., 2009; Wallis and Horswill, 2007). In the current experiment, the Older Experienced drivers were more likely to assess situations as hazardous and had better situation awareness, an ability to read the road (Kuiken & Twisk, 2001). Therefore, differences in hazard perception are seen as differences in what is defined as a hazard, rather than differences in predicting the hazard. This may be partly due to Young drivers not having experienced as broad a range of traffic scenarios as experienced drivers. They are also more likely to be inexperienced at important vehicle control tasks, such as steering and directional control of their vehicle (Matthews & Moran 1986). Matthews and Moran (1986) believe while young drivers' reflexes are quicker, they take longer to respond to and perceive possibly precarious traffic situations.

Underwood, Chapman, Bowden, and Crundall (2002) further support the poor hazard perception in younger drivers and suggest hazard perception (a higher order task) may be in competition with other driving related tasks, such as steering and gear changing which are physical driving skills. This was evident in the current experiment, because if there were many tracking errors (simulated to steering), fewer hazards were detected. On the road, this would be equivalent to the inability to combine mental workload and cognitive load in order to identify hazards while undertaking the task of controlling the vehicle (McKenna & Crick, 1997; Underwood, 2007). It would be expected that Older Experienced drivers would be better at hazard perception, as they have mastered physical driving skills, so no longer require as much attention to be focused on the driving task.

Thus, the driving task has become automated (Underwood, et al., 2002). This was reflected in the current experiment by the Older Experienced drivers having better driving skills and faster reaction times than other groups. With greater driving experience, such as that of the Young Experienced and Older Experienced drivers in this study, less cognitive resources are required to perform efficient hazard perception (Horswill and McKenna 2004).

Another reason for poor hazard perception in younger drivers may be due to their less developed eye scanning skills as discussed in the introduction (Crundall & Underwood, 1998). Novice drivers may master the physical driving skills effectively, but they are said to use less proficient information gathering techniques when searching for hazards whilst driving. However, with experience, visual searching strategies improve (Borrowsky et al., 2010; Crundall and Underwood, 1998; Deery, 1999; Huestegge, Skottke, Anders, Musseler, and Debus, 2010; Kuiken and Twisk, 2001; Underwood, et al., 2002; Wallis and Horswill, 2007).

Underwood (2007) has suggested that poor hazard perception skills are due to poor mental models that Novice drivers have gained through primarily being the passenger of the vehicle, not the driver. With greater experience, as the driver (not passenger), it would be expected there would be more advanced mental models of driving environments; hence hazard perception and detection would improve. According to Deery (1999), hazard perception is related to driving skill as well as the subjective experience of the driver. Further, novice drivers seem to be unprepared for changes in driving environments, whereas more experienced drivers are able to adapt to different driving conditions. Experienced drivers have more advanced scripts and schematas of driving environments and situations and so they are able to adapt to changes in these accordingly. Deery (1999) suggests that novice drivers assess traffic situations on single characteristics, while experienced drivers assess information on numerous characteristics, which they use to determine the degree of potential risk. With experience, drivers are more holistic in their judgement of hazardous situations. Young Novice drivers are very limited in the situations they have experienced, hence when presented with an unfamiliar situation, they have trouble with higher order skills, such as hazard perception.

The second aim of the study focused on the relationship between age, experience and speed choice under different driving conditions. The purpose of this stage of the study was to investigate whether the conditions of wet/dry, day/night and rural/urban yielded significant differences in terms of the estimation of speeds across these conditions. Comparing the speed estimates made by drivers with different levels of experience showed that for each of the conditions, the lowest estimates were made by the Young Novice, followed by the Advanced Novice, Young Experienced and Older Experienced drivers. Higher speeds were estimated during the day compared to speeds at night. Young Novice drivers were more likely to underestimate their speed, while Older Experienced drivers were more likely to overestimate their speed for the majority of road conditions.

In terms of speed preference results, Younger Novice drivers preferred slower speeds than all other experienced groups. In addition, lower speeds were preferred for night-time and wet conditions. This finding that younger drivers underestimate their speeds and prefer lower speeds, and older drivers overestimate their speeds preferring higher speeds concurs with some literature, such as Cestac, Paran, and Delhomme (2011) and Fildes et al., (1991); however, disagrees with other literature, such as Stradling et al., (2003) and Cantwell (2010).

Current results also differed from Cantwell's (2010) research where it was found that Young Inexperienced drivers preferred significantly faster speeds than Older Experienced drivers (Cantwell, 2010). In Cantwell's (2010) research, Young Inexperienced drivers were more likely to choose faster speeds than the road speed limit. It was found that 40% of the Young Inexperienced drivers preferred speeds that were greater than the road limit, with the majority being male (5 male, 2 female). Older Experienced drivers preferred speeds that were below the speed limit, with none of the drivers selecting speeds that were greater than the speed limit for any given road (Cantwell, 2010). In terms of speed estimation, Young Inexperienced drivers had an overall mean total overestimate of 10.1km/h, with Older Experienced drivers overestimating the speed by 8.1km/hr, which demonstrates that both driver groups were prone to overestimate the speed of the vehicle shown in the video footage. Therefore, the overestimation by Older Experienced drivers in the current experiment is consistent with Cantwell's (2010) experienced drivers, but not for the Young Novice group.

One explanation for these findings relates to the sample of young drivers. They were recruited from a high decile local school which places a lot of emphasis on community involvement, and the students are actively involved in driver education programmes as part of their life skills curriculum; this may have raised their awareness of appropriate speed choice. In addition, experimenter expectancy effects may also play a role, with the students responding in a manner which would be fitting for what would be expected of them, as opposed to admitting the speeds they would actually travel in real world environments. The need to please the experimenter is known as socially desirable responding, and is a self presentational bias (Sundstrom, 2008; Elliot et al., 2005). In the current experiment, this can be referred to as impression management, defined as "the deliberate tendency to give favourable self descriptions to others" (Sundstrom, 2008). This is a limitation of the study that must be addressed in future studies, perhaps by recruiting a more representative sample of participants from a wider range of schools with varying decile ratings.

There is some evidence to suggest that unsafe driving behaviours, such as driving after drinking, not using a seat belt, and speeding behaviour, are carried out more frequently by those in low income brackets; that is, there is a negative relationship between income levels and safe driving behaviours (Zhao, Changxu, Houston & Creager, 2010, Males, 2009).

It has been found that in general, drivers are poor at estimating and controlling their speed (Hellier, Naweed, Walker, Husband & Edworthy, 2011), and the overestimation in speeds and preference for higher speeds by Older Experienced males can perhaps be explained in several ways. This is supported by Cestac et al. (2011) and Fildes et al. (1991) who recognized that some drivers will speed, regardless of their level of experience. Cestac, et al. (2011), found that speeding intention increased with driving experience, with drivers who were more experienced being more likely to speed. It was also identified that those who travel greater distances per week, drive at faster speeds than those who drive shorter distances (Fildes et al., 1991). In the current experiment, Older

Experienced drivers drove far greater distances each week, as reported in their demographic responding; this may partially explain their preference for higher speeds.

A further reason for more experienced drivers being more likely to speed is perhaps due to the fact that few experiences of speeding had been associated with negative consequences (Cestac et al., 2011). That is, failure to escape repercussions can result in complacency, and in some cases, even serves as reinforcement for the behaviour in the future (Cestac et al., 2011). Prabhakharan & Molesworth (2011) refer to these failures to escape repercussions for speeding as ‘faulty scripts’. Scripts (or event schematas) are cognitive structures that contain information about an event; for example, common scenes, or sequences common to a particular kind of experience, and these scripts are used by experts in decision making circumstances. When an expert is in a new situation they come to the solution by comparing it to existing scripts which they have gained through experience (Prabhakharan & Molesworth, 2011). One of the most effective and common ways to develop scripts is through personal experience, and in a speeding drivers’ case, scripts are developed through failure to experience an accident or receive a ticket for speeding, or social acceptance of speeding. Hence, the Older Experienced drivers that are selecting higher speeds, may in fact have faulty scripts, which in turn leads them to select higher speeds (Prabhakharan & Molesworth, 2011).

A further reason for the overestimation of speeds in Older Experienced drivers could be the lack of acoustic cues (Horswill & McKenna, 1999; Hellier et al., 2011). According to Hellier, et al. (2011), “there is a growing body of research which suggests that auditory feedback plays a major part in the ability of a driver to make judgements about speed and speed choices" (p. 592) . Acoustic cues such as the noise of the car, changes in acceleration, or gear changes, can provide auditory cues which the driver interprets as to what speed they are travelling, and many people rely solely on them (Hellier et al., 2011). Horswill and McKenna (1999a) found that auditory cues influence drivers' ability to judge speeds accurately. They found that most drivers do not look at their speedometer regularly, however they do use the "feel" of the vehicle in order to estimate speeds. Those that had quieter internal car noise chose to drive faster than those who received louder internal car noises, suggesting the noise of the car is highly relevant to the individual's judgement of speed. Consequently, the current study may have been limited by the fact that drivers could not accurately judge the "feel" of the vehicle, which could lead to some inaccuracies in responding. Older Experienced drivers, who have had a lot of driving experience in terms of driving more kilometres per week (as shown on the demographic questionnaire) may have been more used to hearing engine noise, and using it as a gauge, therefore no engine noises in the current experiment may have led to increased speeds selected by this age group. In contrast, those novice drivers who chose slower speeds, drove less per week and were less likely to be accustomed to the engine noises of the car.

The next part of the study into the relationship between age and experience and speed choice investigates the influence of differing road conditions on speed choice. Higher speeds were estimated during the day compared to speeds at night by all experience levels. During day-time conditions, faster preferred speeds were selected when compared to night-time conditions, and wet conditions produced slower speeds than dry conditions.

Time of Day and Speed Choice

Time of day is a significant factor that can alter driver's choice of speed and in turn have an impact on crash rates. Most fatal crashes occur at night, compared with day-time hours (Ministry of Transport, 2009, 2010a; Ferguson, 2003). The Ministry of Transport Report (2009) states that the highest number of crashes occur in the evening (between 6 pm – 10 pm), and at night on Saturdays and Sundays, with 49-50% occurring in the evening on Saturdays and Sundays. According to Konstantopoulos, Chapman and Crundall (2010), the risk of a fatal crash is increased by four times when driving at night compared to day-time. Between 2006 and 2008, 50% of fatal crashes that occurred on Friday and Saturday nights involved a young driver, as opposed to 28% of day-time crashes involving a young driver (Ministry of Transport, 2009, 2010a). The time of day is an important factor in driving safety, as the reduced light may affect the driver's ability to see. Also, during night-time there are fewer cues on which to base speed choice, resulting in the misjudgement of speed (New Zealand Transport Authority, 2011; Ferguson, 2003) and this together with reduced visibility in night-time conditions, and poor speed judgements, result in an increase in the number of crashes between these hours. These reasons all support the findings that slower estimated and preferred speeds were chosen for night-time conditions.

A study in Sweden by Norrish (1991) cited in ACC & LTSA (2000) reported that speeds are higher during the day-time than night-time, and drivers 'perceptions' of speed differ during day-time and night-time driving. The higher rate of accidents during night-time driving may be due to reduced visual acuity and a decrease in the amount of cues which drivers have available on which to judge speed (ACC & LTSA 2000). The need for lower speeds at night is further explained by Elvik (2010), who reports that due to high travelling speed, stopping distance is not sufficient for drivers to avoid hazardous situations they may find themselves in at night, when dipped headlights are used. Time of day is evidence of a significant factor in terms of speed choice. This factor may have an impact on visibility for certain drivers with fewer cues present to judge speed, or it may be related to the traffic density on the road. In this research, preferred and estimated speeds both display underestimation during night-time conditions, consistent with prior research.

Weather and speed choice

The current study suggests that for speed estimates, wet weather produced higher speed choice than the actual speed being travelled. For preferred speeds, wet weather conditions involved drivers selecting much lower preferred speeds than the actual. Weather is an important condition that affects speed choice and Goldenbeld and van Schagen (2007) suggest that drivers view the legal speed limit for roads as being able to be exceeded if traffic and weather conditions allow (New Zealand Transport Agency, 2011). In worsening weather conditions such as rain, snow, windy conditions, bright sunlight and reduced visibility, such as fog, speeds should be decreased in order to allow the driver to cope with the new difficulty the weather environment provides (ACC & LTSA 2000; Goldenbeld & van Schagen, 2007; Konstantopoulos, et al., 2010). Drivers must be aware of the hazardous weather conditions and slow down to the appropriate speed; for example, in rain, snow and ice, the stopping distance is longer; therefore, travelling distance between cars should be increased and combined with a reduction in speed (New Zealand Transport Agency, 2011). Weather conditions which require speed judgements from the driver in order to keep them safe include fog, windy weather and sunstrike. These conditions, and rain, which reduces visibility, result in a need for slower speeds (New Zealand Transport Agency, 2011; Brooks et al., 2011). There is an increased risk of crashing in wet weather compared to dry weather, and in one meta-analysis, it was found that in rain crash rates increased up to 71% (Konstantopoulos, et al., 2010). Preferred speeds being lower in wet conditions is clearly supported by the literature.

Rural and Urban areas and speed choice

For speed estimates, slower estimates than the actual travelling speed were made in rural areas compared with urban areas, while for speed preferences, slower speeds were adopted in rural areas compared with urban areas. This is inconsistent with the research, which suggests that urban areas produce slower speeds compared to the actual travelling speed. Problems within urban areas are high traffic densities and high levels of hazards, such as pedestrians or vehicles exiting streets or driveways (ACC & LTSA, 2000). Traffic accidents occur predominantly in urban environments, according to Archer, Fotheringham, Symmons, and Corben (2008), with the most frequently occurring crashes in urban areas involving a pedestrian crossing the road (ACC & LTSA, 2000). These areas have a high density of traffic, in addition to pedestrians, intersections, roundabouts, traffic lights and many other potential hazards the driver must consider when selecting their appropriate speed. In 2009, speeding was a factor in 29% of urban crashes (Ministry of Transport, 2010a).

Research such as that by Poulter and McKenna (2007), illustrates that non conformity with the speed limits in urban areas is universally high, which supports the findings of higher speed preferences on urban roads. Reduction of speeds in urban areas could lead to a significant decrease in crash rates, with an added advantage that there may also be a reduction in fuel use, thus reducing environmental impacts such as emissions and noise pollution (Archer et al., 2008). In Australia, certain urban areas had their speed reduced from 60km/hr to 50km/hr, which resulted in a considerable reduction in crashes and fatalities (Archer et al., 2008).

Rural areas consist of low density housing and often run through farming areas, generally being set to speeds between 70 and 100km/hr (ACC & LTSA, 2000). Despite traffic density being generally lower, rural roads have the problem of wandering stock, which may cause crashes that are worsened by higher speeds (ACC & LTSA, 2000). Also, due to the high speed zones in rural areas, there is more overtaking and hence speeding (ACC & LTSA 2000), and these overtaking manoeuvres on rural roads result in an increase in speed and an increase in crash risk (ACC & LTSA 2000). Speeding played a greater role in crashes in rural areas between 2007 and 2009, and made up 24% of the total fatal crashes, compared to 8% in urban areas. This is consistent with the selection of lower speeds in rural areas in the current experiment (Ministry of Transport, 2010a) and is supported by the estimates in the current study of lower speed estimates in rural areas. This is also supported by the Ministry of Transport (2009) research report, which states rural areas account for a higher proportion of crashes in young drivers than urban areas (Ministry of Transport, 2009).

The third and final aim of the thesis was to investigate the relationship between hazard perception and speed choice. Only a very weak relationship was found, which differs from previous findings e.g. McKenna et al (2006).

Like other aspects of driving, hazard perception is impaired when speed is involved, as a reduced hazard perception ability can result in inappropriate speed choice and speeding. Hazard perception skills are decreased at increasing speeds, due to the driver having less time to detect and respond to hazards appropriately, which positions them at greater risk of crashing and increases the severity of crashes that do occur (ACC & LTSA, 2000). Kuiken and Twisk (2001) state that, "hazard perception training improves hazard perception skills while decreasing risk taking propensity", and as speeding is a form of risk taking, they appear to indeed be related (Kuiken & Twisk, 2001).

The link between hazard perception and speed choice can be viewed in research such as McKenna et al. (2006). Their research used three separate experiments to investigate whether anticipation training in the form of hazard perception affected drivers' risk taking (McKenna et al., 2006). McKenna, et al. (2006) supports the idea that it is the driver's ability to perceive hazards that influences their speed choice, as opposed to advanced drivers being more cautious in general compared to novice drivers because hazard perception training reduced the propensity for risk taking - specifically speed choice. The study displayed that hazard perception can be taught and directly relates to speed choice. Speed choice is influenced by a driver's ability to recognise hazardous situations, which is further established by training and experience.

There is evidence however that speed choice and hazard perception are distinct aspects of driver behaviour; for example McKenna & Horswill's (1997). Results, from a Principal Component Analysis, showed that items from their hazard perception test loaded onto a separate component from video-based measures of tailgating, gap acceptance, overtaking and speed choice. Therefore, drivers' risk taking, which speed choice is a part of, correlated poorly with hazard perception ability.

Possible explanations for the current findings include a small sample size, and the test set up. In the current study the two separate tests were quite distinct, with the hazard perception test and the speed choice task not directly related as they were in McKenna et al.'s (2006) study. Perhaps in order to measure the relationship between hazard perception and speed choice, the two experiments could be interlinked, similar to McKenna et al. (2006), who used several experiments including their final one which represented an externally, ecologically valid way of measuring the relationship between speed choice and hazard perception. In their experiment, Advanced Police drivers were compared to those who were Non-Advanced and they were required to choose certain speeds in differing hazardous scenarios. The results showed that Advanced Police drivers chose slower speeds in more hazardous situations than the Non-Advanced Police drivers.

5.2. Limitations of Research

The current study had various limitations, including: roading classifications and issues, subjectivity of the questionnaire items, recruitment strategies, gender bias and the use of a computer based system.

There were minimal limitations related to roading, such as classification of roading as urban and rural areas and the effect of familiarity of the roads presented. This is due to the fact that urban footage was taken in the Auckland area, rural footage was obtained from the Waikato area. This means that participants in the study may have been familiar with certain roads used in the experiment; therefore, their answers may have been biased due to knowledge of that particular road and its posted speed limit. This could have influenced results with participants simply using the speed they knew appropriate for the road rather than actually using estimation through their own visual judgements. To improve this in subsequent experiments, a wide variety of road types could be used from many towns and cities throughout New Zealand, so there is a mixture of roads from which to reduce the familiarity effect. The other issue with roading that arose during the experiment was the classification of the roads as either rural or urban. Rural and urban areas were the only two means of differentiating various road types in the current research. This was for ease of classification, using the law of parsimony to simplify the research criteria. However, previous studies using VST, such as Cantwell (2010), used a wide variety of different areas including rural, semi-rural, semi-urban, suburban and motorways. Therefore, in the future a wide variety of road types may be used.

Another limitation in the current study was the subjectivity of some of the questionnaire items. Some questions were subjective, such as, how many traffic offences and accidents have occurred in the past 12 months. The definition of a traffic offence may be interpreted differently by some people and not others; some people may class something as not an accident because it was minor, while others may include every slight traffic indiscretion. The discrepancy between traffic offences could have been clarified by information obtained from police databases.

Further limitations in the research may have been due to participant's recruitment strategies – as mentioned previously all the Young Novice drivers were recruited from a high decile local boy's school. While the current experiment used first year university psychology students and people from the general population recruited through the newspaper. More effort could be put in to gather participants from a wider range of areas. On a scale of 1 – 10, the decile rating measures the affluence of the area in which the high school is located. It would have perhaps been more reflective of the general population to use a school with a lower decile rating or perhaps to use a number of schools with a wider range of decile ratings.

Gender, represents a further limitation in the current study. While other studies in the past, such as Matthews and Moran (1986), have focused solely on males, as did the current research, this may have restricted research findings. Further studies should consider including both males and females, to gain a more accurate representation of the New Zealand population. However, the use of males only was justified, as both males and females were used in the larger 'Driverge' study, and preliminary analysis revealed no gender differences in hazard perception or speed choice between male and female drivers.

The final limitation to be discussed in the current research is the use of a computer based test system. This system according to White, Cunningham and Titchener (2011), does not allow the necessary insight into the degree of task difficulty required in differing driving situations. Kuiken and Twisk (2001) believe that

“Young people tend to see them (video based scenarios) as games”, as well as the “hazards on videos being quite predictable”, therefore losing their validity (Kuiken & Twisk, 2001). It is very challenging to provide realistic depictions on a television screen of the information in mirrors, blindspots and peripheral vision that exist in real world environments (Kuiken & Twisk, 2001). In the current experiment, video clips used were as realistic as possible, such as filming in a wide range of traffic scenarios, such as day-time and night-time, as well as filming with the car, including the view from the wing mirrors and rear view mirror, to give the closest approximation of real world scenarios.

6. Future Research

The current research was successful in investigating the relationship between age and experience, and hazard perception and speed choice. However, the area of road safety is a diverse one, and there are many other opportunities for research. There is a demand for scientific findings for government agencies, universities and driver education programmes. While the following is a list of future suggestions, the list is far from extensive and there are many more areas that can be explored; however, for the purpose of this thesis only several will be discussed.

Future recommendations would include:

1: **To redesign the test with a more diverse range of Young Novice drivers**. If the test has a wider range of drivers who come from a diverse range of social and economic backgrounds, as well as across two different genders, this may be more representative of the population as a whole, and therefore be more reflective of the target population in the current research.

2: **To separate age and experience by recruiting some Novice Older drivers**. Through this we could have older drivers who were Inexperienced and just starting out, as well as experienced drivers who were very young, to in turn decide which factor, if either, is more significant than the other in driver behaviour**.**

3: **To incorporate auditory cues into the experimental tasks.** Due to the auditory cues that one receives while driving, these can be vital in order to judge appropriate speeds. Perhaps future studies could focus around acoustic cues as opposed to simply perceptual alone, which would allow for a greater investigation into the many senses that are involved in the driving process. Research such as that by Horswill & McKenna (1999) currently has investigated auditory cues, however future studies could extend this and further hone in on the auditory cues are a significant factor in judging speed choice.

4: **To incorporate social influences into the experimental tasks.** Social influence is perhaps another important factor in studying speeding behaviour, including peer pressure and other social pressures. While the factors that influence speed are many, social influences are highly important in that they affect individuals on a daily basis (Elvik, 2010). Examples of social influences include those known to the driver e.g. passengers, such as parents, children and peers, or those unknown to the other driver, e.g. other drivers (Fleiter, Lennon & Watson, 2010; Fleiter, Watson, Lennon & Lewis, 2006; Rienstra & Rietveld, 1996). According to Fleiter et al. (2006), social influences on driving can be related to 'Aker's social learning theory', where learning occurs through relations with others. Fleiter et al. (2006) found that the strongest influence on speeding behaviour for drivers is approval from peers, followed by influences from family members. Risk taking behaviours have been seen to be greater when individuals are in groups as opposed to individually (Gardner & Steinberg, 2005). Therefore, social influences could be incorporated into the experimental task by having participants participate conjointly in groups of peers. Carrying out the experimental tasks at the same time means they are able to give each other advice, such as ‘higher’ or ‘lower’ in reference to speed, or suggesting hazards that have been missed or are not necessary in the hazard perception dual task. The VST task could be modified with either voices recorded that make suggestions, such as “you are travelling too slow”, “speed up”, or perhaps while one person is carrying out the VST, a group of their friends are allowed in concurrently and they are advised to offer advice about the speed to the driver, to investigate social influences on speed choice. Due to the fact that it is well known in the literature already what a difference peer and social influence can make, this could contribute to the study in an effective and innovative way.

5: Use a wider variation of weather conditions. While the current research investigates day compared to night conditions, as well as sunny versus rainy allowed a great depiction of the differing weather conditions; however, there is another weather condition that can be studied, that is fog. Fog can produce low visibility, thus represents a hazardous condition on any type of road. The amount of fog can be determined by the level of visibility, with the level of visibility measured by the distance the driver is able to see in front of the car. Fog can be defined as a reduction in disparity in the visual field (Brooks et al., 2011). The current experiment may wish to use fog as one of the other weather conditions, therefore incorporating a broad spectrum of weather conditions encountered on New Zealand roads.

7. Synthesis

Drivers aged between 15 – 25 represent a high proportion of people dying on New Zealand roads each year and therefore this is a significant safety issue which needs addressing. The statistics for the period 1st to 13th January 2012, reveal that there have already been 11 fatalities on New Zealand roads (Ministry of Transport, 2012). The current study has identified that age and experience play vital roles in the hazard perception abilities and speed choice of younger drivers. The research also found that poor higher level cognitive skills among these drivers, such as hazard perception, are due to inexperience and developing brain functions. As adolescence is a developmental period of rapid brain growth and change, this life stage represents an important vulnerability, which must be taken into consideration in terms of road safety planning (Keating, 2007).

Young drivers (15 – 24) under the New Zealand Governments newly implemented 'Safer Journey's legislation' (Ministry of Transport, 2010b), will aim by 2020 to have reduced the fatality rate of New Zealand young drivers from 17 per 100,000 per population, to a rate similar to Australia, which is 12 per 100,000 (New Zealand Government, 2011b). Changes that need to be implemented as part of this legislation include increasing young driver education opportunities, implementing regulatory interventions, such as occurred in August 2011 when the driving age was raised to 16 years, and targeted enforcement of young drivers. The current research has identified that Young Novice and Advanced Novice, have poor hazard perception skills, and as hazard perception is highly correlated with crash rate, this needs to be focused on in the future, as in the ‘Safer Journey’s Legislation’. This outlines new road safety training and assessments in hazard perception skills (Deery, 1999).

While young drivers are clearly vulnerable, speed choice results have suggested that Older Experienced drivers, those ranging between 26 – 60 years, are also at risk, due to selecting higher speeds and overestimating speeds. According to the ‘Safer Journey’s Legislation’, safe speeds are referred to as speeds that “suit the function and level of safety of the road. People should drive to the nature of the road and the conditions ensure they understand and comply with the speed limit” (The Roads and Traffic Authority, 2010, p3). Therefore, we must not become complacent, and speeding interventions and campaigns must consistently target a wide range of age groups, and not adolescents alone. According to the ‘Safer Journey’s Legislation’, by 2020, there is a goal to implement safer speeds, to reduce the number of speed related crashes that have the outcome of death and serious injury. There are three goals, namely public campaigns to achieve acceptance of safe speeds, creating speed limits which reflect a safe system, as well as increasing the use of speed cameras. It is proposed that with these measures in place, the number of deaths and injuries due to speeding related crashes each year will be significantly reduced.

The current study has highlighted urban areas as those where higher speeds were preferred compared to the actual speed limit, which is an area of great concern. Urban areas contain pedestrians and high levels of traffic density; therefore, in the future, speed reductions should be put in place to prevent accidents and fatalities in these areas. According to The New Zealand Police ‘Tough on Speed Enforcement’ (2011a), a healthy adult struck at 50 km/hr has a 40% chance of being killed, and for a child the odds are worse, emphasizing the importance of enforcement of speed limits around schools to reduce child pedestrian fatalities. In the future, drivers who travel more than 4km/hr over the speed limit around schools and preschools will be ticketed (New Zealand Police, 2011a).

The significance of this current research for future laws and legislation relates to the importance of assessing hazard perception skills within new driver assessment. Hazard perception tests are currently mandatory as part of the driver testing process in countries such as the United Kingdom, Australia, the Netherlands and some other countries in the European Union. Therefore, it is recommended that hazard perception tests be added as a means of assessment in driver training and assessment in the Graduated Driver Licencing System (GDLS) process in New Zealand (The Roads and Traffic Authority, 2010). New governmental legislation for the future, such as in the 'Safer Journey's Legislation', outlines new road safety tests which include hazard perception tests. This legislation has already increased the driving age from 15 years, one of the lowest ages in the Organisation for Economic Co-operation and Development (OECD), to 16 years as of the 1st of August, 2011 (New Zealand Transport Agency, 2011). In the future, we can expect to see changes in the degree of difficulty in obtaining a restricted licence. This would be a significant and desirable change to the law as research shows the restricted driver stage is the most vulnerable stage, with drivers that are involved in the greatest number of traffic crashes. In addition, the restricted licencing phase, as at February 2012, will involve greater hazard perception and risk perception tests, with the restricted licence being in greater alignment with the full licence test currently in place (New Zealand Transport Agency, 2011). It is also proposed that the learner licencing phase will require that individuals undergo 120 hours of supervised driving practice, which is vital to increase experience and hazard perception skills (New Zealand Transport Agency, 2011). The evidence from the current research and in existing literature highlights the importance of hazard perception, and shows that emphasis placed upon this skill would ensure greater safety among young drivers.

Although further research is clearly needed, the findings from this study provide greater insight into speed choice and hazard perception in male drivers. Ultimately this may make a small contribution to reducing the fatalities that occur on our roads in New Zealand, to help save lives. According to District Road Policing Manager, Inspector Leo Toolman, “if every road user takes personal responsibility, we can go a long way in ensuring safer journey’s for all concerned” (The New Zealand Police, 2011b, p.2).

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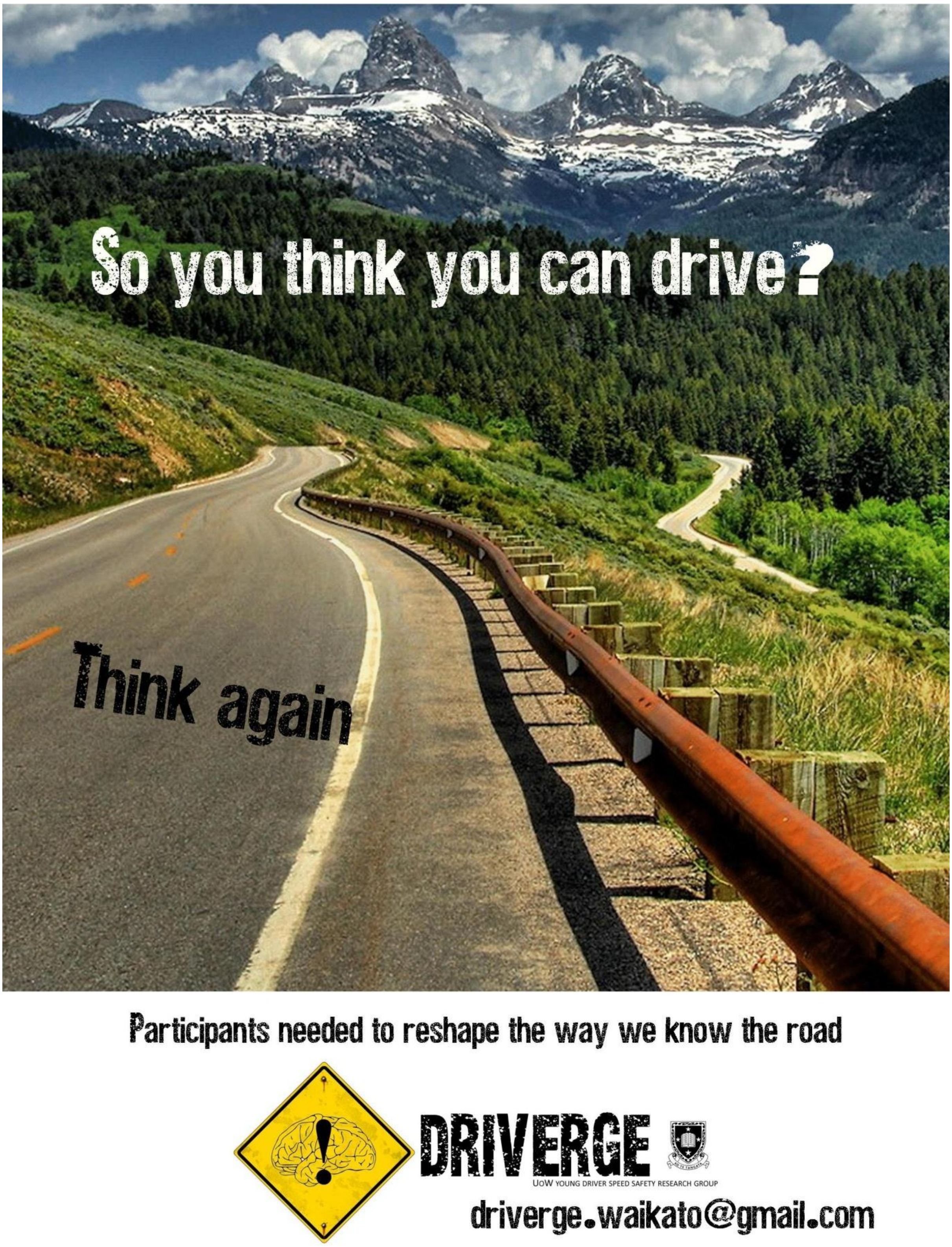
9. Appendices

Appendix A: Participant Advertisement



Appendix B: Participant Advertisement 2

Participants Wanted

Our research team is interested in the relationship between hazard awareness, speed choice, and personality and individual differences.

If you are 15 years or older and have a current NZ learner, restricted or a full driver license, we want to hear from you!

The experiment will take approximately 60-90 minutes to complete, and involves a number of computer based and questionnaire tasks. Participants will receive either 2% course credit (for first year students enrolled PSYC102-11A) or a $10 MTA voucher. For more information contact:

driverge.waikato@gmail.com

DRIVERGE participation
For more information email:
driverge.waikato@gmail.com

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Appendix C: Consent Form

University of Waikato

Psychology Department

CONSENT FORM

PARTICIPANT'S COPY

Research Project:

Name of Researcher:

Name of Supervisor (if applicable):

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 D: Information Sheet

DRIVERGE

UoW YOUNG DRIVER SPEED SAFETY RESEARCH GROUP

Participant Information

What is this study about?

You are being invited to participate in a research project that examines the way the factors age and experience influences driver behaviour. We are primarily focused on the way drivers perceive hazards on the road; choose appropriate speeds, and how this relates to attitudes and beliefs about road usage.

This research will be conducted by the DRIVERGE research team from The University of Waikato, and it is hoped that the findings from this research will greatly benefit all New Zealanders, and hopefully lead to future crash interventions and improvements to driver training.

Am I eligible to take part?

You are eligible to take part in this study if you hold a New Zealand learner, restricted or full drivers licence, and are 15 years or older.

What am I being asked to do?

If you agree to take part in this study, it will involve one session of approximately 90 minutes. There will be a number of tasks involving hazard perception and speed selection carried using a computer, and also some questionnaires. There will also be several questionnaires related to your personal driving behaviour and demographic information (age, gender, etc.) For this, you will need to arrange transport to be at The University of Waikato to meet with a researcher at a pre-arranged time. To show our appreciation for your involvement in this research, you will receive either 2% course credit (if you are enrolled as a first year psychology student, the experiment will be a useful learning experience) or a $10 MTA fuel voucher.

What will happen to my information?

All information received from you will remain strictly confidential, and will not be made available to anyone in a way that will identify you. Your information will be immediately stored on a computer using an anonymous identification number, so even the researchers will not be able to connect your data with your identity. After data collection from all participants, the research team will conduct the analysis of the data and an electronic summary will be sent to those participants who had indicated that they would like to see it.

What can I expect from the researchers?

If you decide to participate in this project, the researchers will respect your right to:

• Ask any questions of the researchers about the study at any time during participation;

• Decline to answer any particular questions or carry out any of the tasks;

• Withdraw from the study at any stage and request your data be excluded or destroyed;

• Provide information on the understanding that it is completely confidential to the researchers. All forms are identified by a code number, and are only seen by the researchers. It will not be possible to identify you in any articles produced from the study;

• Be provided with an electronic summary of the findings if you would like;

• Be kept aware of future publications, newspaper or journal articles related to our research.

Who can I speak with about my participation in this project?

If you, or anyone you know is interested in taking part in this research please contact the Driverge Research team: driverge.waikato@gmail.com.

This research has been approved by the School of Psychology Research and Ethics committee. If you have any concerns about the experiment please contact the convenor: Dr Lewis Bizo (email: lbizo@waikato.ac.nz).

Appendix E: Demographics Questionnaire

1. Age (years)

How old are you? ☐

2. Gender

☐ Male

☐ Female

3. Please indicate which best describes your ethnic background:

☐ New Zealand European

☐ New Zealand Maori

☐ Asian

☐ Pacific Islander

☐ Other European

☐ Other, please specify_______________

4. Are you currently:

☐ Single

☐ In a relationship

☐ Married/Civil Union

☐ Divorced

☐ Widowed

5. What type of licence do you hold?

- ☐ Learners for car
- ☐ Restricted for car
- ☐ Full for car

6. How long have you had your licence?

- ☐ Less than six months
- ☐ More than six months

7. How many years or months driving experience do you have?

Years ☐

Months ☐

8. How many kilometres do you drive in a usual week?

☐

9. In the last twelve months, how many crashes have you been involved in?

A *crash* is any collision that occurred *on the public roads* (but not private property), while you were the driver of the vehicle and irrespective of who was at fault.

☐

10. In the last twelve months, how many near misses have you experienced?

A *near miss* is when you narrowly avoided being in a crash *on public roads* (but not private property), while you were the driver of the vehicle and irrespective of who was at fault.