The Role Of Personality In Predicting Unsafe Driver Behaviour In Young and Older Adults

Julie Riendeau, M.A.

Department of Psychology

Lakehead University, Thunder Bay, Ontario

April 2012

A dissertation submitted in partial fulfillment of the requirements of the degree of Doctor of Philosophy in Clinical Psychology ©

Abstract

Traffic-related collisions represent a considerable social and economic burden on our society. In Canada, drivers aged 16 to 19 years and 70 years or older are consistently overrepresented in victim statistics. Identified risk factors for crash involvement are quite different among young and older drivers. One factor consistently linked to dangerous driving among young and middle-aged adults is personality. Surprisingly, little research has examined the role of personality characteristics in dangerous driving behaviour among older adults. Given the empirical evidence demonstrating a relationship between personality and driver safety among younger populations and the relative stability of personality throughout adulthood, the question arises as to whether personality features recognized to be related to dangerous driving in young adults are also related to dangerous driving in older adults. One hundred and fourteen active drivers ranging in age from 18 to 89 years (M = 42.30 years) were recruited. In addition to capturing self-reported information regarding driving performance and personality, cognitive and simulated driving performance data was collected on all participants. Overall, the current study suggests that personality appears to play some role in the prediction of observational driving performance among older adults. While unexpected, personality did not emerge as a significant predictor of self-reported unsafe driver behaviour. Furthermore, our results suggest that personality may not have equal effects on all groups of drivers. As this study is the first observational investigation of the role of personality in the prediction of unsafe driving behaviour among both young and older adults concurrently, further investigation is needed to provide more conclusive inferences. Future research directions are discussed.

Acknowledgements

In reflecting on this process, I am overwhelmed by the tremendous support I have received. This dissertation could not have been completed without the support and combined contributions of many individuals.

I will begin with the members of my dissertation committee, Dr. Michel Bédard, Dr. Michael Stones, and Dr. Dwight Mazmanian. To my supervisor, Dr. Michel Bédard. Michel, words cannot begin to express my appreciation. You have been a supporter of my professional development for nearly a decade. Your mentorship is to be admired. You have helped me navigate the unfamiliar waters of research and have done so consistently with encouragement. Your palpable confidence that I would reach my goal has been a source of strength along the way and has had profound effects on my academic and professional goals. Dr. Stones, thank you for enthusiastically stepping in as a co-supervisor and for your insightful feedback throughout this process. Dr. Mazmanian, you have expressed a genuine interest in my professional development and have done so with a remarkable sense of humour. Thank you for your many contributions. To the remaining members of my examination committee (Dr. Mirella Stroink, Dr. Peter Brink, and my external examiner), I thank you in advance for your willingness to contribute both time and wisdom to this process.

To my CRSD MERGE colleagues, I have valued your collegiality and continued support throughout this process. You are a wonderful group of people and I certainly miss our regular meetings. Your interest in my progress throughout this journey has not gone unnoticed. To Sacha Dubois, thank you for guiding me toward setting realistic expectations for myself. Your insight and encouragement enabled me to be kinder toward myself, thus propelling me forward on the path of productivity. To Bruce Weaver, your tireless and unwavering commitment to

helping me navigate through my data certainly helped me work my statistical muscles. This process would have seemed insurmountable without your statistical prowess.

To my friends, you have been by my side through the highs and lows of this process. Thank you for your unending support and for your willingness to be my sounding board during the most difficult times. I am so very grateful to have you all in my life.

I am indebted to my family for their unwavering support and encouragement. To my parents, thank you for instilling in me the values of hard work, perseverance, and determination, and for never doubting my ability to reach this goal. To my sisters and my brother, we share childhood memories and grown-up dreams. Thank you for listening without judgment and for your steadfast love and support throughout this process.

Finally, thank you to my husband, Ryan. Your unwavering belief in my strength to persevere enabled me to work toward my goal despite the occasional passing desire to throw in the towel (yes, I know, it may have been more than the occasional passing desire). Without hesitation, you made numerous sacrifices so that I could see my dream come to fruition. Thank you for reminding me not to sweat the small stuff and for doing it with a big smile and a warm heart at all times. Thank you for all you have done (big and small) to help me achieve this milestone.

Scholarship funding was provided by a Social Sciences and Humanities Research Council of Canada Doctoral Fellowship. I wish to thank the agency for its financial support.

Table of Contents

List of Tables

List of Figures

List of Appendices

The Role Of Personality In Predicting Unsafe Driver Behaviour In Young and Older Adults

Driving a vehicle has become an important feature of modern North American culture and is inextricably linked to independence, autonomy, and quality of life (Dickerson et al., 2007; Kua, Korner-Bitensky, Desrosiers, Man-Son-Hing, & Marshall, 2007). Canadians are among the most mobile population in the world. Seventy-four out of every 100 Canadian citizens aged 16 years or older owns a motor vehicle (Canadian Council of Motor Transport Administrators, 2006). It is estimated that each Canadian travels approximately 16,000 kilometers per year (Canadian Council of Motor Transport Administrators, 2006). Unfortunately, this level of mobility comes with a price. Traffic-related collisions represent a considerable social and economic burden on our society. Each year in Canada there are approximately 200,000 collisions resulting in personal injuries and 2,500 collisions resulting in fatalities (Transport Canada, 2007). Ironically, collisions remain the leading cause of unintentional injury among North Americans despite an increase in environmental safeguards (e.g., increased use of seat belts, improvements in road engineering) implemented to protect drivers and laws to control unsafe driving behaviour (Boyce & Geller, 2002; Schwebel et al., 2007).

In Canada, drivers aged 16 to 19 years are consistently overrepresented in traffic collision statistics (Canadian Council of Motor Transport Administrators, 2006). While this sample comprises only 5% of the driver population, they represent 10% of fatally injured drivers, and 13% of seriously injured drivers (Canadian Council of Motor Transport Administrators, 2006). In addition, comparisons made on the basis of kilometers driven reveal that the risk of being fatally injured is seven times higher among young drivers than the general driving population (Canadian Council of Motor Transport Administrators, 2006).

Given the increased susceptibility of the older age groups to injury and death, it is not surprising that the second highest rate of fatal and non-fatal crash injuries per kilometer driven is among those aged 70 years or older (Dobbs, 2008; McGwin, Owsley, & Ball, 1998). For example, the odds of a fatal injury among drivers aged 65 to 79 years is 2.3 times that of drivers aged 40 to 49 years. Among drivers 80 years or older, the odds of a fatal injury is five times that of drivers aged 40 to 49 years (Bédard, Guyatt, Stones, & Hirdes, 2002). Increases in the crash rate of older drivers are expected over the next several decades as Canadians aged 65 years or older represent the fastest growing segment of the population and this group is projected to make up 24% of the total population by the year 2030 (Dobbs, 2008). While drivers aged 65 years or older currently account for 14% of total driver fatalities, this number is expected to increase to 25% by the year 2030 (Lyman, Ferguson, Braver, & Williams, 2002). The high crash rates of the youngest and oldest driver segments of the Canadian population have implications that extend beyond those driver cohorts as the social and economic impact of collisions in Canada is staggering with an estimated social cost as high as 25 billion dollars annually (Health Canada & Transport Canada, 2005).

Unsafe Driving

Concerns about unsafe driving have become increasingly more prominent over the last decade (Beck, Wang, & Mitchell, 2006). Unsafe driving, which is distinguished from road rage, is defined as "engaging in behavior that puts the driver and others at risk and often includes driving at excessive speed, weaving in and out of lanes, and running through red lights or stop signs" (Beck et al., 2006, p. 159). Unsafe driving may be studied as acute behaviour, which is defined as single incidences of behaviour that temporarily increase the immediate risk of injury or fatality, or habitual unsafe driving behaviour, which places an individual at regular risk of

injury or fatality (Blows, Ameratunga, Ivers, Lo, & Norton, 2005). Blows and colleagues (2005) examined the relationship between risky driving habits, prior traffic convictions, and motor vehicle injury in a cross-sectional design of 21,893 individuals. The results demonstrated that those who had frequently engaged in risky driving behaviour in the previous 12 months were two to four times at greater risk of having been injured while driving during that period, compared to those who reported rare, acute incidences of risky driving.

Research indicates that approximately 90% of all crashes are the result of driver characteristics and behaviour (Lewin, 1982). Identified risk factors for crash involvement are quite different among young and older drivers (Owsley, McGwin, & McNeal, 2003). Crash risk among young drivers has been associated with driving inexperience, risk-taking behaviour (e.g., speeding, passing when not safe to do so), moving violations, and alcohol use (Owsley et al., 2003). Alternately, it has been established that risk factors for traffic-related collisions among older drivers include reduced driving abilities in driving situations in which they are less capable of responding to safely (e.g., unprotected left turns, stop sign controlled intersections; Bédard, Stones, Guyatt, & Hirdes, 2001; Freund, Colgrove, Burke, & McLeod, 2005).

Given that human factors explain significantly more variability in crash rates than any other factors (e.g., vehicular, roadway), it is not surprising that more recent research has focused on examining the relationship of human factors and unsafe driving (Dahlen & White, 2006). One factor consistently linked to unsafe driving among young and middle-aged adults is personality (Schwebel et al., 2007). Proponents of personality psychology argue that some individuals are more likely than others to regularly engage in unsafe driving behaviour (Boyce & Geller, 2002). Research has revealed that personality characteristics are a direct contributor to engaging in unsafe driving behaviour among young and middle-aged adults. In addition, there is evidence to

suggest that personality may act as a distal influence on driving behaviour through risk perception (Machin & Sankey, 2008). Surprisingly, little research has examined the role of personality characteristics in unsafe driving behaviour among older adults. The challenge for researchers is to provide a better understanding of how personality characteristics contribute to crashes among drivers, particularly those most at risk (Elander, West, & French, 1993).

Personality

Personality traits can be defined as relatively stable, enduring patterns of thoughts, feelings, and behaviours that describe the ways in which people differ from or are similar to one another (McCrae & Costa, 1995; Tellegen, 1991). Personality traits are useful for at least three reasons. Fist, traits help us describe and better understand the differences between individuals. Second, traits help us to explain behaviour. In fact, the reason people do what they do may be related, in part, to a function of their personality traits. Lastly, traits are useful because they help predict future behaviour (Larsen & Buss, 2008). Therefore, personality is useful in describing, explaining, and predicting differences and similarities between individuals (Larsen & Buss, 2008).

In addition to being the set of psychological traits, personality is the set of psychological mechanisms. While mechanisms are like traits, they refer more to the processes of personality. Most psychological mechanisms have three important components: inputs, decision rules, and outputs. For example, psychological mechanisms may make an individual more sensitive to particular kinds of information from the environment (input), may make them more likely to think about specific options (decision rules), and may guide their behaviour toward certain actions (outputs; Larsen & Buss, 2008).

In the last decade, personality researchers have increasingly moved toward cultivating a consensus about the higher-order structure of adult personality (Caspi, Roberts, & Shiner, 2005). The higher order, broad traits represent the most general dimensions of individual differences in personality (e.g., extraversion). More specific traits, or lower order traits, (e.g., sociability) are found at successively lower levels, and are in turn composed of more specific responses (e.g., talkative). The taxonomy of personality traits that has received the most attention and support from researchers over the past two decades is the five-factor model (FFM; Costa & McCrae, 1992). Also referred to as the *Big Five*, the broad traits composing the FFM have been provisionally named Extraversion, Neuroticism, Conscientiousness, Agreeableness, and Openness to Experience (Caspi et al., 2005). As a comprehensive trait model of personality, the FFM has been widely used to provide a systematic approach to various outcome variables from organizational behaviours to crash involvement (Sümer, Lajunen, & Özkan, 2005).

The Big Five

Extraversion

Individuals vary in the degree to which they are actively involved with the world around them. Extraverted individuals are outgoing, energetic, and dominant, whereas introverted individuals are often described as quiet, inhibited, and more comfortable following the lead of others (McCrae & Costa, 2003). Recent research has identified three core features of this trait: frequent positive moods, sensitivity to potential rewards, and the tendency to evoke and enjoy social attention. Extraversion consists of at least four lower order traits. The lower order traits include social inhibition or shyness, sociability, dominance, and energy/activity level. Social inhibition or shyness reflects feelings of discomfort in social interactions. Sociability, the preference to be with others rather than alone and a tendency to seek close relationships,

addresses elements of approach and positive emotionality. The lower order trait of dominance refers to a tendency to be assertive and confident in social encounters and to exert control over others. In adults, a high level of positive activity is generally associated with extraverted individuals (Caspi et al., 2005).

Neuroticism

Individuals high on Neuroticism are anxious, vulnerable to stress, lacking in confidence, moody, and easily frustrated. Individuals low on the trait of Neuroticism are emotionally stable and adaptive (McCrae & Costa, 2003). Neuroticism includes both anxious and irritable distress. Anxious distress is inner-focused and includes tendencies toward anxiety, sadness, insecurity and guilt. In contrast, irritable distress is directed outward in anger, jealousy, frustration, and irritability (Caspi et al., 2005). Research indicates that the distinction between inner- and outer-directed distress is akin to the distinction between internalizing and externalizing psychological disorders, such that both are likely to follow separate developmental paths and result in distinct outcomes (Caspi et al., 2005).

Conscientiousness

Individuals high on the trait of Conscientiousness are responsible, attentive, careful, persistent, and orderly. While there is ongoing debate regarding how high scores on this trait should be conceptualized, high scores are most commonly interpreted as a willingness to follow authority and conform to group norms or as engaging positively in task related endeavors. In contrast, those low on this trait are irresponsible, unreliable, careless, and distractible (McCrae & Costa, 2003). Conscientiousness includes six lower-order traits: self control versus impulsivity, attention, achievement motivation, orderliness, responsibility, and conventionality. Self-control ranges from the tendency to be methodical and cautious to a tendency to be careless and

impulsive. Attention reflects one's capacity to regulate attention by shifting mental sets, focusing attention, and continued persistence in a task regardless of distractions. Achievement motivation taps an individual's tendency to strive for high standards. Orderliness, as the name suggests, taps an individual's propensity to be neat, clean and organized versus careless and disorganized. Responsibility, a blend of Conscientiousness and Agreeableness, ranges from the tendency to be reliable to being unreliable. Lastly, conventionality taps one's tendency to uphold societal norms. Research in this area suggests that Conscientiousness serves as one of the strongest predictors of avoiding risky behaviours such as drinking and driving (Caspi et al., 2005).

Agreeableness

Agreeable individuals are generally cooperative, considerate, generous, polite, and kind. Research also suggests that Agreeableness includes a propensity to accommodate others' wishes. Those low on this trait are aggressive, rude, spiteful, and manipulative (McCrae & Costa, 2003). Agreeableness is linked with Neuroticism in that both traits measure components of anger proneness. Agreeableness is also linked with Conscientiousness as both traits reflect aspects of inhibition versus disinhibition.

Three lower order traits of Agreeableness have been identified. Antagonism ranges from the tendency to be peaceful to the tendency to be hostile and aggressive. The lower order trait of prosocial tendencies taps an individual's tendencies to be kind, considerate, empathic, and nurturant. Lastly, cynicism/alienation, related to both Neuroticism and Agreeableness, reflects an individual's tendency to mistrust others and to feel unfairly mistreated (Caspi et al., 2005).

Openness-to-Experience

Although it is the most debated and least understood of the Big Five traits, Openness-to-Experience includes a number of important traits. Individuals high on the trait of Openness-to-

Experience are imaginative, creative, and esthetically sensitive. In addition, they are intellectually curious and often seek out new experiences (e.g., through travel, the arts, movies; Caspi et al., 2005; McCrae & Costa, 2003).

Sensation Seeking

While the FFM of personality has been proven to be more robust and replicable than any other taxonomy of personality factors, critics of the model suggest that there are personality factors beyond the Big Five. In addition to the broader constructs that comprise the FFM, Sensation Seeking has received considerable attention in investigations of driving outcome and behaviour (Dahlen & White, 2006).

Sensation seeking is "a trait defined by the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience" (Zuckerman, 1994, p. 27). For example, if an individual drives while intoxicated they may kill or injure themselves (physical risk), they may be arrested (legal risk), they may be fined (financial risk), or they may be condemned by others as a drunk driver (social risk; Zuckerman, 1994). Central to this trait is the optimism with which individuals approach novel stimuli in their environment (Jonah, 1997). Sensation seekers underestimate or accept risk as the price for the reward provided by the sensation or experience. In contrast, individuals low in sensation seeking see no reward in sensation seeking experiences that are associated with high levels of risk (Zuckerman, 1994).

Continuity and Change in Personality Traits

The definition of personality emphasizes that personality resides within the individual and, hence, is at least somewhat stable over time and somewhat consistent across situations (Larsen & Buss, 2008). The debate about the stability of personality across the lifespan has a

long history in personality psychology. Numerous studies have been conducted on the stability of personality in adulthood. The results from many cohort studies (18 though 84 years) yield a strong general conclusion: the Big Five traits show moderate to high levels of stability across self-report measures of personality, conducted by different investigators, and over differing time intervals (e.g., 3 to 30 years). The average correlation across all five traits, measured using numerous scales and time intervals, is roughly +.65. Similarly, when other data sources (e.g., spouse report, peer report) are utilized, moderate to high levels of personality stability are found (Larsen & Buss, 2008). For example, in one 6 year longitudinal study using spouse ratings (men and women aged 21 to 96 years) on the NEO Personality Inventory (NEO PI; Costa & McCrae, 1985), retest correlations for spouse ratings were +.83 for Neuroticism, +.77 for Extraversion, and +.80 for Openness-to-Experience (Costa & McCrae, 1988). Little change, however, does not mean there is no change.

Until recently, the dominant perspective proposed by McCrae and Costa (1994) was that there was no change in personality traits beyond the age of 30. Newer studies confirm that stability is the predominant feature of personality in adulthood, but cross-sectional and longitudinal research in North America has documented predictable changes in personality between young (college age) and older adulthood (McCrae et al., 1999). Specifically, research indicates there are moderate declines in Neuroticism, Extraversion, and Openness-to-Experience, and increases in Agreeableness and Conscientiousness throughout adulthood (Costa & McCrae, 2006).

McCrae and colleagues (1999) confirmed these findings using translations of the Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1992) administered to samples from five culturally diverse countries. The results from the five samples were remarkably consistent.

Older adults (both men and women) were lower in Extraversion and Openness-to-Experience and higher in Agreeableness and Conscientiousness. While not as consistent, there was a tendency for younger individuals to score higher on Neuroticism. These results were highly consistent with the results observed in North American samples. Further, support for mean level changes in personality traits comes from a review of data from 80 longitudinal studies synthesized and organized according to the FFM (Roberts, Robins, Trzesniewski, & Caspi, 2003). Consistent with cross-sectional comparisons of different age groups, declines were observed in the domains of Neuroticism, Extraversion, and Openness-to-Experience. Additionally, traits belonging to the domains of Agreeableness and Conscientiousness increased throughout adulthood.

The empirical results of longitudinal and cross-sectional studies allow us to infer limited, but notable principles about personality. First, similar developmental patterns are observed for men and women across domains of the Big Five (Caspi et al., 2005; Costa & McCrae, 2006). In other words, personality develops in the same way among men and women over the life course. Second, personality change is most pronounced in early adulthood, not in adolescence as might be suspected (Caspi et al., 2005; Costa & McCrae, 2006). Lastly, domains of the Big Five change throughout adulthood, that is, well beyond the original age marker of 30 years. Specifically, Neuroticism, Extraversion, and Openness-to-Experience decline with age, whereas Agreeableness and Conscientiousness increase with age (Caspi et al., 2005; Costa & McCrae, 2006).

While research on the consistency of Sensation Seeking across the lifespan is limited, the data suggest that it increases with age from childhood to adolescence and peaks around ages 18 to 20 years. Beyond this age, there is a gradual decline as individuals age (Larsen & Buss, 2008).

Driving and Personality

Some individuals go an entire lifetime and never experience a crash, whereas others are involved in multiple crashes as licensed drivers (Boyce & Geller, 2002). Proponents of personality psychology suggest that such variability is observed because some individuals are more prone to take risks than others (Boyce & Geller, 2002). It is commonly accepted that personality traits underlie drivers' motivation to take risks on the road and that they are closely linked to the chosen driving style (Sümer, Lajunen, & Ozkan, 2005). Past research on the personality correlates of crash involvement have identified a number of traits associated with unsafe driving; however, the research is difficult to interpret in terms of clarity and conclusions due to a lack of theory and the use of unstandardized, ad hoc questionnaires, inventories, and tests (Arthur & Graziano, 1996; Arthur & Doverspike, 2001). Interest in personality as a potential underlying contributing factor in unsafe driving behaviour has wavered since Tillmann and Hobbs' statement concerning crash liability that "a man drives as he lives" (Tillmann & Hobbs, 1949). Tillmann and Hobbs' (1949) contribution was a study in which Tillmann rode with, and interviewed male taxi drivers for 3 months. He compared 20 high crash frequency drivers with 20 low crash frequency drivers (comparable in terms of age and miles driven) in terms of childhood, adolescent and adult history, and employment. Tillman concluded that the lives of low crash drivers were marked by caution, tolerance, foresight, and consideration for others, and as such they drove in the same manner. Conversely, the lives of the high crash frequency drivers were devoid of such characteristics and consequently their driving was characterized by aggressiveness and a much higher crash rate.

An extensive body of literature has emerged since Tillmann and Hobbs (1949) proposed that a driver's personality is a potential causal factor in driver behaviour (Jonah, Thiessen, & Au-

Yueng, 2001). Reviews of the existing research have highlighted the fact that past research evidence relating personality traits to unsafe driving have been equivocal (Sümer et al., 2005). Using the trait approach in personality may facilitate a better understanding of the association between personality and unsafe driving (Sümer et al., 2005). The FFM has been used widely by researchers as a framework to explore the criterion-related validity of personality in relation to unsafe driving (Clarke & Robertson, 2005). In addition, the advent of the FFM has given rise to a more systematic and comprehensive approach to the study of personality and its relation to driving behaviour (Arthur & Graziano, 1996; Arthur & Doverspike, 2001). As a result, stronger relationships have been demonstrated between FFM personality factors and unsafe driving behaviour (Arthur & Graziano, 1996).

Extraversion and Driving

Extraversion has been associated with crashes, traffic fatalities, traffic violations, and driving under the influence (Fine, 1963; Lajunen, 2001; Renner & Anderle, 2000; Smith & Kirkham, 1981). One of the earliest studies designed to study the relationship between Extraversion and driver behaviour was conducted by Fine (1963). Nine hundred and ninety-three male freshmen were administered a personality measure. In addition, the driving records of each participant were accessed (e.g., total number of crashes and violations). Fine hypothesized that individuals high on the trait of Extraversion would commit more driving violations and have a greater frequency of crashes relative to introverts as a consequence of being less bound by the prescribed road rules. He determined that individuals high on the trait of Extraversion committed significantly more on-road violations and had significantly more crashes than introverts. Similar results were demonstrated by Smith and Kirkham (1981) who administered self-report questionnaires assessing Extraversion and driving history to 113 male drivers aged 20 to 23

years. A significant relationship between Extraversion and total crashes was observed. More specifically, drivers high on the trait of Extraversion were more likely to have had a history of non-intersection crashes. Arthur and Graziano (1996) sampled 227 college students and determined that Extraversion was significantly related to both self-reported number of at fault crashes ($r = .13$, $p < .05$) and total crashes ($r = .15$, $p < .05$). Lajunen (2001) examined the relationship between personality dimensions and traffic fatalities in a sample of 34 countries and determined that Extraversion correlated positively with the number of traffic fatalities ($r = .58$, $p < .001$). Further analyses revealed that countries with high Extraversion scores had a greater number of traffic fatalities than countries with low or moderate Extraversion scores ($F(2, 30) = 3.10$, $p = .060$). In their meta-analysis of the relationship between crash involvement and the Big Five, Clarke and Robertson (2005) determined that Extraversion is a valid and generalizable predictor of crashes (corrected mean validity coefficient = .24).

While some authors have reported significant associations between Extraversion and unsafe driving, some studies have either failed to support these findings or yielded mixed results (Sümer et al., 2005). Lester (1991) reviewed nine studies examining the relationship between Extraversion and crash risk and concluded that it was not significantly associated with crash risk. Similarly, Elander, West, and French (1993) have argued that the evidence on the relationship between Extraversion and crash risk is inconclusive and difficult to interpret, as many studies have not controlled for driving experience and exposure.

The mechanism responsible for higher crash risk among individuals high on the trait of Extraversion is unclear. Eysenck (1962) postulated that extraverts are at higher risk of crash involvement due to low levels of vigilance and subsequently reduced attention to tasks (e.g., driving). The finding that extraverts seek stimulation to a far greater extent and consequently

demonstrate significantly poorer performance on vigilance tasks, relative to introverts, has been well validated. More specifically, there is significant evidence to support a decline in performance under monotonous conditions such as driving (Clarke & Robertson, 2005).

Overall, the literature presents a complex picture with evidence both for and against the role of Extraversion in the prediction of unsafe driving behaviour. Nevertheless, much of the driving research supports a positive relationship between Extraversion and unsafe driving.

Neuroticism and Driving

Hansen (1989) proposes that individuals high on the trait of Neuroticism are at a greater risk of crash as they tend have a tendency to be preoccupied with their own anxieties and worries and are, therefore, more distractible. Sümer and colleagues (2005) examined the mediated relationships between the Big Five personality factors and crash risk in 1,001 drivers. Neuroticism was associated with an increase in unsafe driving behaviour ($r = .15$, $p < .05$) and crash risk. Clarke and Robertson (2005) argue that the mechanisms linking Neuroticism to crash risk may be related to the stress response of those high on the trait. Supporting this claim, Matthews, Dorn, and Glendon (1991) examined the relationship between stress, personality, and driver performance among 159 participants. They determined that general driver stress was positively correlated with Neuroticism and with minor crash involvement. These results suggest that individuals high on the trait of Neuroticism may respond more negatively to environmental stressors (Clarke & Robertson, 2005). Clarke and Robertson (2005) observed conflicting results in their meta-analysis of the relationship between crash involvement and the Big Five. Despite a small effect size for Neuroticism, the confidence intervals included zero, suggesting a non-significant relationship between Neuroticism and crash involvement.

Although Elander and colleagues (1993) argue that research on the relationship between Neuroticism and crash risk is inconclusive and difficult to interpret, overall, the literature suggests a positive relationship between Neuroticism and crash risk, perhaps due to greater distractibility and increased vulnerability to stress (Clarke & Robertson, 2005).

Conscientiousness and Driving

Another personality variable that has received considerable attention in the crash prediction literature is Conscientiousness (Arthur & Graziano, 1996). Given the attention to detail and adherence to rules that is required of licensed drivers, researchers posit that highly Conscientiousness individuals are better able to resist temptation (e.g., speeding) and are more responsive to social obligation norms than those low in Conscientiousness (Arthur & Graziano, 1996). Arthur and Graziano (1996) examined the relationship between Conscientiousness and crash involvement in two samples: college students and individuals recruited through a temporary employment agency. Participants were administered two independent measures of Conscientiousness and a standard driving questionnaire. Among the temporary employment agency sample, the results revealed a significant inverse relationship between Conscientiousness (as measured by the NEO Five-Factor Inventory) and at-fault (r = -.19, p <.01) and total crashes (r = -.16, p <.01), and moving violations (r = -.16, p <.01). Specifically, individuals who reported one or more at-fault crashes (M = 2.67, SD = .53) had significantly lower Conscientiousness scores than individuals who had not had any at-fault crashes (M = 2.85, SD = .48), t(248) = 2.72, p <.01. Similar differences were observed for moving violation tickets. Specifically, individuals who reported one or more moving violation tickets (M = 2.74, SD = .51) had significantly lower Conscientiousness scores than those reporting no moving violation tickets (M = 2.87, SD = .49), t(248) = 1.97, p <.01. The direction of these relationships was consistent with those obtained for

the college sample. The authors concluded that the sensitivity of conscientious individuals to social responsibility norms could result in less risk taking and greater avoidance of unsafe driving situations. Conversely, individuals who are low on Conscientiousness exhibit behaviours associated with immediate gratification without considering the costs and benefits, a tendency not to plan ahead, and failure to follow rules and regulations (West, Elander, & French, 1993). Arthur and Doverspike (2001) sought to replicate Arthur and Graziano's (1996) inverse relation between Conscientiousness and crash involvement. The authors found a significant inverse relationship between Conscientiousness and self-reported crashes (r = -.40, p <.01) over the past 3 years in a sample of 48 college students.

Schwebel, Severson, Ball, and Rizzo (2006) examined the role of Conscientiousness in the prediction of unsafe driving behaviour in 73 college students. Participants completed personality and driving history questionnaires, and also engaged in a virtual environment task designed to assess risky driving behaviour. Conscientiousness correlated significantly with risky driving behaviour as measured by both the self-report measures and the virtual environment task.

Sümer and colleagues (2005), in their investigation of the relationships between the Big Five factors and unsafe driving behaviour, determined that Conscientiousness had stronger predictive power than any of the other personality traits. Conscientiousness had both a stronger direct effect on unsafe driving behaviour, and an indirect effect on crash risk. More specifically, low Conscientiousness appeared to make drivers prone to a host of unsafe driving behaviours, which subsequently led to a greater risk of crash. Recently, Clark and Robertson (2005) conducted a meta-analytic review of 47 empirical studies examining the relationship between crash involvement and the Big Five personality dimensions. They concluded that low

Conscientiousness was consistently found to predict crash involvement (corrected mean validity coefficient = .27).

Impulsiveness, a lower-order component of Conscientiousness has also received empirical attention in the crash prevention literature. Impulsiveness has been associated with drinking and driving, reduced seatbelt use, impaired driving behaviour, and increased crash risk (Dahlen, Martin, Ragan, & Kuhlman, 2005). Stanford, Greve, Boudreaux, Mathias, and Brumbelow (1996) examined the relationship between impulsiveness and risk taking behaviour (e.g., aggression, drunk driving, not wearing seatbelts) in two independent groups: college students and high school students. In both groups, individuals high on the trait of impulsiveness had a markedly higher rate of risk taking behaviour than those low on impulsiveness. More specifically, those high on impulsiveness were more likely to engage in drunk driving and less likely to wear seatbelts. Stanford and colleagues' (1996) results were recently replicated in a study by Dahlen and colleagues (2005). The authors investigated the role of impulsiveness in the prediction of aggressive and risky driving in 224 undergraduate students. Participants completed a series of questionnaires measuring driving behaviour and personality factors. The results revealed that impulsiveness was related to risky driving ($r = .35$, $p = .01$).

Owsley and colleagues (2003) examined the relationship between personality characteristics and aspects of driver safety among a sample of older drivers. Participants ranged in age from 57 to 87 years old with a mean age of 71.8 years ($SD = 6.4$ years). Consistent with the results of previous studies, the results demonstrated that drivers who reported committing driving maneuver errors and violating traffic laws were more impulsive. More specifically, individuals who reported four or more driving errors were more likely to have high impulsivity

(OR = 2.49, 95% CI 1.38-4.48). Therefore, regardless of age, impulsive individuals are more likely to engage in risky driving behaviour (Owsley et al., 2003).

Agreeableness and Driving

Although limited, there is some evidence to support a negative relationship between Agreeableness and crash risk. Sümer and colleagues (2005) concluded that Agreeableness had a negative effect on unsafe driving behaviour and an indirect effect on crash risk. Similar results were observed by Clark and Robertson (2005). The authors confirmed that low Agreeableness is consistently associated with crash risk (corrected mean validity coefficient = .217).

Although Arthur and Graziano (1996) reported that participants scoring low on Agreeableness had significantly more moving violation tickets, they did not find a significant relationship between Agreeableness and total crashes. Agreeableness includes elements of trust, compliance, and altruism. Low Agreeableness is characterized by belligerence, hostility, and aggression. The research suggests that Agreeableness and crash risk may be related to one another due to higher emotional arousal (e.g., more liable to respond aggressively to situations) and an inability to cooperate effectively with others among individuals low on Agreeableness (Clarke & Robertson, 2005).

Openness-to-Experience and Driving

Few studies have investigated the role of Openness-to-Experience in relation to driving performance. Both Clarke and Robertson (2005) and Arthur and Graziano (1996) found very weak or insignificant links between Openness-to-Experience and crash risk. Meta-analyses have supported a relationship between Openness-to-Experience and training proficiency, suggesting that high Openness-to-Experience is associated with a positive disposition toward learning. However, in monotonous environments, the imaginative, curious and unconventional low order

traits of Openness-to-Experience may result in rule violations, experimentation, and improvisation. Those low on the trait of Openness-to-Experience would have an enhanced ability to focus on the task at hand and consequently be less at risk for a crash (Clarke & Robertson, 2005).

Sensation Seeking and Driving

There is a considerable body of literature examining the relationship between the personality trait of Sensation Seeking and unsafe driving. High sensation seekers are assumed to engage in unsafe driving to provide the type of stimulation they find satisfying (Dahlen & White, 2006). High Sensation Seeking is related to crashes, moving citations, driving while intoxicated, speeding, not wearing seatbelts, passing when it is not safe to do so, and a variety of other unsafe driving behaviours (Arnett, 1990; Furnham and Saipe, 1993; Jonah, 1997; Jonah et al., 2001; Trimpop & Kirkcaldy, 1997).

Zuckerman and Neeb (1980) inquired about participants' customary driving speed on a highway with a posted speed limit of 55 miles per hour. The results revealed a highly significant and linear relationship between reported driving speeds and scores on the Sensation Seeking Scale (SSS-V; Zuckerman, Eysenck, & Eysenck, 1978) for both sexes (males, $F(6, 851) = 19.9$, $p = <.001$; females, $F(6, 1202) = 33.1$, $p = <.001$). The higher total scores on the SSS-V were found in those who reported that, on average, they drove 75 miles per hour or greater.

In Jonah's (1997) review of 40 studies on Sensation Seeking as a direct risk factor of unsafe driving, all but four studies found a significant positive association between Sensation Seeking and some aspect of risky driving. He also noted that Sensation Seeking accounted for approximately 10% to 15% of the variance in risky driving. This relationship has been observed among drivers in Canada, the United States, and numerous European countries (Jonah et al.,

2001). In a similar study, Jonah and colleagues (2001) examined the relationship between Sensation Seeking and risky driving in 279 college students. Participants completed two questionnaires designed to assess their driving behaviour and their level of Sensation Seeking. The results demonstrated that participants high in Sensation Seeking reported engaging in significantly more risky driving behaviours than those low in Sensation Seeking. For example, those high in Sensation Seeking were more likely to speed (p = .001), not to wear seat belts (p = .02), to drink and drive (p = .04), and to perceive a low risk of detection for impaired driving (p = .01).

Trimpop and Kirkcaldy (1997) explored the relationship between personality and driving behaviour in a sample of young (16 to 29 years) male drivers. Participants provided details about their driving history, which included the number of moving violations (e.g., fines for speeding, traffic tickets, reckless driving, drinking and driving) and crashes they had experienced. The results demonstrated that Sensation Seeking was related to, and predictive of, traffic violations and crash involvement. Specifically, statistically significant differences were observed between traffic violators and non-violators on measures of Sensation Seeking (p <.01). In addition, a comparison between crash- and non-crash driver groups revealed a statistically significant difference on two subscales of the SSS-V (Experience Seeking, $F(1,130) = 3.99$, p = .05; Disinhibition, $F(1,130) = 4.25$, p = .05).

A more recent study investigated the potential contribution of Sensation Seeking in the prediction of aggressive and risky driving (Dahlen et al., 2005). Two hundred and twenty-four undergraduate students completed measures designed to assess driving behaviour and personality dimensions. Findings demonstrated that Sensation Seeking was significantly associated with risky driving (r = .33, p <.01) and was among the most useful variables in the prediction of

unsafe driving behaviour as it predicted the largest number of variables (e.g., lost concentration (2% of unique variance), loss of control (4% of unique variance), aggressive driving (3% of unique variance), risky driving (4% of unique variance)). Similarly, Dahlen and White (2006) examined the role of personality traits in the prediction aggressive driving, risky driving, and various crash-related outcomes in 312 undergraduate psychology students. Consistent with the results of Dahlen and colleagues (2005), Sensation Seeking was significantly associated with risky driving ($r = .26$, $p < .01$). The results revealed support for Sensation Seeking in the prediction of risky non-aggressive driving, aggressive driving, loss of concentration while driving, moving citations, minor/major crashes.

Furnham and Saipe (1993) found that Sensation Seeking correlated significantly with a scale designed to assess attitudes toward driving risks. Subscales of the risk scale reflected a lack of regard for driving laws, enjoyment in the sensation of speed and feelings of confidence despite illegal or risky driving behaviour. These results suggest that high sensation seekers have a remarkable confidence in their abilities to survive risky driving and escape legal punishment (Zuckerman, 1994).

The literature strongly suggests that individuals high on Sensation Seeking have a greater crash risk, are more likely to have had convictions for driving offences and are at higher risk of crash involvement when compared to low sensation seekers.

Measuring Driving Performance

To date, the criterion measure of driving performance, as it relates to personality, has largely been drawn from self-report or archival data (e.g., driving records). Arthur and Graziano (1996) have proposed that the use of self-reports to measure driving behaviour limits research because any observed correlation may be an artifact of self-presentation. Supporting this claim,

Lajunen, Corry, Summala, and Hartley (1997) administered a measure of impression management (e.g., deliberate tendency to give favourable self-descriptions to others) and self-deception to 404 drivers. The results revealed that impression management correlated negatively with self-reported crashes, violations, and unsafe driving behaviour. Additionally, impression management correlated positively with self-reported compliance with rules of the road. Moreover, driving records may be deficient simply because of underreporting (e.g., drivers involved in a crash do not report it; Arthur & Graziano, 1996).

Recently, driving simulators have surfaced as a popular testing alternative to on-road/closed-course driving evaluations in driving research as they are a safe and economical method to assess driving performance (Lee, Cameron, & Lee, 2003) and allow the experimenter to place participants in challenging situations that may not arise in the course of a typical on-road evaluation (e.g., complex driving situations, driver reaction to sudden events; Bieliauskas, 2005). While there has been some concern that data obtained from virtual driving may lack external validity (Bieliauskas, 2005), several researchers have asserted that simulators are reasonably sensitive to real-world driving errors (Ponds, Brouwer, & van Wolffelaar, 1988; Rizzo, McGehee, Dawson, & Anderson, 2001) and have demonstrated that driving simulator performance directly correlates with on-road testing (Bédard, Parkkari, Weaver, Riendeau, & Dahlquist, 2010; Freund et al., 2005). Freund, Gravenstein, Ferris, and Shaheen (2002) compared on-road and simulated driving performance in a group of older drivers. They found a significant association between hazardous and lethal errors committed on the simulator and failing the on-road test.

A distinct advantage of the research presented in this study was the reliance upon an objective measure of driving performance which facilitated measurement of the dependent

measures without the confounds associated with assessing driver behaviour via self-report, archival data, or an in-vehicle observer.

The Present Study

Given the enormous social and economic impact associated with motor vehicle crashes, successful prediction of crash involvement is desirable. Research on older driver safety has focused primarily on the role of functional impairment when examining unsafe driver behaviour (Owsley et al., 2003). While this approach makes intuitive sense given the increased incidence of chronic medical conditions (e.g., dementing, eye, and musculoskeletal diseases) among older adults and that the effective control of a motor vehicle requires the combination of visual, cognitive, and physical processes, it fails to consider the role of individual personality variables in driver behaviour (Owsley et al., 2003). Given the empirical evidence demonstrating a relationship between personality and driver safety among younger populations and the relative stability of personality throughout adulthood, the question arises as to whether personality features recognized to be related to unsafe driving in young adults are also related to unsafe driving in older adults (Owsley et al., 2003). If there are shared personality features that predispose both young and older adults to risky driving then similar strategies could be developed to reduce risk in both age cohorts.

On the basis of conceptual linkages and prior research, we hypothesized that there would be a significant inverse relationship between Conscientiousness and unsafe driving (characterized by a greater number of: 1) infractions on the simulated drive and 2) self-reported lapses, violations, and errors on the Driver Behaviour Questionnaire). This hypothesis is based on previous research demonstrating a lower crash risk among individuals high on the trait of Conscientiousness (Arthur & Doverspike, 2001; Arthur & Graziano, 1996; Clarke & Robertson,

2005). The empirical evidence suggests that Conscientiousness increases with age; therefore we expected to observe higher levels of Conscientiousness among older drivers and consequently, lower risk of unsafe driving compared to their younger counterparts.

In addition, we hypothesized that we would observe a significant positive relationship between unsafe driving (characterized by a greater number of: 1) infractions on the simulated drive and 2) self-reported lapses, violations, and errors on the Driver Behaviour Questionnaire) and the traits of Extraversion, Neuroticism, and Sensation Seeking. Given that Extraversion, Neuroticism, and Sensation Seeking decline with increasing age, we expected to observe higher scores of Extraversion, Neuroticism, and Sensation Seeking among young drivers compared to older drivers, and thus, greater risk of unsafe driving among young drivers.

While we did not expect to observe significant relations among the other two Big Five traits (Agreeableness and Openness-to-Experience) and unsafe driving, supplementary objectives of the study entailed investigating possible relations among these dimensions for exploratory purposes. Finally, given the proposed mechanisms underlying higher risk of unsafe driving among individuals high on the traits of Extraversion (e.g., low levels of vigilance, reduced attention to tasks), Neuroticism (e.g., distractibility) and Openness-to-Experience (e.g., reduced attention to tasks), we expected to observe lower performance scores (as evidenced by a higher Useful Field of View® test sum) on a measure of processing speed related to driving among individuals high on the traits of Extraversion, Neuroticism, and Openness-to-Experience. As the mechanisms underlying increased risk of unsafe driving among individuals low on the traits of Agreeableness and Conscientiousness and high on the trait of Sensation Seeking are largely unclear, these traits were included for exploratory purposes.

To restate, there were four main hypotheses:

(1) We expected to observe an inverse relationship between Conscientiousness and unsafe driver behaviour;

(2) We expected to observe a positive relationship between the traits of Extraversion, Neuroticism, and Sensation Seeking and unsafe driving;

(3) We expected to observe higher levels of Conscientiousness among older drivers and consequently, lower risk of unsafe driving compared to their younger counterparts;

(4) We expected to observe higher scores of Extraversion, Neuroticism, and Sensation Seeking among young drivers compared to older drivers, and thus, greater risk of unsafe driving among young drivers.

In addition, there were two supplementary hypotheses:

(5) We did not expect to observe significant relations among the remaining Big Five traits (Agreeableness and Openness-to-Experience) and unsafe driving;

(6) We expected to observe lower performance scores on a measure of processing speed related to driving among individuals high on the traits of Extraversion, Neuroticism, and Openness-to-Experience.

Method

Participants

Potential participants were selected from a pool of volunteers in undergraduate Psychology courses at Lakehead University, Thunder Bay, Ontario and from adults aged over 65 years in the Thunder Bay, Ontario region. A number of recruitment methods were used to reach potential participants, including newspaper advertisements, flyers, and announcements in the Lakehead University Communications Bulletin. Additionally, participants who had previously

participated in research at the Centre for Research on Safe Driving and had consented to being contacted for future studies were contacted directly by phone or by letter and informed of the study. Lastly, several community organizations (e.g., Faye Peterson Transition House, Thunder Bay 55 Plus Centre, Fort William Family Health Network) were contacted and liaised with to recruit participants from their members. Participants enrolled in the Introductory Psychology course who completed the study received two bonus percentage points to be applied to their final grade. All other Psychology students were reimbursed with a $10 gift card. Participants aged over 65 years were reimbursed $50 for their participation.

To be eligible to participate in the study, participants were required to possess a valid General class (5) driver's licence, to be an active driver (average of at least once a week) for at least one year, and to be fluent in English. Potential participants were contacted according to their preferred method of contact (email or phone) and a mutual time for the appointment, which required approximately 1.5 to 2 hours, was scheduled for interested volunteers. Participants were instructed to bring their glasses (reading and/or distance), if they required them, to the appointment.

Materials

Demographic questionnaire (Appendix A). A demographic questionnaire consisting of seven items was administered to collect basic demographic information (e.g., age, sex).

Driving performance measures.

Driving history/habits questionnaire (Appendix B). This nine item measure was used to gather general driver behaviour information (e.g., driving habits, driving restrictions).

The Driving Behaviour Questionnaire (DBQ; Appendix C). The DBQ is a 49 item self-report instrument that yields information about lapses, violations, and errors. Lapses are failures

in attention and memory (e.g., forgetting where the car is parked) that are less likely to result in serious crashes (Reason, Manstead, Stradling, Baxter, & Campbell, 1990). Violations (e.g., speeding) are deliberate actions to infringe the rules and correlate strongly with crashes, while errors are actions that fail to achieve the intended results (e.g., braking too quickly on a slippery road) and pose some risk for driver safety (Reason et al., 1990). The instrument uses a six-point forced rating scale, reflecting how frequently (ranging from *never* to *frequently*) each behaviour is performed while driving. The DBQ is one of the most frequently used instruments for measuring unsafe driver behaviour.

Personality measures.

NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992). The NEO-FFI is an authorized short form of the Revised NEO Personality Inventory (NEO PI-R) and consists of 60 items that provide a quick, reliable, and accurate measure of the five domains of adult personality: Extraversion, Neuroticism, Conscientiousness, Agreeableness, and Openness-to-Experience. The NEO-FFI can assist in understanding an individual's basic emotional, interpersonal, experiential, attitudinal, and motivational styles. Items are answered on a five-point Likert-type scale ranging from *strongly disagree* to *strongly agree.*

The Sensation-Seeking Scale – Form V (SSS-V; Zuckerman, 1994). Sensation Seeking is operationally defined in terms of scores on the SSS-V. The SSS-V is a 40 item forced choice measure that requires individuals to choose between two statements: one reflecting a desire for sensation (e.g., "I like wild and uninhibited parties") and one that reflects a more cautious predilection (e.g., "I prefer quiet parties with good conversation"; Jonah, 1997). The measure yields an overall score of Sensation Seeking as well as four individual subscale scores. The four subscales are: (1) Thrill and Adventure Seeking (TAS; a measure of an individual's desire to

engage in activities involving some physical danger or risk); (2) Experience Seeking (ES; a measure of the desire to seek new experiences through the mind and senses); (3) Boredom Susceptibility (BS; a measure of the need to disinhibit behaviour in the social sphere); and (4) Disinhibition (Dis; a measure of an aversion for repetitive experience of any kind; Jonah, 1997; Zuckerman, 1994). While these dimensions of Sensation Seeking are modestly correlated, they appear to measure different components of Sensation Seeking and have been found to relate differently to various risky behaviours (Jonah, 1997).

Cognitive measure.

The Useful Field of View® test (UFOV; Ball & Owsley, 1993; Edwards et al., 2005). The useful field of view refers to the "the visual field area over which information can be acquired in a brief glance without eye or head movements" (Edwards et al., 2006, p. 276). The UFOV test is the most widely used assessment of the useful field of view. This computerized task was developed to assess an individual's ability to process and react to multiple visual events occurring simultaneously, skills that are used during driving. The test can be administered in approximately 15 minutes. Performance is measured in milliseconds, on three UFOV subtests. The first subtest (visual search and visual processing) determines a participant's threshold for discriminating stimuli presented in central vision (a silhouette of a car or a truck). The correct identification and response time are recorded based on the exposure duration of the target. The second subtest (divided attention) requires that participants continue to identify a centrally presented object; however, they are also required to identify the location of a second object presented concurrently in the visual periphery. A threshold for both the identification of the central target and correct localization of the peripheral target is determined. The third subtest (selective attention) requires the participant to complete the central identification and peripheral

localizing tasks; however, with the addition of distractors in visual periphery. As in the second subtest, the threshold exposure duration for correct performance of both the identification and localization tasks is determined. The range of performance on each of the subtests is 16 ms to 500 ms. A total score (UFOV sum) can be computed by summing the threshold scores (reported in ms) for the three subtests (Weaver, Bédard, McAuliffe, & Parkarri, 2009). Empirical evidence suggests that the UFOV is a valid correlate of driving performance. However, more recently, researchers have proposed that the predictive value of the UFOV is unclear (Bédard, Weaver, Dărzin, & Porter, 2008).

Procedure

Upon arrival to the Centre for Research on Safe Driving for their appointment, participants read the information letter (Psychology 1100 students Appendix D; all other participants Appendix E) and signed the consent form (Appendix F). Participants were then asked to complete a series of questionnaires, presented in the following order: the demographic questionnaire, the driving history/habits questionnaire, the DBQ, the SSS-V, and the NEO-FFI. Participants then completed the UFOV.

Upon completing the measures participants were seated in the driving simulator and asked to familiarize themselves with the instruments and to adjust the seat as required. The driving simulator had a driver's seat, passenger seat, steering console with horn and indicator, and brake and accelerator foot pedals. The driver's view was presented across three 17" monitors, providing a 135-degree field-of-view at any one time. Rear- and side-view mirrors were displayed on the center and side monitors respectively. The dashboard was displayed on the center monitor and included a circular speedometer. There was also a fourth monitor and keyboard through which the researcher controlled the simulator. Participants were informed that

some people experience physical discomfort when driving the simulator and that should they experience this discomfort, they should immediately inform the researcher. Given that 5% to 30% of users in virtual environment research end participation early due to simulator sickness (e.g., symptoms of physical discomfort; Stanney et al., 1998), measures were taken to minimize the likelihood of these symptoms occurring (e.g., maintaining cool room temperature and air flow). Upon familiarizing themselves with the mechanics of the driving simulator, participants drove a 15 min orientation drive. Upon completion of the orientation drive, participants were given the following instructions: "Please go through the course as if you are actually driving. We ask that you drive as closely as possible to how you would normally drive on-road". The researcher answered any questions and then departed the room as it was hypothesized that participants would be more likely to drive as they would normally if not being observed directly. The 20 min simulated route consisted of mixed city and highway driving as well as environmental cues such as traffic signs and signals, and pedestrians. The driving simulation courses (orientation and test) were designed using STISIM Drive™ software (Systems Technology, Inc, Hawthorne, CA). Both simulated routes were set under daylight driving conditions with fine weather. The system responded to input from the driver and generated images in real-time. The simulator then recorded several indices of driving performance, including the total number or speed exceedances, road edge and lane excursions, collisions, illegal turns, and speeding. In addition, simulator driving behaviour was assessed post-simulated drive (using the play-back function of the simulator) by the experimenter using a road examination demerit system (Manitoba Road Test form), wherein participants were given demerit points in situations where they did not adhere to accepted safe practices. Demerit points were assessed for infractions falling in five general categories (starting/stopping, signal

violations/right of way/inattention, moving on the roadway, passing/speed, turning). More demerits were given for grievous mistakes (e.g., running a red light) and fewer demerits for minor mistakes (e.g., going 10 km/h over the posted speed limit). Upon completion of the simulated drive participants were debriefed and thanked for their participation.

Statistical Analyses

All of the variables of interest were quantitative and reasonably well distributed; therefore, associations between variables were explored via bivariate correlations, scatterplots, *t* tests for independent samples, and multiple regression models. Three multiple regression models were used to examine the presence of possible relationships between sex, age, personality and unsafe driver behaviour (observational and self-reported). Participant sex, age, and the personality variable of interest were entered into Model 1. Given the possibility of a curvilinear relationship between participant age and unsafe driver behaviour, a variable representing the quadratic age term was also included. Model 2 included the variables listed in Model 1; however, it also included a variable capturing the linear component of the age by personality variable interaction. Model 3 included all variables from Model 2 as well as a variable representing the quadratic component of the age by personality variable interaction.

The more predictor variables we incorporate from a specific data set in a model, the greater the possibility of overfitting (which occurs when a statistical procedure responds to the idiosyncratic features of the sample; Babyak, 2004). On the other hand, we do not want to miss important properties of the data (e.g., a clearly non-linear relationship of a predictor to the outcome; Steyerberg, 2009). The method outlined below addresses these concerns. We sought to identify the most parsimonious models for the data. To achieve this we began by running Model 3. When there was evidence ($p \leq .05$) for the quadratic component of the age by personality

variable interaction, we retained Model 3. When there was evidence for the linear component ($p \leq .05$), but not the quadratic component ($p \geq .05$) of the age by personality variable interaction, we reverted to Model 2. When there was no evidence ($p \geq .05$) for either the linear or the quadratic component of the age by personality variable interaction, we reverted to Model 1 (see Figure 1). All analyses were performed with PASW Statistics version 18.

Preliminary data screening. Prior to completing the main analyses, data screening was performed for accuracy of data entry, missing values, normality and outliers. Accuracy checks on the data file were conducted by comparing values entered to recorded values from data record forms and computer-generated output. In addition, frequencies and descriptives were run on the main variables to identify odd or extreme values. Histograms and scatterplots were constructed to identify atypical or abnormal distributions. Main variables of interest were also transformed to z-scores to check for univariate outliers. From these investigations four univariate outliers (standardized scores in excess of 3.29) were identified. Of these, two were data inputting errors. While the remaining two outliers (both 4 standard deviations above the mean) were possible values, they were assigned new values, one unit larger than the next most extreme score (3 standard deviations above the mean) in the variable distribution due to possible undue influence on the results (Tabachnick & Fidell, 2001).

Multivariate outliers were detected using the Cook's distance statistic (D), a measure of the overall influence of a particular case on a model. Cook and Weisberg (1982) have suggested that values greater than one may be cause for concern. One case was identified (D = 1.63) and its values were visually-inspected across variables. The case was retained within the data set, as the values did not appear to be excessively extreme.

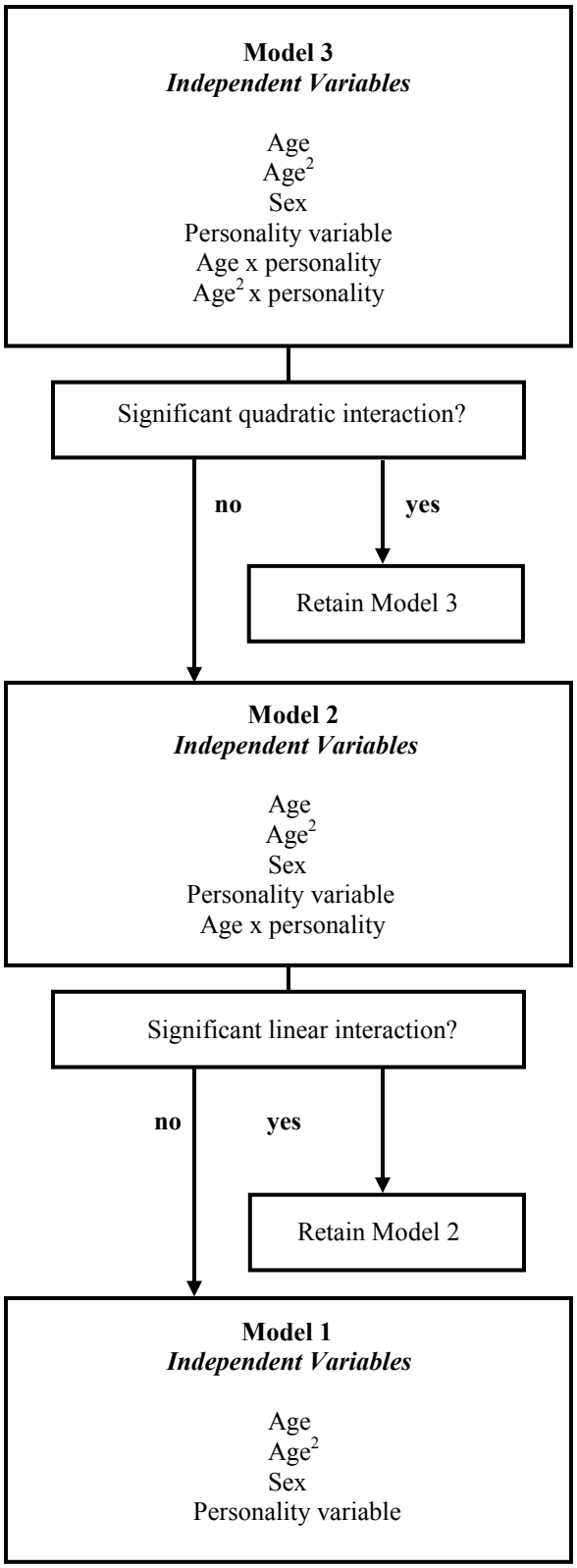

Figure 1. Flow chart depicting decision rules for identifying the most parsimonious regression model.

Missing data. A formal analysis of missingness revealed that, with the exception of the UFOV sum and the total score on the Manitoba Road Test (which were missing at a prevalence of approximately 5%), data for the main variables of interest were 100% complete. Despite taking precautions (e.g., maintaining cool room temperature and air flow) to minimize simulator sickness, six participants failed to complete the simulated drive due to symptoms of simulator sickness (a type of motion sickness that occurs in simulators). Consequently, driving simulation data were not collected for these individuals. A Missing Value Analysis (MVA) was performed in order to determine whether participants who completed the simulated drive differed significantly from those who did not complete the drive on any of the main variables of interest. The results of the MVA revealed a significant difference in age, $t(8.1) = -5.3$, $p = .001$ between participants who failed to complete the simulated drive ($M = 70.71$, $SD = 11.60$) and those who completed the drive ($M = 42.30$, $SD = 26.50$). No other significant differences on the main variables of interest were observed between completers and those who failed to complete the simulated drive.

Results

Sample Characteristics

Overall, 114 participants ranging in age from 18 to 89 years were included in the analyses. The overall age of participants was 42.30 years ($SD = 26.50$ years); the majority of participants were women (54.4%). Participants' characteristics are presented in Table 1. Participants were categorized into two age groups (<65 years, young; 65+ years, older) for the purposes of comparison. These age groups were arrived at based on crash data. Descriptive statistics for the main variables of interest are displayed in Tables 2 and 3 by age and sex. While

Table 1

Participants' demographic characteristics

Characteristic	Total *N* = 114
Age	
Range	18-89
Mean (SD)	42.30 (26.5)
Men, No. (%)	52 (45.6)
Age started driving	
Range	13-34
Mean (SD)	17.53 (3.8)
Number of years licensed	
Range	1-75
Mean (SD)	24.78 (25.6)
Km driven per week, No. (%)	
0-20	8 (7)
21-50	22 (19.3)
51-100	47 (41.2)
>100	37 (32.5)
Speed (km/hr) driven on local streets (posted speed limit of 50 km/hr), No. (%)	
35 km/hr or less	0
36-45 km/hr	5 (4.4)
46-55 km/hr	56 (49.1)
56-65 km/hr	51 (44.7)

Table 1 *(continued)*

66 km/hr or more	2 (1.8)
Speed (km/hr) driven on major highways (posted speed limit of 90 km/hr), No. (%)	
85 km/hr or less	1 (0.9)
86-95 km/hr	31 (27.2)
96-105 km/hr	48 (42.1)
106-115 km/hr	30 (26.3)
116 km/hr or more	4 (3.5)

Note. SD = standard deviation.

Table 2

Descriptive statistics for driving, personality, and cognitive factors by age group

	Younger (*n* = 75)		Older (*n* = 39)	
Characteristic	Range	Mean (SD)	Range	Mean (SD)
Driving factors				
ManTot	10-116	63.76 (24.20)	15-122	54.36 (23.97)
DBQ Total	4-82	35.04 (17.85)**	0-28	11.46 (7.50)
Personality factors				
neoE	37-63	50.60 (6.09)	38-62	50.51 (6.25)
neoN	40-66	53.11 (6.00)**	36-75	58.54 (9.22)
neoC	29-59	42.95 (6.95)**	25-55	39.10 (6.88)
neoA	25-55	35.56 (8.64)	25-51	34.67 (7.71)
neoO	30-59	44.47 (6.13)*	38-62	47.23 (6.55)
SSS-V Total	31-63	48.11 (8.01)**	15-49	32.23 (9.41)
Cognitive factor				
UFOV Sum (ms)	50-208	100.61 (43.17)**	113-525	335.87 (108.04)

Note. ManTot = Manitoba Road Test total; neoE = Extraversion; neoN = Neuroticism; neoC = Conscientiousness; neoA = Agreeableness; neoO = Openness-to-Experience; SSS-V total = Sensation Seeking Scale – Form V Total; SD = standard deviation; Personality factors are reported as T-scores.

*difference between young and older drivers, $p < .05$. ** difference between young and older drivers, $p < .01$.

Table 3

Descriptive statistics for personality, driving, and cognitive factors by sex

	Younger (N = 75)				Older (N = 39)			
	Men (n = 27)		Women (n = 48)		Men (n = 25)		Women (n = 14)	
Characteristic	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)
Driving factors								
ManTot	10-116	63.89 (26.35)	15-115	63.69 (23.19)	30-95	52.36 (17.79)	15-122	57.93 (32.69)
DBQ Total	4-82	40.11 (17.22)	5-78	32.19 (17.73)	0-28	12.24 (7.63)	0-25	10.07 (7.32)
Personality factors								
neoE	41-62	53.56 (5.27)**	37-63	48.94 (5.93)	38-62	51.40 (6.94)	43-60	48.92 (4.60)
neoN	44-66	56.44 (5.85)**	40-64	51.23 (5.26)	45-75	60.84 (8.37)**	36-69	54.43 (9.55)
neoC	29-57	43.37 (7.65)	29-59	42.71 (6.59)	25-55	39.28 (6.69)	26-55	38.79 (7.44)
neoA	25-54	37.85 (7.78)	25-55	34.27 (8.90)	25-50	35.92 (6.33)	25-51	32.43 (9.56)
neoO	33-58	45.41 (6.53)	30-59	43.94 (5.89)	38-57	46.24 (6.17)	38-62	49.00 (7.06)
SSS-V Total	31-62	48.63 (9.52)	31-63	47.81 (7.12)	15-49	31.32 (10.12)	21-48	33.86 (8.06)
Cognitive factors								
UFOV Sum (ms)	50-208	101.74 (46.40)	50-208	100.00 (41.83)	113-525	321.69 (108.52)	217-525	357.14 (107.69)

Table 3 *(continued)*

Note. ManTot = Manitoba Road Test total; neoE = Extraversion; neoN = Neuroticism; neoC = Conscientiousness; neoA = Agreeableness; neoO = Openness-to-Experience; SSS-V total = Sensation Seeking Scale – Form V Total; SD = standard deviation; Personality factors are reported as T-scores.
* difference between men and women, $p < .05$. ** difference between men and women, $p < .01$.

significant group differences were not observed on the Manitoba Road Test total, total self-reported unsafe driving behaviours (DBQ total) were significantly greater among young drivers than older drivers (see Table 2). In addition, the UFOV sum (expressed in ms) was significantly lower among young drivers (see Table 2). With regard to personality, statistically significant group differences were observed between young and older drivers on the NEO-FFI domains of Neuroticism, Conscientiousness, Openness-to-Experience, and Sensation Seeking (see Table 2). While the mean value for Sensation Seeking (expressed as a T-score) was in the expected direction (lower among older drivers), mean values representing domains of the NEO-FFI (expressed as T-scores) were in a direction contrary to empirical evidence. More specifically, young drivers were significantly lower in Neuroticism and Openness-to-Experience and significantly higher in Conscientiousness. Sex differences on the main variables of interest were explored using *t* tests for independent samples (see Table 3). Among young drivers, there were no significant differences between males and females in demerit points on the simulated drive, in self-reported unsafe driving behaviours, or in the UFOV sum. With respect to personality factors, young males were higher in Extraversion and Neuroticism than young females. Similarly, no significant differences among driving factors or the UFOV sum were observed among older drivers. With respect to personality factors, older males were significantly higher in Neuroticism than older females.

Main Hypotheses

Hypothesis 1. The association between Conscientiousness and unsafe driving was explored via correlations and scatterplots. As presented in Table 4, while Conscientiousness was not significantly correlated with observed unsafe driver behaviour, it was significantly correlated with self-reported unsafe driver behaviour ($r = .19$, $p < .05$). Figures 2 and 3 show scatterplots

Table 4

Intercorrelations among all variables

Variables	1	2	3	4	5	6	7	8	9	10
1. Man Tot[a]	-									
2. DBQ Total[a]	.16	-								
3. neoE[a]	.19*	.15	-							
4. neoN[a]	.15	-.16	.16	-						
5. neoC[a]	.02	.19*	.21*	-.09	-					
6. neoA[a]	.15	.18	.10	.40**	.03	-				
7. neoO[a]	-.09	-.23*	.15	.25**	.11	.09	-			
8. SSS-V Total[a]	.13	.51**	.08	-.21**	.05	.12	-.25**	-		
9. UFOV Sum[b]	-.21*	-.50**	-.06	.15	-.26**	-.15	.12	-.59**	-	
10. Age[a]	-.27**	-.62**	-.05	.29**	-.23*	-.05	.25**	-.65**	.84**	-

Note. Man Tot = Manitoba Road Test total; neoE = Extraversion; neoN = Neuroticism; neoC Conscientiousness; neoA = Agreeableness; neoO = Openness-to-Experience; SSS-V total = Sensation Seeking Scale – Form V Total.
[a] $N = 114$. [b] $N = 106$.
*$p < .05$. ** $p < .01$.

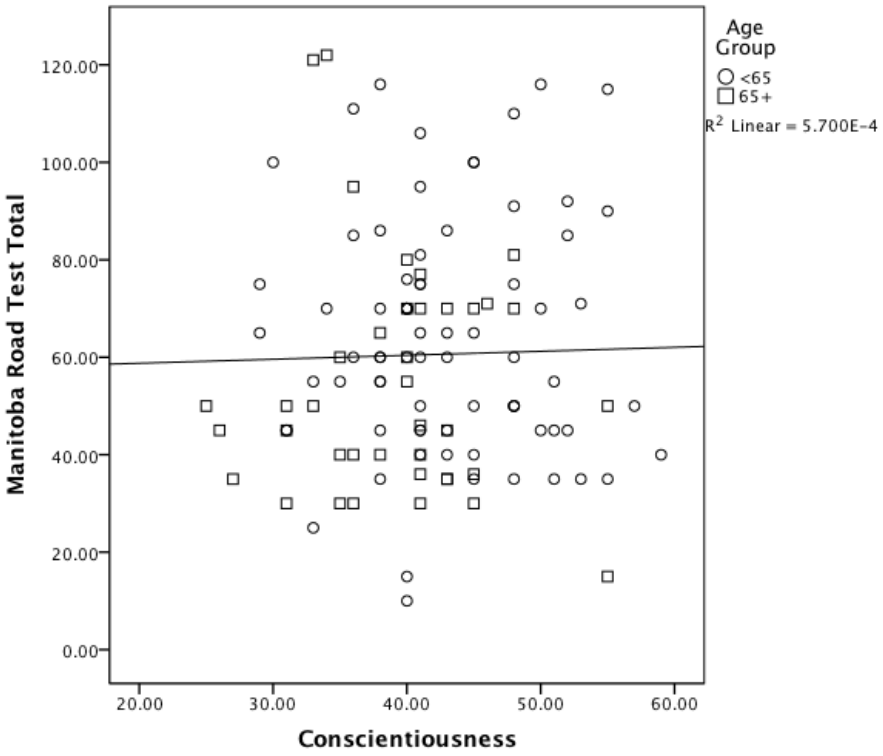

Figure 2. Total score on the Manitoba Road Test (e.g., number of demerit points) as a function of Conscientiousness. *Y* = Manitoba Road Test Total; *X* = the T-score for Conscientiousness; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

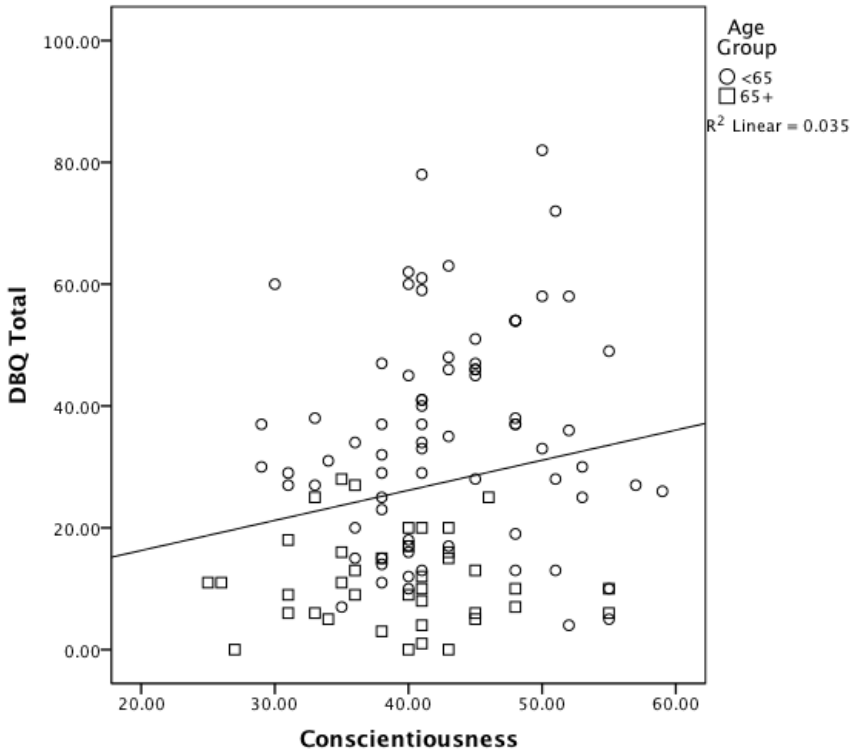

Figure 3. Self-reported unsafe driving as a function of Conscientiousness; *Y* = DBQ total; *X* = the T-score for Conscientiousness; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

with Y = the Manitoba Road Test total (e.g., number of demerit points on the simulated drive) and the DBQ total, respectively; X = the Conscientiousness T-score in each figure. R^2 values from linear regression models are also displayed. These figures suggest that Conscientiousness is not even moderately associated with the Manitoba Road Test total score or self-reported unsafe driver behaviour (DBQ total); however, it is important to note that age and sex were not considered in these univariate analyses. As hypotheses 3 and 4 do not strictly refer to simple correlations, multivariable analyses will be conducted to further explore these relationships.

Hypothesis 2. The associations between Extraversion, Neuroticism, Sensation Seeking, and unsafe driving (as represented by the Manitoba Road Test total and the DBQ total) were explored via correlations and scatterplots. Extraversion was significantly correlated with infractions on the Manitoba Road Test ($r = .19$, $p < .05$) but not with self-reported unsafe driver actions (see Table 4). Neuroticism was not significantly correlated with either measure of unsafe driving. Figures 4 and 5 illustrate the relationship between unsafe driving and Extraversion and Figures 6 and 7 display the relationship between unsafe driving and Neuroticism. Similar to the results of Hypothesis 1, visual inspection of Figures 4 through 7 suggests that Extraversion and Neuroticism are not even moderately associated with either measure (observational or self-report) of unsafe driver behaviour.

As noted in Table 4, Sensation Seeking correlated significantly with self-reported unsafe driver behaviour ($r = .51$, $p < .01$), but not with observed unsafe driver behaviour. Figures 8 and 9 display the relationship between unsafe driving and Sensation Seeking. Consistent with the above findings, visual inspection of the figures suggests that there is little association between Sensation Seeking and the Manitoba Road Test total. Conversely, consistent with predictions and

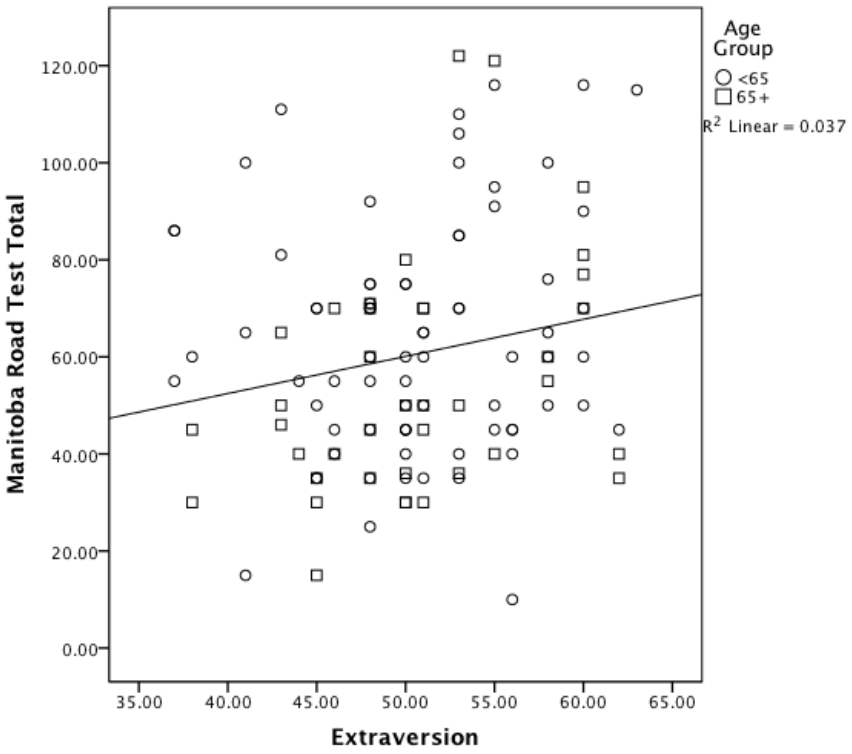

Figure 4. Total score on the Manitoba Road Test (e.g., number of demerit points) as a function of Extraversion. *Y* = Manitoba Road Test Total; *X* = the T-score for Extraversion; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

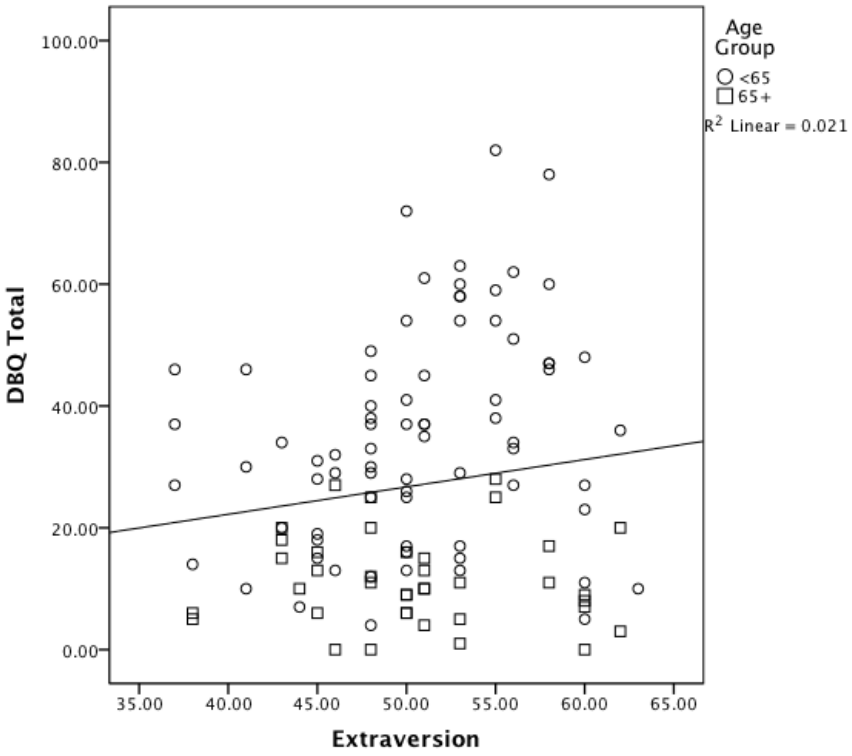

Figure 5. Self-reported unsafe driving as a function of Extraversion; *Y* = DBQ total; *X* = the T-score for Extraversion; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

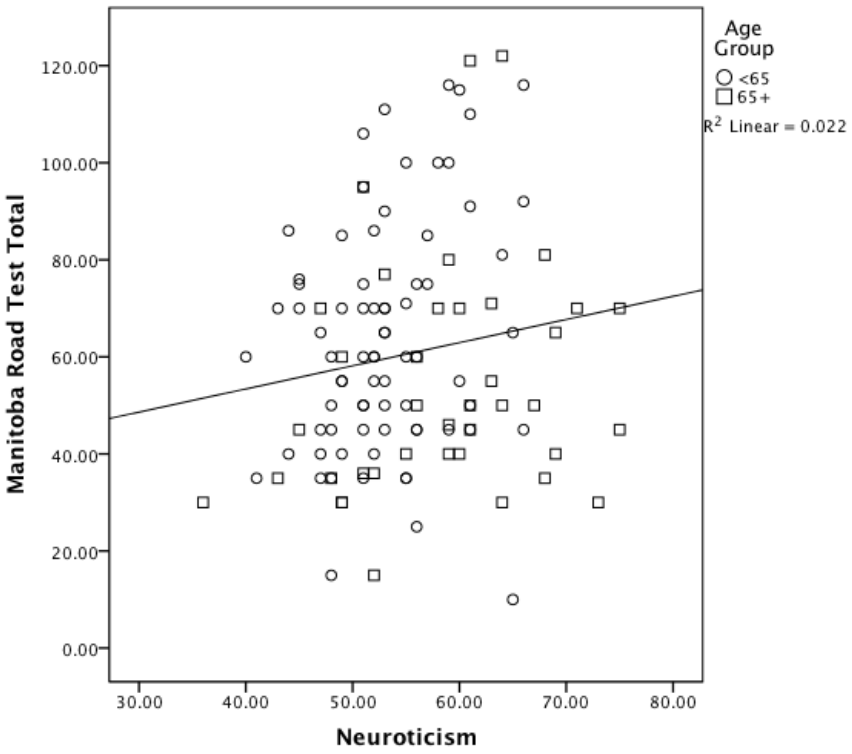

Figure 6. Total score on the Manitoba Road Test (e.g., number of demerit points) as a function of Neuroticism. *Y* = Manitoba Road Test Total; *X* = the T-score for Neuroticism; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

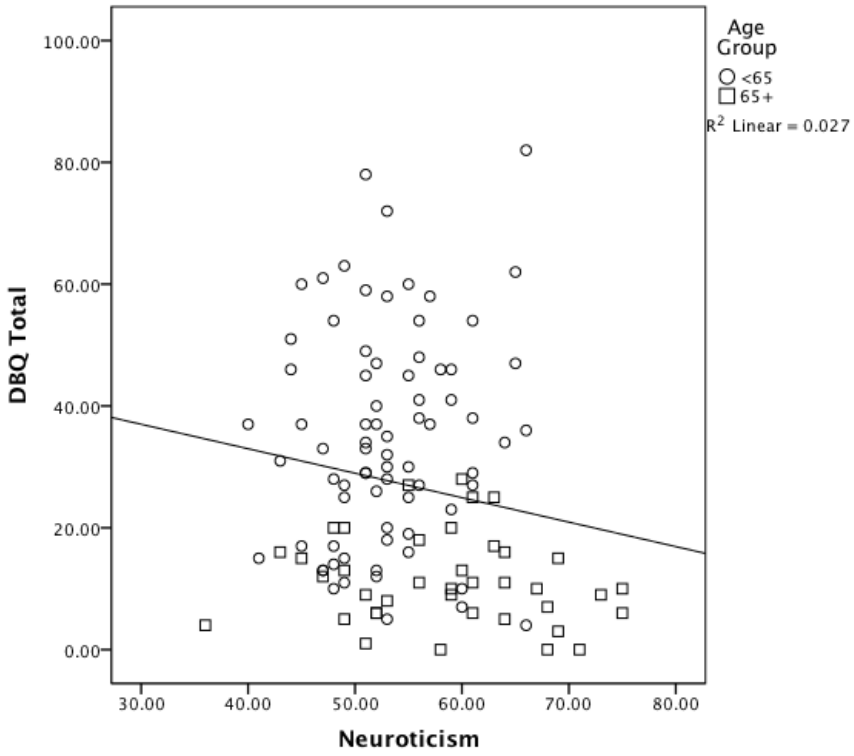

Figure 7. Self-reported unsafe driving as a function of Neuroticism; *Y* = DBQ total; *X* = the T-score for Neuroticism; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

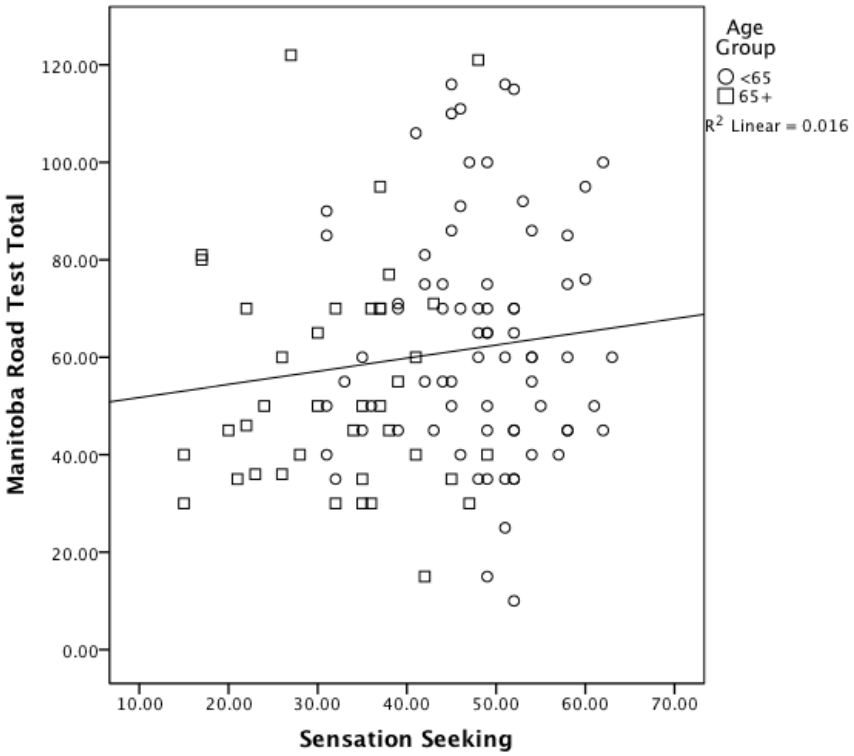

Figure 8. Total score on the Manitoba Road Test (e.g., number of demerit points) as a function of the SSS-V Total subscale. *Y* = Manitoba Road Test Total; *X* = the T-score for SSS-V total; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

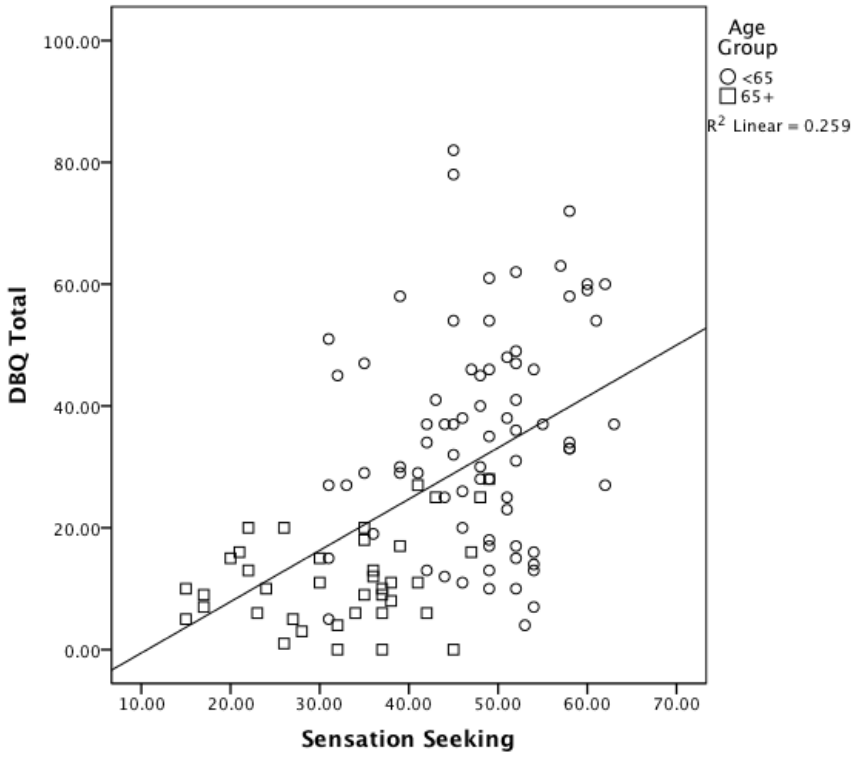

Figure 9. Self-reported unsafe driving as a function of the SSS-V Total subscale; *Y* = DBQ total; *X* = the T-score for SSS-V Total; Round and square data points are for younger (<65 years) and older (65+ years) participants respectively.

previous research (Schwebel et al., 2006), Sensation Seeking is moderately positively associated with self-reported unsafe driver behaviour. As noted above, age and sex were not considered in these univariate analyses. As hypotheses 3 and 4 do not strictly refer to simple correlations, multivariable analyses will be conducted to further explore these relationships.

Hypotheses 3 and 4. Multiple regression models were used to examine the presence of possible relationships between sex, age, personality (Extraversion, Neuroticism, Conscientiousness, and Sensation Seeking) and unsafe driving behaviour (observational and self-reported). Centering, the practice of subtracting a constant from predictors before fitting the model, was applied to age and personality for both statistical and practical reasons. In multiple regression, the intercept represents the value of the outcome when all of the predictors take a value of zero. Given that there are some predictors for which a value of zero makes little sense (e.g., having an age of zero), centering the predictors changes the meaning of the intercept (Tabachnick & Fidell, 2001). As such, Extraversion, Neuroticism, Conscientiousness, and Sensation Seeking were centered at 50 (population mean of T-scores). Age was centered at 20, a value near its minimum. As the regression coefficient represents the expected change in Y for a one-unit change in X (the predictor), the magnitude of that coefficient is partly determined by the length of the units being used. When units are quite small and not necessarily clinically or theoretically meaningful, rescaling can be useful. As the original scales of the predictor variables do not lend themselves to immediately meaningful coefficients, the predictor variables were rescaled to produce more meaningful coefficients. It should be noted that rescaling the predictors to make meaningful regression coefficients has no impact on the strength of the association or on significance levels. As such, we divided age and personality by a scaling constant (10) before performing the regression analyses. To represent this in our regression we rescaled the predictors

by dividing them by 10 and then substituting (in the equation) the original predictors with the newly created divided by 10 predictors (Tabachnick & Fidell, 2001). Thus, the new coefficients for age and personality factors represent the change in the fitted value of *Y* for a 10-point increase in the original variables.

The data were assessed to determine whether the assumptions of multiple regression were met. Multicollinearity and singularity were investigated by reviewing a correlation matrix of all the predictor variables. With the expected exception of age and age-squared, there were no substantial bivariate correlations between predictors (see Table 4) and therefore, no evidence for either singularity or multicollinearity. In addition, conditioning indices and variance proportions (collinearity diagnostics) were also examined for evidence of multicollinearity. Examination of collinearity diagnostics demonstrated that the assumption was met.

Examination of histograms of the residuals and scatterplots of residuals against fitted values provided a test of the assumptions of normality, linearity, and homoscedasticity. Visual inspection of the plots revealed that the data met the assumptions. The test of the assumption of independent errors was performed using the Durbin-Watson statistic. The Durbin-Watson statistic tests whether adjacent residuals are correlated. The test statistic can vary between 0 and 4. A value of 2 indicates that the residuals are uncorrelated. Given the sample size and number of predictors in the models, the Durbin-Watson statistics indicated no evidence of serial correlation (Durbin & Watson, 1951).

Extraversion. Tables 5 and 6 display results from two regressions, one predicting the Manitoba Road Test total (see Table 5) and the other predicting the DBQ total (see Table 6). The model predicting the Manitoba Road Test total was statistically significant, $F(4, 109) = 4.66$, $p < .01$, and accounted for 15% (12% adjusted) of the variability in the Manitoba Road Test total.

Table 5

Standard multiple regression of sex, age and Extraversion on the Manitoba Road Test total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-4.38	4.73	-0.09
age[a]	-11.26	4.39	-1.22*
age^2	1.53	0.73	1.00*
neoE[b]	7.48	3.74	0.19*

Note. R^2 = .15; Adjusted R^2 = .12; neoE = Extraversion; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoE the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

Table 6

Standard multiple regression of sex, age and Extraversion on the DBQ total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	5.23	3.00	0.14
age[a]	-2.29	2.79	-0.32
age^2	-0.40	0.47	-0.34
neoE[b]	2.54	2.38	0.08

Note. R^2 = .42; Adjusted R^2 = .40; neoE = Extraversion; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoE the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

Age (B = -11.26) and age-squared (B = 1.56) were statistically significant predictors of infractions on the simulated drive. Increasing age was associated with a decrease in the number of demerit points until the relationship was eventually reversed (increasing age associated with an increase in infractions). As we see from Figure 10, the number of demerit points varied according to the age of the driver. The curve in Figure 10 has a classic U-shape, such that drivers at either end of the age spectrum engaged in a greater number of unsafe driving actions on the simulated drive. In addition, Extraversion (B = 7.48) emerged as a statistically significant predictor, such that participants higher in Extraversion committed a greater number of infractions on the simulated drive (see Figure 11). The model predicting total self-reported unsafe driving behaviour was also statistically significant, $F(4, 109) = 19.62$, $p < .001$, with 42% (40% adjusted) of the variability in the DBQ total explained by the predictor variables. Unlike the prediction of unsafe driver behaviour on the simulated drive, no significant individual predictors of interest emerged.

Neuroticism. Two regression models predicting unsafe driver behaviour are displayed in Tables 7 and 8. The model predicting the Manitoba Road Test total was statistically significant, $F(4, 109) = 5.14$, $p = .001$ (see Table 7). The model explained 16% (13% adjusted) of the variability in the Manitoba Road Test total. Age (B = -9.30) was a significant predictor of infractions on the simulated drive, such that increasing age was associated with a decrease in infractions on the simulated drive. While the quadratic component of age was not statistically significant, the relationship more closely illustrates a U-shaped curve than a straight line (see Figure 12). Neuroticism (B = 7.96) was also a statistically significant predictor of the Manitoba Road Test total. Compared with those low on Neuroticism, participants high on Neuroticism committed a greater number of driving infractions on the simulated drive (see Figure 13). When

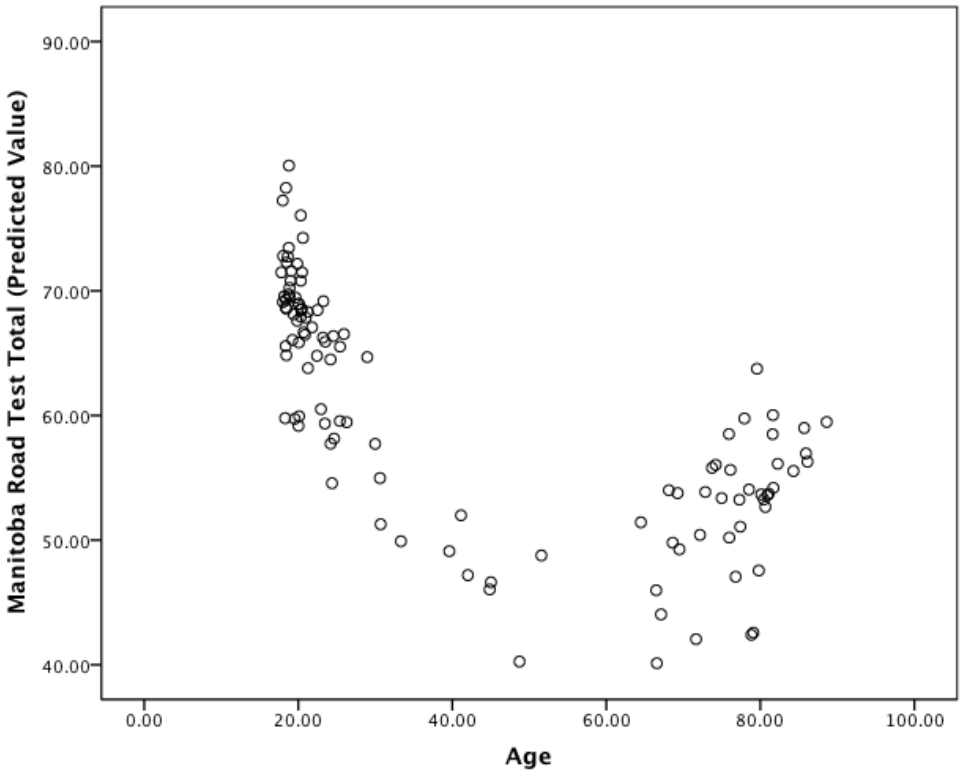

Figure 10. Plot of age with the predicted value of the Manitoba Road Test total (model includes Extraversion)

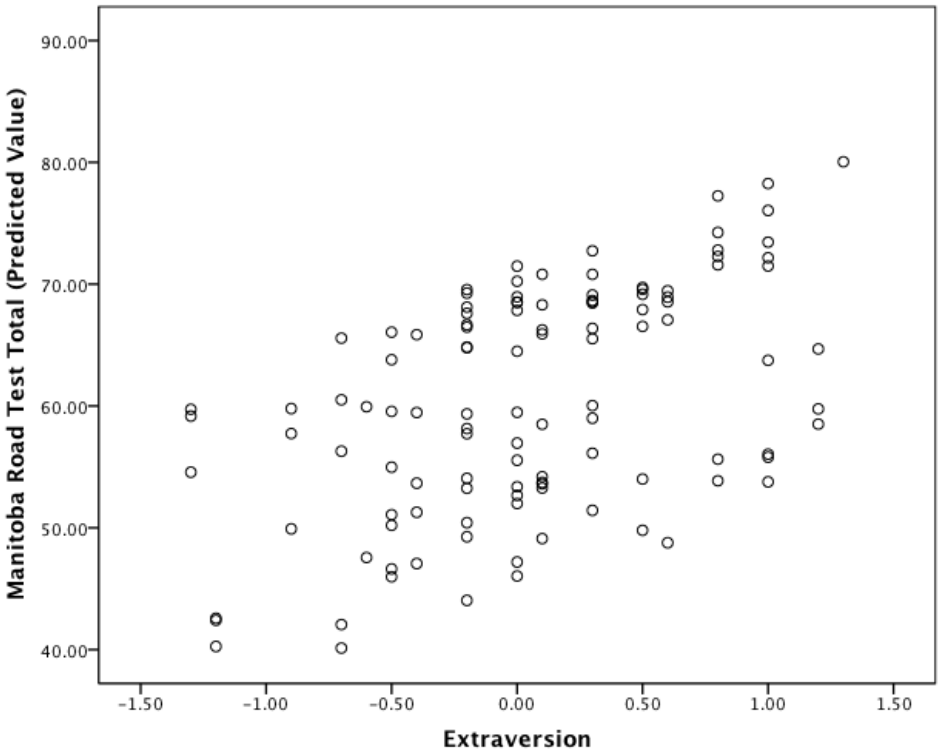

Figure 11. Plot of Extraversion with the predicted value of the Manitoba Road Test total.

Table 7

Standard multiple regression of sex, age and Neuroticism on the Manitoba Road Test total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-5.82	4.82	-0.12
age[a]	-9.30	4.50	-1.01*
age^2	1.09	0.76	0.71
neoN[b]	7.96	3.33	0.25*

Note. R^2 = .16; Adjusted R^2 = .13; neoN = Neuroticism; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoN the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

Table 8

Standard multiple regression of sex, age and Neuroticism on the DBQ total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	6.76	3.10	0.18**
age[a]	-2.97	2.89	-0.42
age^2	-0.29	0.49	-0.24
neoN[b]	-0.98	2.14	-0.04

Note. R^2 = .41; Adjusted R^2 = .39; neoN = Neuroticism; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoN the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

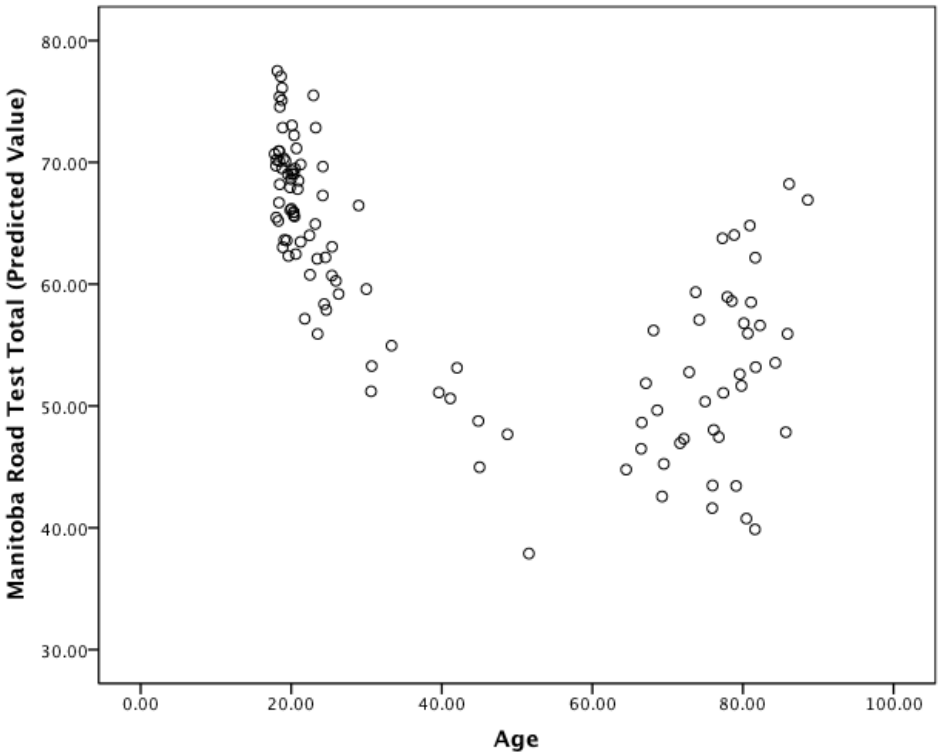

Figure 12. Plot of age with the predicted value of the Manitoba Road Test total (model includes Neuroticism).

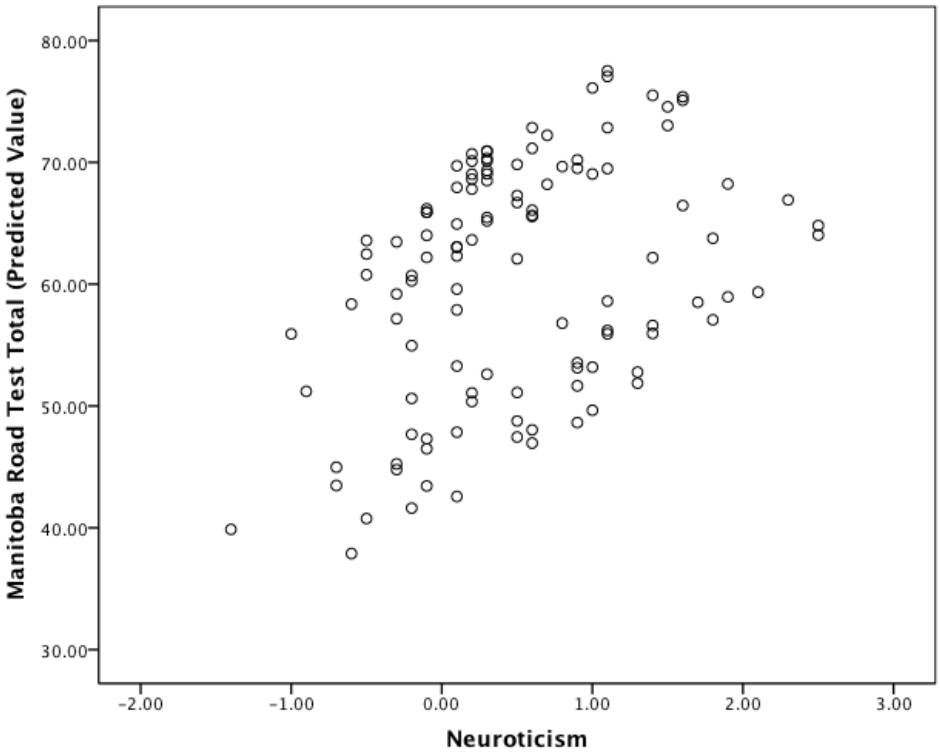

Figure 13. Plot of Neuroticism with the predicted value of the Manitoba Road Test total.

self-reported unsafe driver behaviour was predicted instead of simulated driving performance, the model was also statistically significant, $F(4, 109) = 19.23$, $p < .001$ (see Table 8). The combination of predictor variables accounted for 41% (39% adjusted) of the variability in self-reported unsafe driving behaviour. Sex ($B = 6.76$) was significantly associated with the DBQ total, with men reporting greater instances of unsafe driving behaviour than women.

Conscientiousness. Results of the analysis predicting the Manitoba Road Test total are displayed in Table 9. The model was statistically significant, $F(6, 107) = 3.67$, $p < .01$. Altogether, 17% (12% adjusted) of the variability in the Manitoba Road Test total was predicted by the model. Age ($B = -27.95$) and age-squared ($B = 4.21$) were significant predictors of infractions on the driving simulator. Figure 14 represents the number of demerit points according to the age of the driver. In addition, both the linear ($B = -17.96$) and quadratic ($B = 2.92$) interactions of age and Conscientiousness were statistically significant. In order to assist in interpreting the significant interaction between age and Conscientiousness, a plot of predicted values of the Manitoba Road Test total at various combinations of age and Conscientiousness is presented in Figure 15. As demonstrated in Figure 15, the nature of the quadratic relationship between Conscientiousness and the Manitoba Road Test total differs at different values of age. As age increases, the effect of Conscientiousness on the Manitoba Road Test total becomes greater, until approximately 50 years of age, where the effect of Conscientiousness begins to decrease. In other words, the effect of Conscientiousness on unsafe driving behaviour was greatest among middle-aged participants.

The model predicting self-reported unsafe driving behaviour was also statistically significant, $F(4, 109) = 19.23$, $p < .001$; 41% (39% adjusted) of the variability in the DBQ total was predicted by the combination of independent variables. Sex ($B = 6.17$) was significantly

Table 9

Standard multiple regression of sex, age and Conscientiousness on the Manitoba Road Test total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-0.22	4.49	-0.01
age[a]	-27.95	7.38	-3.03**
age^2	4.21	1.25	2.75**
neoC[b]	2.92	4.04	0.09
ageBYneoC	-17.96	6.73	-2.78**
age^{2}BYneoC	2.92	1.12	2.70*

Note. R^2 = .17; Adjusted R^2 = .12; neoC = Conscientiousness; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoC the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

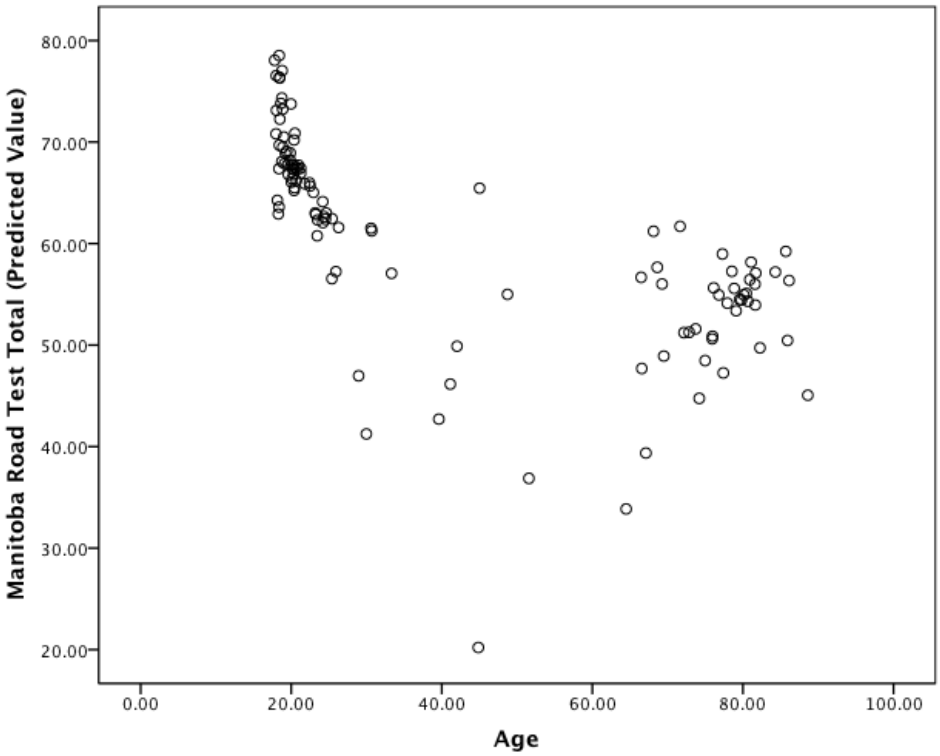

Figure 14. Plot of age with the predicted value of the Manitoba Road Test total (model includes Conscientiousness).

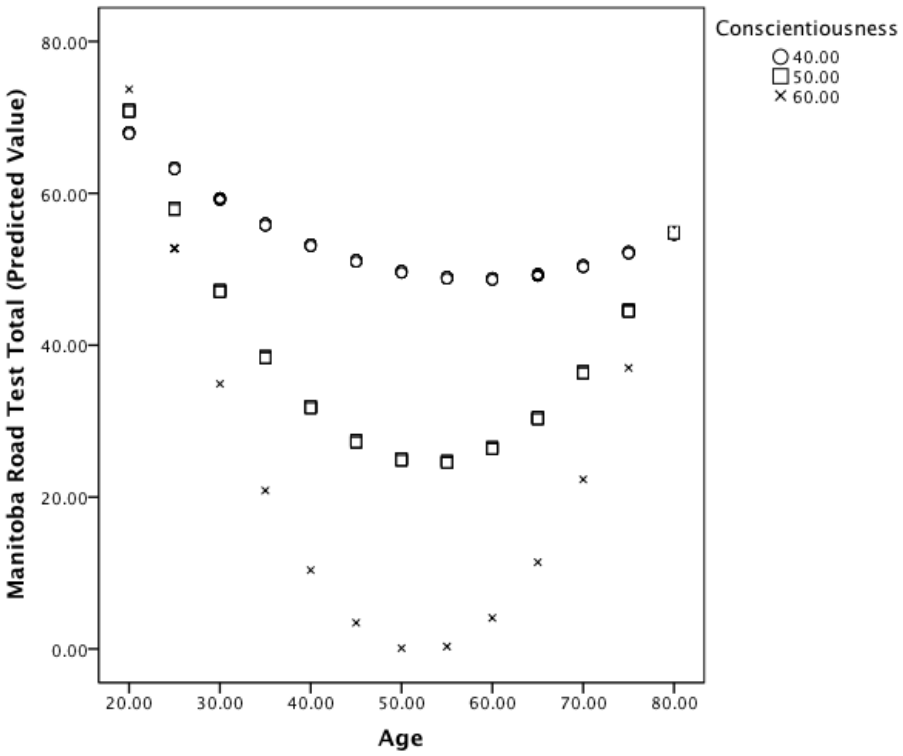

Figure 15. Predicted values of the Manitoba Road Test total at selected combinations of age and Conscientiousness.

Table 10

Standard multiple regression of sex, age and Conscientiousness on the DBQ total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	6.17	2.87	0.16*
age[a]	-2.68	2.79	-0.38
age^2	-0.34	0.47	-0.28
neoC[b]	0.91	2.00	0.04

Note. R^2 = .41; Adjusted R^2 = .39; neoC = Conscientiousness; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoC the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

associated with unsafe driver behaviour, with men reporting more instances of unsafe driver behaviour (see Table 10).

Sensation Seeking. The model predicting the Manitoba Road Test total was statistically significant, $F(4, 109) = 3.55$, $p < .01$. Altogether, 12% (8% adjusted) of the variability in the Manitoba Road Test total was predicted by knowing scores on the predictors variables. Age (B = -12.12) and age-squared (B = 1.61) were both significantly associated with infractions on the simulated drive, with the number of infractions decreasing with increasing age until the relationship was eventually reversed (see Table 11). Consistent with the above models, the U-shaped curve is displayed in Figure 16. The model predicting self-reported unsafe driver behaviour was also statistically significant, $F(4, 109) = 20.53$, $p < .001$; 43% (41% adjusted) of the variability in the DBQ total was explained by the model. Sex (B = 6.27) emerged as a statistically significant predictor of unsafe driver behaviour, with men reporting more unsafe driving actions (see Table 12).

Supplementary Hypotheses

Hypothesis 5. A series of multiple linear regressions were performed to confirm lack of a strong association between Agreeableness, Openness-to-Experience and unsafe driving (as measured by the Manitoba Road Test total and the DBQ total). The most parsimonious models for the data were identified using the method previously described (see Figure 1). Table 4 displays the correlations between variables. Agreeableness and Openness-to-Experience were centered on 50; age was centered on 20. In addition, all predictor variables were rescaled such that the coefficients reflect the impact of a 10-unit increase. Evaluation of the main assumptions of regression revealed that all assumptions were adequately met.

Table 11

Standard multiple regression of sex, age and Sensation Seeking on the Manitoba Road Test Total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-1.46	4.57	-0.03
age[a]	-12.12	4.45	-1.32**
age^2	1.61	0.76	1.05*
ss[b]	-0.69	2.64	-0.03

Note. R^2 = .12; Adjusted R^2 = .08; ss = Sensation Seeking; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for ss the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

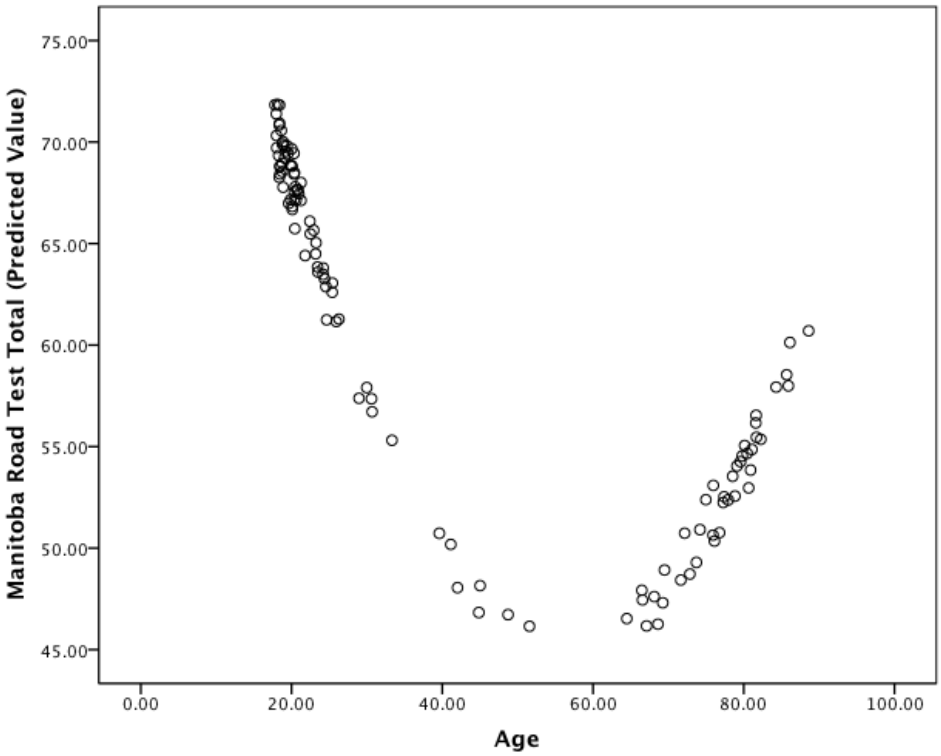

Figure 16. Plot of age with the predicted value of the Manitoba Road Test total (model includes Sensation Seeking).

Table 12

Standard multiple regression of sex, age and Sensation Seeking on the DBQ total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	6.27	2.83	0.17*
age[a]	-2.97	2.75	-0.42
age^2	-0.16	0.47	-0.13
ss[b]	2.94	1.63	0.18

Note. R^2 = .43; Adjusted R^2 = .41; ss = Sensation Seeking; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for ss the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

Table 13

Standard multiple regression of sex, age and Agreeableness on the Manitoba Road Test (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-2.83	4.62	-0.06
age[a]	-11.72	4.41	-1.27**
age^2	1.60	0.74	1.04*
neoA[b]	4.00	2.69	0.14

Note. R^2 = .13; Adjusted R^2 = .10; neoA = Agreeableness; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoA the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

Agreeableness. Results of the analysis predicting the Manitoba Road Test total are presented in Table 13. The model predicting infractions on the simulated drive was statistically significant, $F(4, 109) = 4.15$, $p = .004$; 13% (10% adjusted) of the variability in the Manitoba Road Test total was predicted by knowing scores on the predictors variables. Age ($B = -11.72$) and age-squared ($B = 1.60$) emerged as statistically significant predictors of interest. The classic U-shaped curve is presented in Figure 17. The analysis was repeated with the DBQ total as the dependent variable. The model was also statistically significant, $F(4, 109) = 20.31$, $p < .001$, with 43% (41% adjusted) of the variability in the DBQ total predicted by the model. No significant individual predictors of interest emerged (see Table 14). As predicted, Agreeableness was not significantly associated with simulated or self-reported unsafe driver behaviour.

Openness-to-Experience. The model predicting the Manitoba Road Test total was statistically significant, $F(4, 109) = 3.06$, $p < .01$. Overall, 12% (8% adjusted) of the variability was predicted by the combination of independent variables. Age ($B = -12.18$) and age-squared ($B = 1.66$) were significant predictors (see Table 15). The U-shaped curve representing this association is presented in Figure 18. The analysis was repeated with the DBQ total as the dependent variable. The model was statistically significant, $F(4, 109) = 19.65$, $p < .001$; 42% (40% adjusted) of the variability in the DBQ total was predicted by knowing scores on the predictor variables. As evidenced in Table 16, sex ($B = 6.19$) emerged as a significant predictor, with men reporting greater instances of unsafe driver behaviour. Consistent with our hypothesis, Openness-to-Experience did not significantly predict simulated or self-reported unsafe driver behaviour.

Hypothesis 6. Multiple linear regression analyses were performed in order to explore the presence of possible relationships between sex, age, personality, and performance scores on the

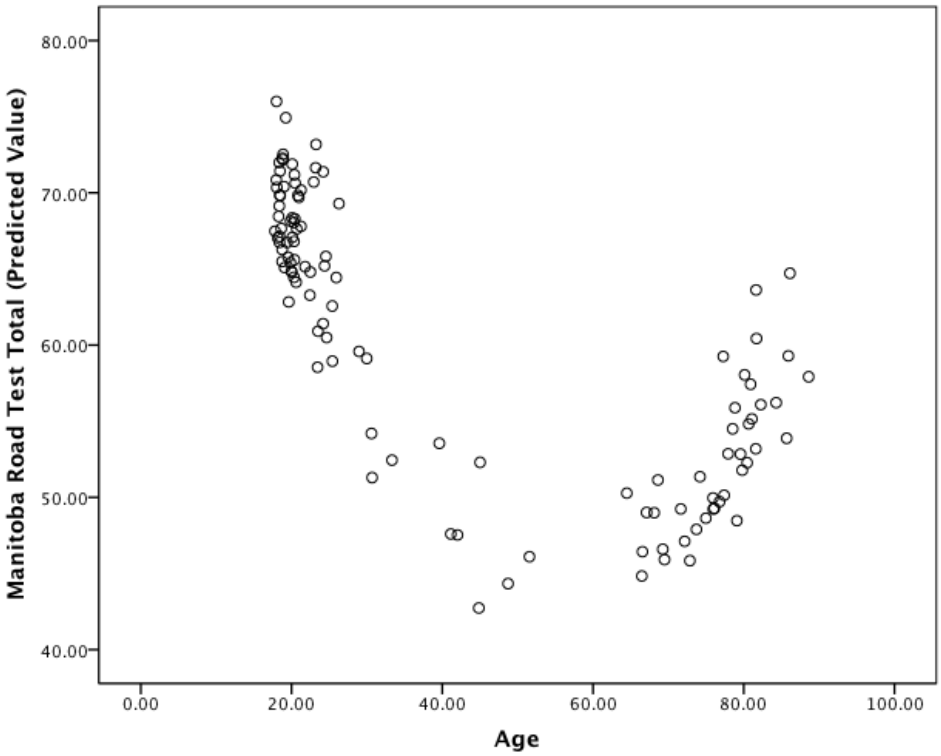

Figure 17. Plot of age with the predicted value of the Manitoba Road Test total (model includes Agreeableness).

Table 14

Standard multiple regression of sex, age and Agreeableness on the DBQ total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	5.26	2.89	0.14
age[a]	-2.27	2.76	-0.32
age^2	-0.40	0.46	-0.34
neoA[b]	2.80	1.68	0.12

Note. R^2 = .43; Adjusted R^2 = .41; neoA = Agreeableness; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoA the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

Table 15

Standard multiple regression of sex, age and Openness-to-Experience on the Manitoba Road Test (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-1.47	4.57	-0.03
age[a]	-12.18	4.44	-1.32**
age^2	1.66	0.74	1.08*
neoO[b]	-1.18	3.56	-0.03

Note. R^2 = .12; Adjusted R^2 = .08; neoO = Openness-to-Experience; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoO the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

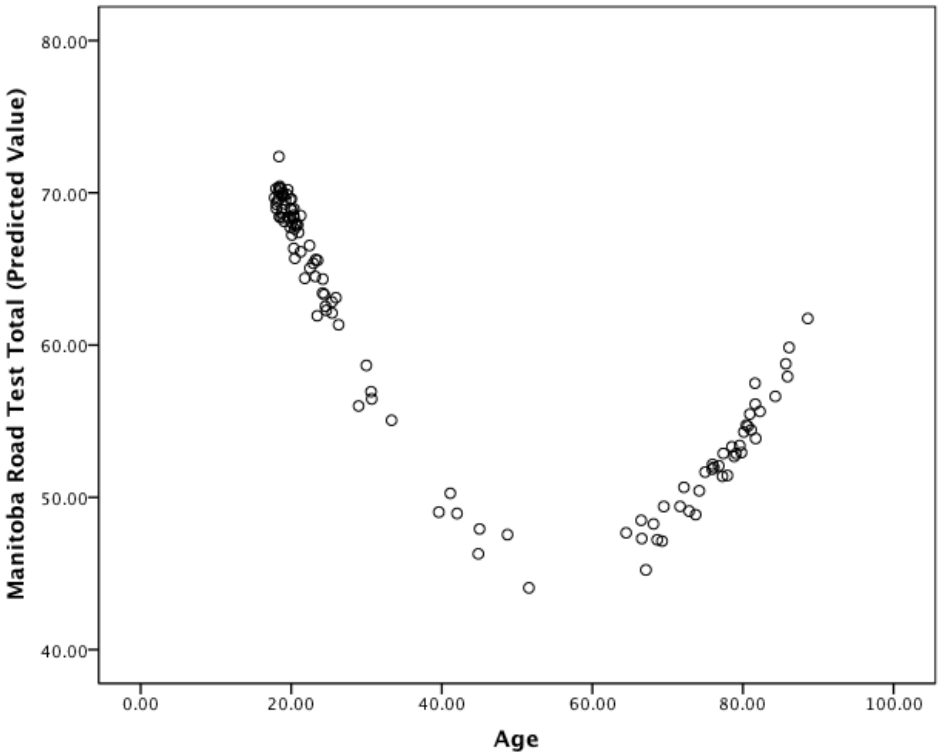

Figure 18. Plot of age with the predicted value of the Manitoba Road Test total (model includes Openness-to-Experience).

Table 16

Standard multiple regression of sex, age and Openness-to-Experience on the DBQ total (N = 114)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	6.19	2.85	0.17*
age[a]	-2.56	2.77	-0.36
age^2	-0.34	0.46	-0.29
neoO[b]	-2.43	2.22	-0.08

Note. R^2 = .42; Adjusted R^2 = .40; neoO = Openness-to-Experience; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoO the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

UFOV. The process of identifying the most parsimonious models for the data is presented in Figure 1. Table 4 displays the correlations between variables. A series of analyses were completed for each personality trait with the UFOV sum as the dependent variable. Evaluation of the main assumptions of regression revealed that all assumptions were adequately met.

Extraversion. Results of the regression analysis that included Extraversion as a predictor are presented in Table 17. The model predicting UFOV performance was statistically significant, $F(4, 101) = 60.60$, $p < .001$. The independent variables accounted for 71% (69% adjusted) of the variability in the UFOV sum. Age ($B = 41.18$) emerged as a statistically significant predictor, with the UFOV sum increasing with increasing age (see Figure 19).

Neuroticism. The model predicting UFOV performance was statistically significant, $F(5, 100) = 53.22$, $p < .001$. Altogether, 73% (71% adjusted) of the variability in UFOV performance was predicted by the model. Age ($B = 37.35$) emerged as a significant predictor, with the UFOV sum increasing with increasing age (see Table 18 and Figure 20). In addition, the linear interaction of age and Neuroticism ($B = -8.30$) was significantly associated with the UFOV sum. A plot of predicted values of the UFOV sum at various combinations of age and Neuroticism is presented in Figure 21. As demonstrated in Figure 21, the slope of the linear function relating age to the UFOV sum depends on the level of Neuroticism. The higher the level of Neuroticism, the steeper the slope relating age to the UFOV sum. More specifically, Neuroticism did not have an effect on the UFOV performance of young participants, whereas, among older participants, high Neuroticism had a protective effect on UFOV performance.

Conscientiousness. The model predicting UFOV performance was statistically significant, $F(4, 101) = 61.90$, $p < .001$, with 71% (70% adjusted) of the variability in the UFOV sum predicted by the independent variables. Age ($B = 42.19$) was a statistically significant

Table 17

Standard multiple regression of sex, age and Extraversion on the UFOV test sum (N = 106)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-10.82	15.42	-0.04
age[a]	41.18	14.99	0.83**
age^2	0.18	2.49	0.02
neoE[b]	2.76	12.30	0.01

Note. R^2 = .71; Adjusted R^2 = .69; neoE = Extraversion; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoE the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

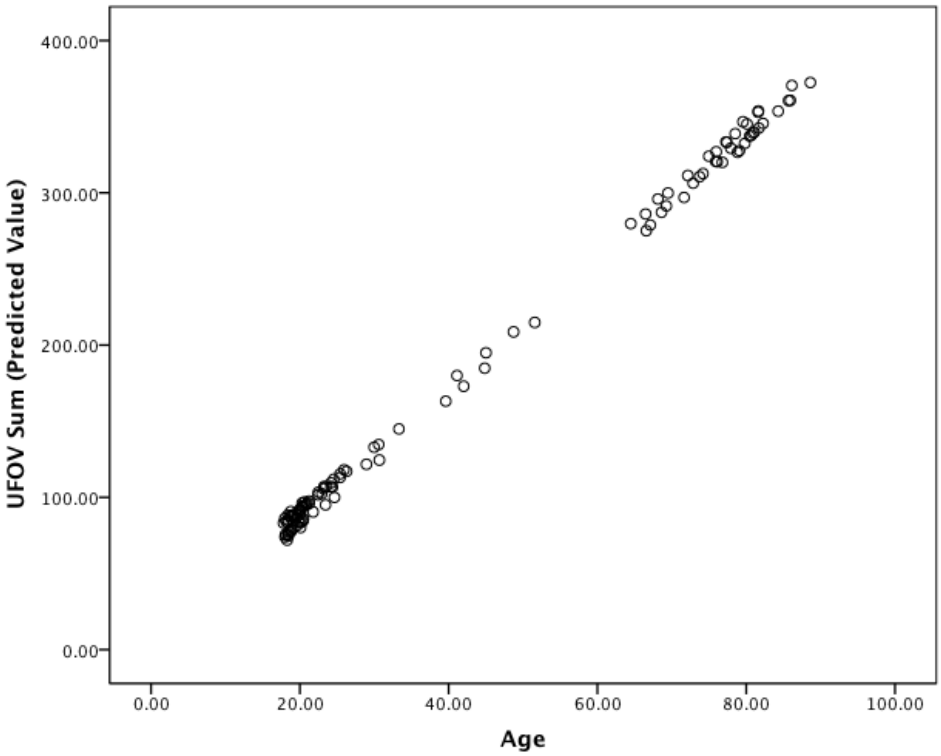

Figure 19. Plot of age with the predicted value of the UFOV test sum (model includes Extraversion).

Table 18

Standard multiple regression of sex, age and Neuroticism on the UFOV test sum (N = 106)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-8.24	15.49	-0.03
age[a]	37.35	15.17	0.75*
age^2	1.83	2.56	0.22
neoN[b]	15.36	16.19	0.09
ageBYneoN	-8.30	3.42	-0.25*

Note. R^2 = .73; Adjusted R^2 = .71; neoN = Neuroticism; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoN the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

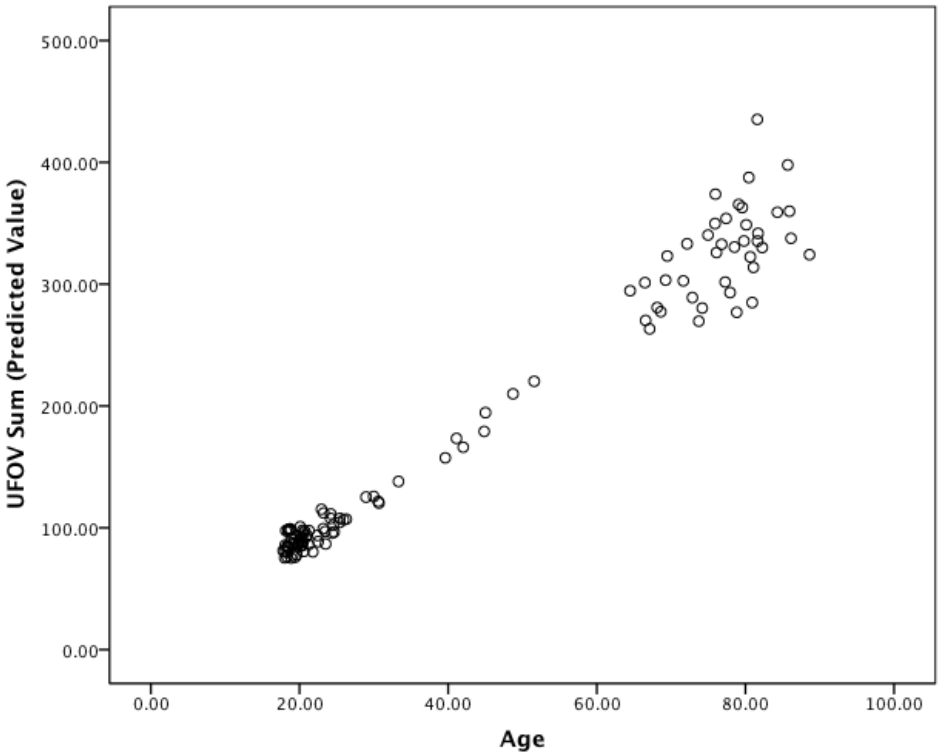

Figure 20. Plot of age with the predicted value of the UFOV test sum (model includes Neuroticism).

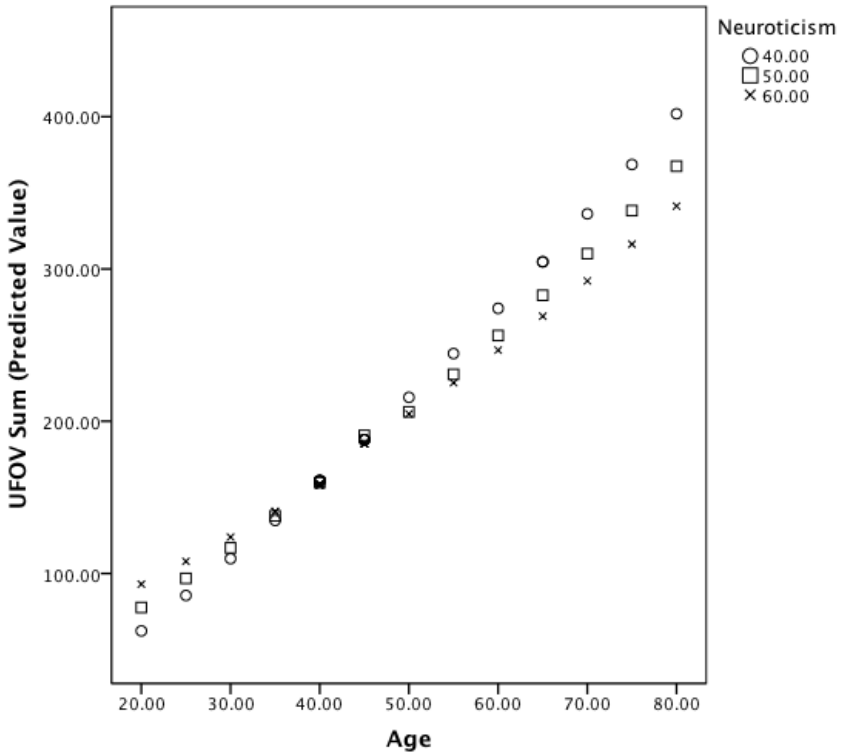

Figure 21. Predicted values of the UFOV test sum at selected combinations of age and Neuroticism.

Table 19

Standard multiple regression of sex, age and Conscientiousness on the UFOV test sum (N = 106)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-8.83	14.68	-0.03
age[a]	42.19	14.82	0.85**
age^2	-0.15	2.48	-0.02
neoC[b]	-12.55	9.97	-0.07

Note. R^2 = .71; Adjusted R^2 = .70; neoC = Conscientiousness; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoC the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

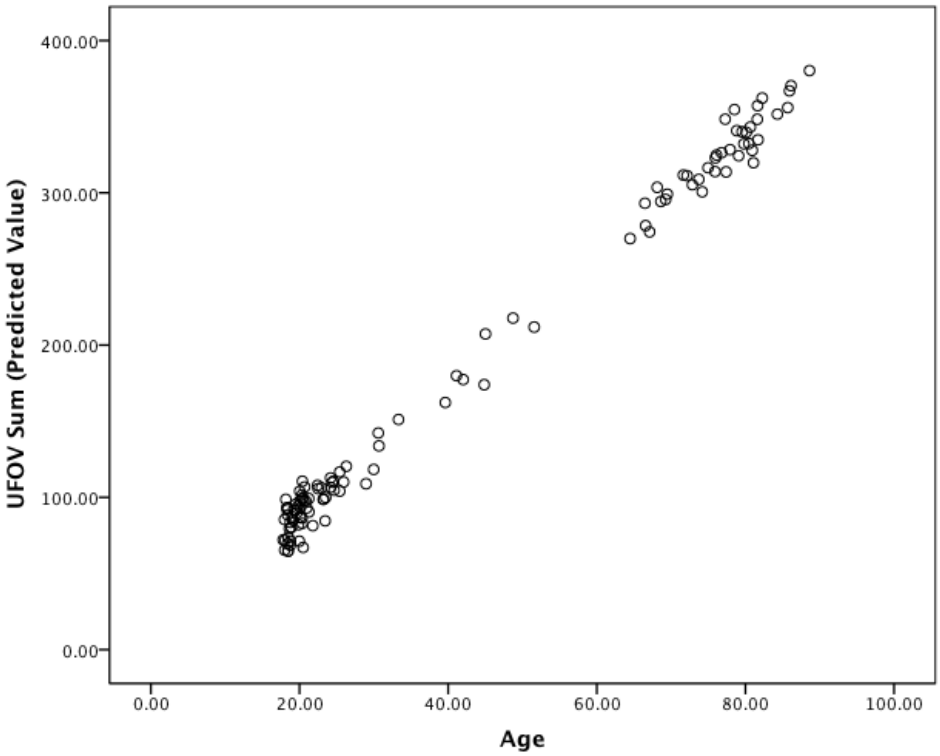

Figure 22. Plot of age with the predicted value of the UFOV test sum (model includes Conscientiousness).

predictor with the UFOV sum increasing with increasing age (see Table 19 and Figure 22).

Agreeableness. The model predicting the UFOV sum was statistically significant, $F(5, 100) = 52.97$, $p < .001$ (see Table 20). The model accounted for 73% (71% adjusted) of the variability in UFOV performance. The linear interaction of age and Agreeableness ($B = -7.70$) was significant. As demonstrated in Figure 23, the slope of the linear function relating age to the UFOV sum depends of the level of Agreeableness. The higher the level of Agreeableness, the steeper the slope relating age to the UFOV test sum. Agreeableness has a protective effect on UFOV performance, such that high Agreeableness is associated with a lower UFOV sum (better performance).

Openness-to-Experience. The model predicting UFOV performance was statistically significant, $F(5, 100) = 53.34$, $p < .001$ (see Table 21); 73% (71% adjusted) of the variability in the UFOV sum was predicted by the independent variables. Age ($B = 32.11$) was significantly related to the UFOV sum, with the UFOV sum increasing with increasing age (see Figure 24). In addition, the linear interaction of age and Openness-to-Experience ($B = -9.50$) emerged as statistically significant (see Table 21). Figure 25 demonstrates the nature of the interaction between age and Openness-to-Experience. The higher the level of Openness-to-Experience, the steeper the slope relating age to the UFOV test sum. Openness-to-Experience has a protective effect on speed of information processing with increasing age, such that high Openness-to-Experience is associated with a lower UFOV sum (improved performance).

Sensation Seeking. The model predicting the UFOV sum was significant, $F(6, 99) = 43.21$, $p < .001$. Together, the independent variables accounted for 72% (71% adjusted) of the variability in UFOV performance. The linear ($B = -33.27$) and quadratic interactions of age and Sensation Seeking ($B = 5.60$) emerged as significant predictors of UFOV performance (see Table

Table 20

Standard multiple regression of sex, age and Agreeableness on the UFOV test sum (N = 106)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-8.07	14.59	-0.03
age[a]	26.38	15.59	0.53
age^2	0.63	2.41	0.08
neoA[b]	1.51	10.36	0.01
ageBYneoA	-7.70	3.36	-0.28*

Note. R^2 = .73; Adjusted R^2 = .71; neoA = Agreeableness; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoA the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

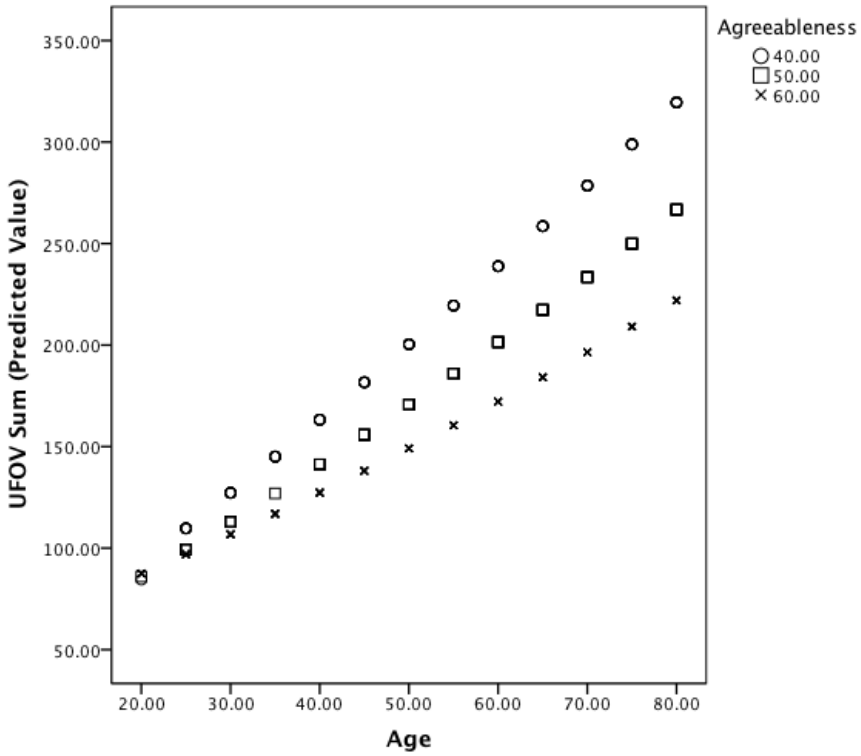

Figure 23. Predicted values of the UFOV test sum at selected combinations of age and Agreeableness.

Table 21

Standard multiple regression of sex, age and Openness-to-Experience on the UFOV test sum (N = 106)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-14.93	14.51	-0.06
age[a]	32.11	15.15	0.65*
age^2	1.33	2.46	0.16
neoO[b]	1.39	14.58	0.01
ageBYneoO	-9.50	4.30	-0.16*

Note. R^2 = .73; Adjusted R^2 = .71; neoO = Openness-to-Experience; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for neoO the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

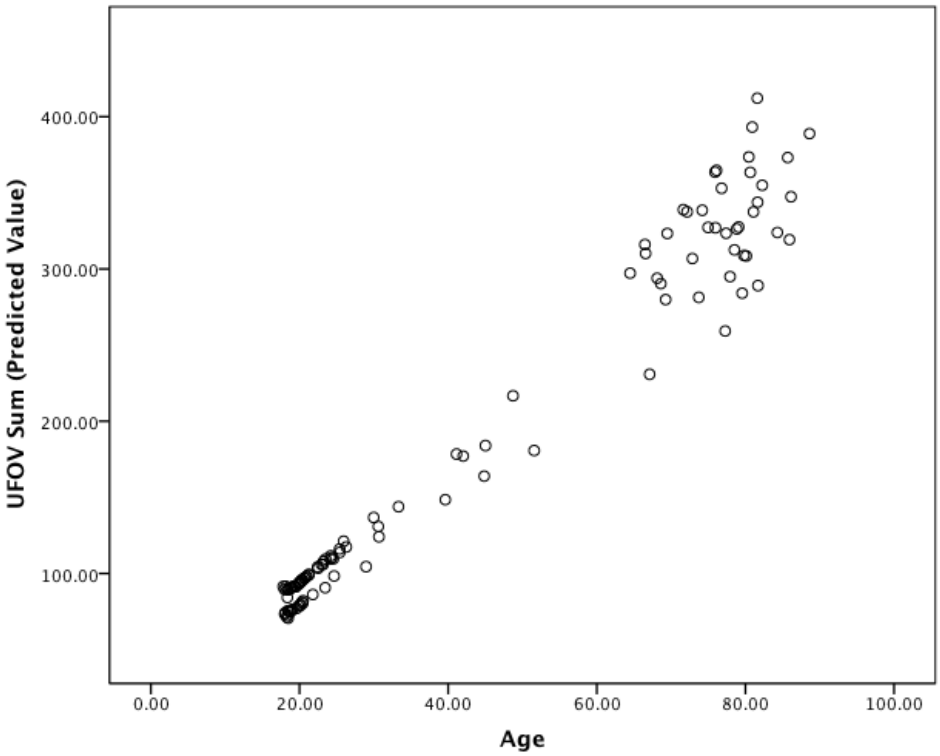

Figure 24. Plot of age with the predicted value of the UFOV test sum (model includes Openness-to-Experience).

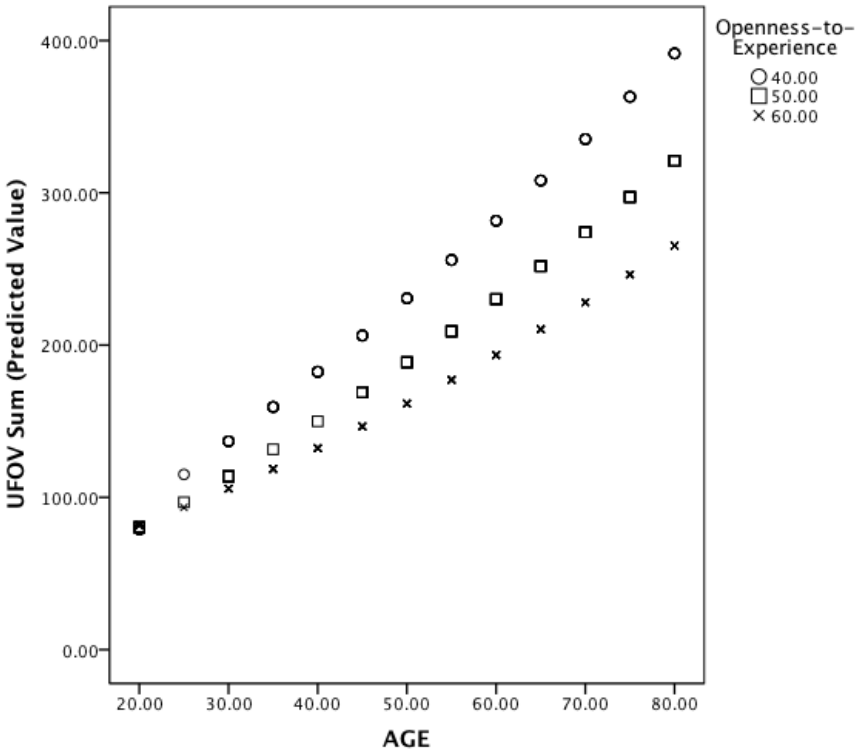

Figure 25. Predicted values of the UFOV test sum at selected combinations of age and Openness-to-Experience.

Table 22

Standard multiple regression of sex, age and Sensation Seeking on the UFOV test sum (N = 106)

Variable	*B*	*SE B*	*ß*
sex (Male = 1, Female = 0)	-17.28	14.96	-0.07
age[a]	11.26	19.43	0.23
age^2	5.26	3.50	0.64
ss[b]	0.94	11.68	0.01
ageBYss	-33.27	14.62	-1.50**
age^{2}BYss	5.60	2.41	1.50**

Note. R^2 = .72; Adjusted R^2 = .71; ss = Sensation Seeking; [a] for age the raw score was centered on a value of 20 and scaled such that the coefficient reflects the impact of a 10-unit increase; [b] for ss the raw T-score centered on a value of 50 and scaled such that the coefficient reflects the impact of a 10-unit (1 SD) increase.
*p <.05. ** p <.01.

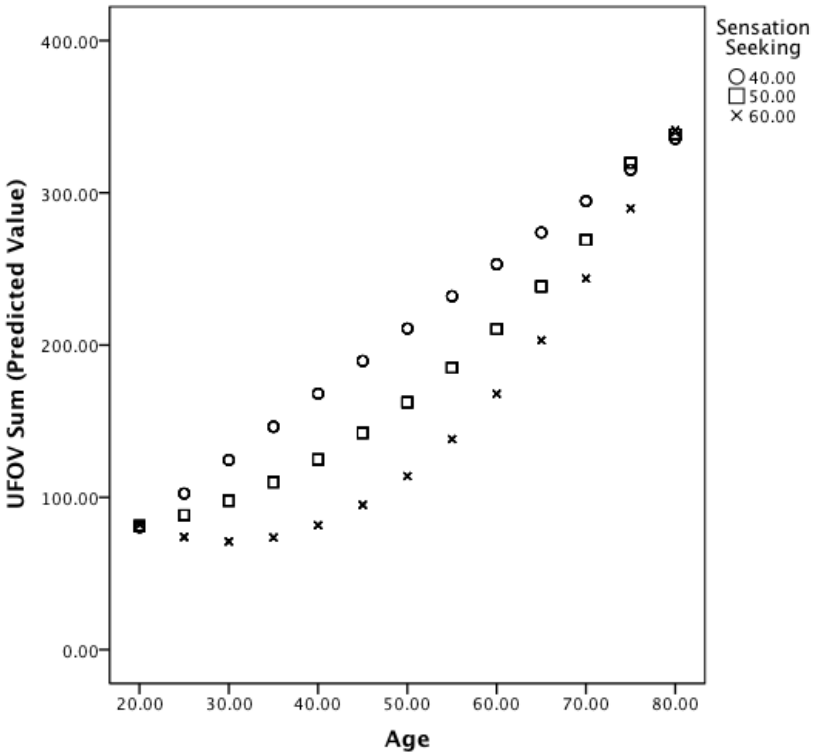

Figure 26. Predicted values of the UFOV test sum at selected combinations of age and Sensation Seeking.

22). A plot of predicted values of the UFOV sum at various combinations of age and Sensation Seeking is presented in Figure 26. As demonstrated in Figure 26, the nature of the linear relationship between Sensation Seeking and UFOV performance is dependent on age. The higher the level of Sensation Seeking, the steeper the slope relating age to the UFOV sum. The effect of Sensation Seeking on the UFOV sum becomes greater with increasing age until approximately 50 years of age where the effect of Sensation Seeking begins to decrease.

Discussion

Researchers continue to discover a number of individual difference variables in the driver that influence the safe operation of a motor vehicle. One factor consistently linked to unsafe driving among young and middle-aged adults is personality (Schwebel et al., 2007). Surprisingly, little research has examined the role of personality in unsafe driving behaviour among older adults. Given the empirical evidence demonstrating a relationship between personality and driver safety among younger populations and the relative stability of personality throughout adulthood, a logical extension was to examine whether there are shared personality features that predispose both young and older adults to risky driving. To the best of the authors' knowledge, previous studies have not examined the role of personality in the prediction of unsafe driving behaviour (observational and self-report) of both young and older adults concurrently. See Table 23 for a summary of the results.

Main Hypotheses

Hypotheses 1. *We expected to observe an inverse relationship between Conscientiousness and unsafe driver behaviour.*

Hypothesis 2. *We expected to observe a positive relationship between the traits of Extraversion, Neuroticism, and Sensation Seeking and unsafe driving.*

Table 23. *Visual representation of the multiple regression models and associated significant and non-significant predictor variables*

Personality Variable	Simulated Driving Performance (Manitoba Road Test Total)	Self-Reported Driving Performance (DBQ)	UFOV
Extraversion	☒ sex ☑ age ☑ age^2 ☑ neoE ☒ ageBYneoE ☒ age^2BYneoE	☒ sex ☒ age ☒ age^2 ☒ neoE ☒ ageBYneoE ☒ age^2BYneoE	☒ sex ☑ age ☒ age^2 ☒ neoE ☒ ageBYneoE ☒ age^2BYneoE
Neuroticism	☒ sex ☑ age ☒ age^2 ☑ neoN ☒ ageBYneoN ☒ age^2BYneoN	☑ sex ☒ age ☒ age^2 ☒ neoN ☒ ageBYneoN ☒ age^2BYneoN	☒ sex ☑ age ☒ age^2 ☒ neoN ☑ ageBYneoN ☒ age^2BYneoN
Conscientiousness	☒ sex ☑ age ☑ age^2 ☒ neoC ☑ ageBYneoC ☑ age^2BYneoC	☑ sex ☒ age ☒ age^2 ☒ neoC ☒ ageBYneoC ☒ age^2BYneoC	☒ sex ☑ age ☒ age^2 ☒ neoC ☒ ageBYneoC ☒ age^2BYneoC
Agreeableness	☒ sex ☑ age ☑ age^2 ☒ neoA ☒ ageBYneoA ☒ age^2BYneoA	☒ sex ☒ age ☒ age^2 ☒ neoA ☒ ageBYneoA ☒ age^2BYneoA	☒ sex ☒ age ☒ age^2 ☒ neoA ☑ ageBYneoA ☒ age^2BYneoA

Table 23 *(continued)*

Openness-to-Experience	☒ sex ☑ age ☑ age^2 ☒ neoO ☒ ageBYneoO ☒ age^{2}BYneoO	☑ sex ☒ age ☒ age^2 ☒ neoO ☒ ageBYneoO ☒ age^{2}BYneoO	☒ sex ☑ age ☒ age^2 ☒ neoO ☑ ageBYneoO ☒ age^{2}BYneoO
Sensation Seeking	☒ sex ☑ age ☑ age^2 ☒ ss ☒ ageBYss ☒ age^{2}BYss	☑ sex ☒ age ☒ age^2 ☒ ss ☒ ageBYss ☒ age^{2}BYss	☒ sex ☒ age ☒ age^2 ☒ ss ☑ ageBYss ☑ age^{2}BYss

Note. neoE = Extraversion; neoN = Neuroticism; neoC Conscientiousness; neoA = Agreeableness; neoO = Openness-to-Experience; SSS-V total = Sensation Seeking Scale – Form V Total; ☑ = significant predictor, $p \leq .05$; ☒ = non-significant predictor, $p > .05$

With the exception of the association between Sensation Seeking and self-reported unsafe driving behaviour, results of preliminary analyses to explore the relationship between personality and unsafe driver behaviour demonstrated no association between personality and observer-rated and self-reported driving behaviour. While the correlations and scatterplots provide an indication of the overall relationship between the dependent and predictor variables, they do not give us a precise idea of the relationship between the two variables as they fail to consider other important predictor variables (e.g., age, sex). In addition, the univariate analyses do not consider the possibility of nonlinear relationships between variables. To further explain these possibilities, hypotheses 3, 4, and 5 were tested with multivariable analyses.

Hypothesis 3. *We expected to observe higher levels of Conscientiousness among older drivers and consequently, lower risk of unsafe driving compared to their younger counterparts.*

Contrary to predictions, when participants were categorized into two age groups (<65 years, young; 65+ years, older) for the purposes of comparison, young drivers were significantly higher in Conscientiousness than older drivers. Naggara and colleagues (2011) recommend that, if a continuous variable is to be dichotomized, the choice of cut-point should be done prior to data analysis (as done by the authors) and with some theoretical justification. In the current crash literature, older drivers are customarily defined as individuals aged 65 years or older. As such, this consideration led to our determination of the cut-point. However, caution is recommended in interpreting this finding due to the problems associated with dichotomizing continuous variables. In addition to increasing the probability of Type II errors and decreasing power, dichotomizing variables results in a tremendous loss of information. For example, participants above or below age 65 are treated as different yet they may differ little on the dependent and independent variables (e.g., it is probable that a participant aged 64 is more comparable to a participant aged

65 years than to a participant aged 20 years).

In addition, age and age-squared emerged as significant predictors of infractions on the simulated drive. These results are consistent with the literature that has demonstrated a U-shaped function relating driving fatality rates with age, starting high for young drivers, declining and remaining steady for middle-aged drivers, and then steadily increasing with drivers aged 65 and older (Bédard et al., 2001; McGwin & Brown, 1999; Whitfield & Fife, 1987). In addition, the results of the analysis predicting unsafe driver performance on the simulated drive revealed a significant nonlinear interaction between age and Conscientiousness. The effect of Conscientiousness was most pronounced among middle-aged drivers, such that those high in Conscientiousness were at a lower risk of unsafe driving compared to those low in Conscientiousness. The results observed among middle-aged drivers are consistent with research demonstrating a significant inverse link between Conscientiousness and unsafe driver behaviour (Arthur & Graziano, 1996). These results suggest that middle-aged drivers who describe themselves as more responsible, attentive, careful, persistent, and orderly are less likely to commit unsafe driver actions on the driving simulator. Unlike predictions, Conscientiousness did not have an effect on unsafe driver behaviour among drivers at both ends of the age continuum. These results suggest that the effect of personality may be diluted in the presence of other variables enacting a significant effect on the driving performance of the young and old. To date, much of the literature on safety among older drivers has focused primarily on cognitive, perceptual, and motor processes that change in ways that may influence safe driving. It is possible that such factors have diluted the effect of Conscientiousness among older drivers. This is consistent with Owsley and colleagues' (2003) proposal that research on personality should focus on how personality interacts with functional impairment in understanding older driver

behaviour. Conversely, the problems encountered by young drivers are often attributed to inexperience. Experience is important in that drivers learn to handle a number of driving tasks, some of which become automated, thus allowing more time and capacity for assessing the situation on the road (Olsen & Dewar, 2007). Akin to the oldest participants, driving inexperience may have reduced the effect of Conscientiousness among the youngest participants. As the risk factors that are present among drivers at both ends of the age continuum are not present among middle-aged participants, the effect of Conscientiousness may have been most pronounced among that subgroup. Another possible explanation for the results is that experience with video games or the driving simulator was not measured and may have contributed to simulated driving behaviour. For example, it is possible that older drivers high in Conscientiousness were unable to be responsible, attentive, and careful as the simulated environment was novel and therefore presented new information to participants unfamiliar with video games. Additionally, a small minority of participants had previous experience with the driving simulator owing to having previously participated in other studies within the same laboratory. It is probable that pre-existing comfort and familiarity influenced driving behaviour among this minority. Future research should consider the possible relationship between Conscientiousness and previous exposure to the driving simulator and video games.

Sex emerged as the only significant predictor of self-reported unsafe driver behaviour, with men reporting more instances of unsafe driving behaviours. The strong effect of sex confirms a well-established finding within the risk research community (Oltedal & Rundmo, 2006). Numerous researchers have reported sex differences in risk taking behaviour. Men's crash involvement is more often related to the violation of traffic laws than is women's (Simon & Corbett, 1996). Al-Balbissi (2003), in his examination of the influence of driver sex on crash

rates, found significantly higher crash rates among male drivers when compared to female drivers. Similar results were observed when adjusted for distance traveled.

Hypothesis 4. *We expected to observe higher scores of Extraversion, Neuroticism, and Sensation Seeking among young drivers compared to older drivers, and thus, greater risk of unsafe driving among young drivers.*

Extraversion. Contrary to our hypothesis, no significant difference in scores of Extraversion was observed when age was categorized into two groups (<65 years, young; 65+ years, older). As noted previously, the problems inherent in dichotomizing continuous variables should be considered when interpreting the above finding. In addition, we did not observe an interaction between age and Extraversion as hypothesized. Specifically, we did not observe higher scores of Extraversion and consequently greater risk of unsafe driver behaviour among young drivers. There was, however, a statistically significant positive relationship between Extraversion and unsafe driving on the simulator, such that those higher on the trait of Extraversion engaged in significantly greater unsafe driving actions. To the best of the authors' knowledge, the role of Extraversion in the prediction of unsafe driver behaviour has not been measured observationally (simulated or on-road) therefore, these results cannot be confirmed or disconfirmed. These results are however, consistent with Eysenck's (1962) postulation that extraverts are at higher risk of crash involvement due to low levels of vigilance and subsequently reduced attention to tasks (e.g., driving). The relationship between Extraversion and vigilance will be revisited later in relation to UFOV performance. Given the inherent safety in the simulated environment (e.g., free from injury), it is possible that participants high in Extraversion sought stimulation to a greater degree (as proposed by Clarke & Robertson, 2005) and consequently demonstrated significantly greater unsafe driver actions on the simulated drive,

relative to those low in Extraversion. Certainly, these findings would need to be replicated in order to ascertain their reliability. In addition to Extraversion as a significant predictor, age and age-squared emerged as significant predictors of infractions on the simulated drive. This expected relationship is demonstrated by a U-shaped function relating simulator infractions with age.

Unlike in the prediction of unsafe driving behaviour on the simulator, Extraversion did not emerge as a significant predictor of self-reported unsafe driver actions. While there is much research to suggest an association between Extraversion and self-reports of unsafe driver behaviour, the literature in this area is mixed and our results are not unlike others in this field (Elander et al., 1993; Lester, 1991). One possible explanation for our somewhat divergent results is the variability in what represents unsafe driver behaviour. For instance, a majority of studies have investigated the relationship between Extraversion and self-reported crashes. While this method seems to make intuitive sense, crashes are relatively rare occurrences. As such, this measure of unsafe driver behaviour may not adequately capture an individual's unsafe driving behaviour.

Neuroticism. Contrary to predictions, significantly lower scores of Neuroticism were observed among young drivers (<65 years) compared to older drivers (65+ years). As noted elsewhere, caution is recommended in interpreting the above finding. Unlike our original hypothesis, we did not observe an interaction between age and Neuroticism; however, Neuroticism emerged as a significant predictor of infractions on the simulated drive, such that compared to those low in Neuroticism, participants high in Neuroticism committed a greater number of driving infractions on the simulated drive. These results are consistent with the literature suggesting a positive relationship between Neuroticism and unsafe driver behaviour

(Hansen, 1989; Matthews et al., 1991; Sümer et al., 2005). Individuals high in Neuroticism have been described as anxious, vulnerable to stress, lacking in confidence, moody, and easily frustrated (McCrae & Costa, 2003). These features have the effect of decreasing cognitive and performance capacities (e.g., reaction time) and of increasing errors (Clarke & Robertson, 2005). As previously noted, Clarke & Robertson (2005) proposed that individuals high on the trait of Neuroticism may respond more negatively to environmental stressors. The simulated environment enables researchers to ensure that environmental stressors are held constant among participants, thereby eliminating varying degrees of stressors as possible confounders. Age also emerged as a significant predictor of unsafe driver behaviour on the simulated drive, such that increasing age was associated with a decrease in infractions on the simulated drive. It is important to note, however, that while the quadratic component of age was not a significant predictor of infractions, the relationship more closely illustrates a U-shaped curve than a straight line.

Conversely, Neuroticism was not significantly associated with self-reported unsafe driver behaviour. As noted above in relation to Extraversion, one possible explanation for these somewhat divergent results is the variability present between studies in what constitutes unsafe driver behaviour. Consistent with the literature, sex emerged as a significant predictor of self-reported driver behaviour, with men reporting significantly greater occurrences of unsafe driving behaviour.

Sensation Seeking. Consistent with predictions, young drivers (<65 years) scored significantly higher on Sensation Seeking than their older counterparts (65+ years). As noted previously, caution is recommended in interpreting the aforementioned result. Unlike our original hypothesis, we did not observe an interaction between age and Sensation Seeking. In

fact, age and age-squared were the only significant predictors of infractions on the simulated drive. Sex emerged as the only significant predictor of self-reported unsafe driver behaviour, such that men reported significantly more unsafe driver behaviours. These results are divergent from the empirical research consistently linking Sensation Seeking to risky driving behaviour. It is worth noting, however, that the instruments used to assess Sensation Seeking have varied considerably between studies. For example, more often than not, Sensation Seeking is operationally defined in terms of scores on the Sensation Seeking Scale (SSS); however, this scale has been revised several times (Jonah, 1997). While Form V of the SSS (SSS-V) is the most commonly used measure of Sensation Seeking, abbreviated versions of the SSS-V have been developed by other researchers, thereby making interpretation of findings difficult. In addition, the SSS-V consists of four subscales (e.g., Thrill and Adventure Seeking, Experience Seeking) that have been found to relate to various risky behaviours. While using the subscale scores may have been beneficial in further understanding the relationship of the construct to unsafe driver behaviour we opted to use an overall score of Sensation Seeking to examine possible relationships in order to reduce the number of parameters in the model. Specifically, rules of thumb for the sample sizes required for modeling suggest that for linear models, 10 to 15 observations per predictor variable will produce good estimates (Babyak, 2004). In addition, Green (1991) proposes that a larger number of observations may be required if the predictors are highly correlated. With one exception, correlations between the four subscales were statistically significant and ranged from .25 to .53, suggesting that we did not have ample sample size to include all subscales of the SSS-V in the models. Furthermore, overfitting the models, by including more terms than are necessary, poses considerable risk for spurious findings (Babyak, 2004), further raising concerns about the inclusion of all subscales of the SSS-V in the models.

In addition, most studies have relied on self-report measures of driving behaviour or driving records, suggesting the possibility that our inclusion of the simulated drive could have tapped somewhat different aspects of risky driving.

Supplementary Hypotheses

Hypothesis 5. *We did not expect to observe significant relations among the remaining Big Five traits (Agreeableness and Openness-to-Experience) and unsafe driving.*

Agreeableness. As predicted, Agreeableness did not emerge as a significant predictor of observed or self-reported unsafe driver behaviour. Consistent with the above models, age and age-squared emerged as significant predictors of infractions on the simulator. No significant individual predictors of interest emerged in the prediction of self-reported unsafe driver behaviour.

Openness-to-Experience. As predicted, Openness-to-Experience did not emerge as a significant predictor of observed or self-reported unsafe driver behaviour. These results are consistent with those of Arthur and Graziano (1996) and Clarke and Robertson (2005) who found weak or insignificant links between Openness-to-Experience and crash risk. As expected, the linear and quadratic components of age were significant predictors of infractions on the simulated drive. In addition, sex emerged as a significant predictor of self-reported unsafe driver behaviour, with men reporting significantly higher instances of unsafe driving behaviour. This finding is consistent with the literature, as noted elsewhere.

Hypothesis 6. *We expected to observe lower performance scores on a measure of processing speed related to driving among individuals high on the traits of Extraversion, Neuroticism, and Openness-to-Experience.*

Extraversion. Unlike predictions, we did not observe poorer performance (as evidenced by a higher UFOV sum) among those high on Extraversion. Despite previous research suggesting that Extraversion shows the most stable and highest correlation with speed of information processing among adolescents (Zebec et al., 2011), our results revealed that among the personality dimensions, Extraversion emerged as least correlated with UFOV performance. Unlike results presented previously (in the prediction of unsafe simulated driver behaviour), the relationship between Extraversion and low levels of vigilance, as proposed by Eysenck (1962), in the prediction of reduced attention to tasks was not replicated in the prediction of UFOV performance. Eysenck's (1962) theory of Extraversion also predicts that in cases of slightly increased levels of external arousal, higher Extraversion is related to slightly higher speed of information processing; this was not observed among our sample. Socan and Bucik (1998) found that Extraversion correlated positively with speed of information processing. They also determined that different facets of Extraversion showed different strengths of relationship measures with speed of information processing, offering support for inclusion of a more inclusive measure of the lower order traits of the Big Five. Age was the only variable to emerge as a statistically significant predictor of the UFOV sum, such that older participants had significantly higher UFOV sums than younger participants. These results are as expected and in line with the evidence for age-related declines in visual field (Ball, Beard, Roenker, Miller, & Griggs, 1988).

Neuroticism. Contrasting with predictions, we did not observe higher UFOV sums among those high on the trait of Neuroticism; however, the linear interaction of age and Neuroticism emerged as a statistically significant predictor of the UFOV performance. Neuroticism did not have an effect on performance of young participants; however, among older

participants, high Neuroticism had a protective effect on UFOV performance. Specifically, older participants higher on the trait of Neuroticism had quicker processing speeds than those low on the trait of Neuroticism. This is largely inconsistent with much of the research that has observed slower processing speeds among individuals high in Neuroticism on measures of speed of information processing (Edman, Schalling, & Levander, 1983; Eysenck, 1967; Stelmack, Houlihan, & McGarry-Roberts, 1993). Anxious distress, a component of Neuroticism, includes tendencies toward anxiety. Given the relationship between moderate levels of anxiety and enhanced performance, it is possible that our sample of older adults varied in some important way from previous samples. Wolfe (1989) noted that performance anxiety can have both positive and negative effects on performance. He identified adaptive and maladaptive components of performance anxiety. The adaptive components include arousal/intensity and competence/confidence; the maladaptive components are nervousness/apprehension and self-conscientiousness/distractibility. As such, one possible explanation for the divergent findings is the possibility of increased levels of anxious distress and adaptive anxiety (leading to improved UFOV performance) among our sample of older adults. In addition to the linear interaction of age and Neuroticism, age also emerged as a statistically significant predictor. As noted above, this is expected given the well-established age-related visual field declines.

Conscientiousness. The relationship between Conscientiousness and UFOV performance was examined for exploratory purposes only. As noted previously, consistent with evidence for age-related declines in visual field extent and sensitivity, age emerged as the only significant predictor of UFOV performance, such that such that older participants had significantly higher UFOV sums than young participants. Our results are consistent with others (Zebec et al., 2011) who have found that Conscientiousness does not correlate with speed of information processing.

Agreeableness. Exploratory analyses revealed a significant linear interaction between age and Agreeableness. Our results suggest that with increasing age, Agreeableness has a protective effect on speed of information processing, such that high Agreeableness is associated with improved performance on the UFOV. These results are consistent with Zebec and colleagues' (2011) determination that performance among those high in Agreeableness was better on a measure of processing speed when compared to those low in Agreeableness. Given the literature suggesting that Agreeableness includes elements of compliance with increasing age, it is possible that older participants high in Agreeableness were more compliant with instructions provided by the researcher, thus resulting in improved test performance. In addition, the tendency toward being highly agreeable in an effort to please others (e.g., researcher) among those high in Agreeableness, may also account for the observed findings.

Openness-to-Experience. Unlike predictions, we did not observe lower performance (as evidenced by a higher UFOV sum) among individuals higher on Openness-to-Experience. Previous research has revealed high Openness-to-Experience to be associated with a disposition toward learning. However, in monotonous environments, those low on Openness-to-Experience would have an enhanced ability to focus on the task at hand and consequently be less at risk for a crash. The significant linear interaction between age and Openness-to-Experience suggests that Openness-to-Experience demonstrates varying effects on UFOV performance depending on age. Specifically, with increasing age, Openness-to-Experience has a protective effect on speed of information processing, such that high Openness-to-Experience is associated with a lower UFOV sum.

Sensation Seeking. The relationship between Sensation Seeking and the UFOV performance was examined for exploratory purposes only. A significant nonlinear interaction

emerged between age and Sensation Seeking in the prediction of the UFOV sum. Specifically, the effect of Sensation Seeking was diluted among those at both ends of the age continuum. The effect of Sensation Seeking on UFOV performance was demonstrated by a U-shaped function, such that high Sensation Seeking had the most pronounced effect among middle-aged drivers. The results suggest that in middle-aged drivers, high Sensation Seeking is associated with improved performance on the UFOV. Additional research is needed to determine the pathway through which Sensation Seeking influences UFOV performance.

Unexpected Findings

This study produced a number of unexpected findings. First, the nonlinear interaction of age and Conscientiousness in the prediction of unsafe simulated driving performance was unexpected. Given the well-established protective effect of high Conscientiousness in driving performance (both in previous studies and among middle-aged drivers in our sample) the diluted effect of Conscientiousness among the ends of the age continuum offers some indication that there may be differential predictability of particular types of personality traits across the lifespan.

Second, given the well-established association between personality and unsafe driver behaviour in the literature, the lack association between personality and self-reported unsafe driver behaviour was not expected. These results are unlike those of Schwebel and colleagues (2006; 2007) who found that personality was more closely related to self-reported unsafe driver behaviour than it was to unsafe driver behaviour on the simulator. We can only speculate why our results may have converged from theirs. One possibility is measurement. We used different self-report questionnaires to assess personality and driving behaviour possibly explaining the disparity. Measurement of unsafe driving behaviour could also partially explain the divergence. While Schwebel and colleagues (2007) raised concerns about whether their simulator was a

surrogate for real-world driving, previous research has examined the validity of our driving scenario (Bédard et al., 2010). The authors showed that the on-road driving behaviour of older adults was highly correlated ($r = .74$, $p = .035$) with simulated driving behaviour. In addition, our rather consistent demonstration of the classic U-shaped function relating simulated unsafe driver actions with age further enhances our confidence in the validity of our approach. These results suggest that the simulated driving scenario presented to participants in this study demonstrated relative validity (approximates on-road driving behaviour) and was representative of the types of decisions that drivers must make while negotiating actual roadways. In addition, our simulated driving scenario could have tapped somewhat different aspects of unsafe driving than those of Schwebel and colleagues (2006; 2007). Finally, participants were monitored from afar during the simulated drive by Schwebel and colleagues (2007). In our study the researcher remained in another room throughout the simulated drive, possibly enhancing the ecological validity of the drive. Performance was rated at a later date using the playback function of the simulator. Further work is need to explore these divergent findings.

Lastly, age was highly correlated with the UFOV sum ($r = .84$, $p < .01$). With the exception of Agreeableness and Sensation Seeking, age consistently emerged as a significant predictor of UFOV performance, such that increasing age was associated with increasing response time. While originally developed to examine age-related changes in the functional visual field (Bergen & Julesz, 1983), the literature in this field suggests that the UFOV has ecological validity in predicting driving outcomes among older drivers. In addition, researchers suggest that performance on the UFOV is more closely related to measures of cognition than vision (Ball, Owsley, Sloane, Roenker, & Bruni, 1993). As such, it is commonly used in medical and rehabilitation settings with clinical populations at risk for cognitive impairment (e.g., stroke,

traumatic brain injury, multiple sclerosis). In contrast with the above conjectures, our results suggest that UFOV performance may, in large part, reflect age associated biological changes (e.g., vision impairment). Further research examining UFOV performance among participants of the full age range is required.

Limitations and Directions for Future Research

There are a number of limitations that should be considered. While we chose the DBQ total score as a dependent measure of self-reported unsafe driving behaviour, as noted previously, the DBQ also yields important information about three broad factors of driving behaviour: lapses, violations, and errors. Reason et al. (1990), upon introduction of the DBQ, demonstrated that errors were statistically distinct from violations and as such, were governed by different psychological processes. In their meta-analysis investigating the relation of errors (which included lapses) and violations from the DBQ to crash involvement, de Winter and Dodou (2010) concluded that both errors and violations correlated positively with self-reported crash involvement. In addition, they determined that younger age, male gender, and greater exposure (as represented by increased mileage and more driving hours per week) were found to be related to more violations. Errors and lapses are more often reported by females, older drivers, and those driving more hours per week (de Winter & Dodou, 2010; Lajunen & Summala, 2003). Taken together, these results suggest that our reliance on an aggregated score (due to concerns noted previously, e.g., overfitting) in the prediction of self-reported unsafe driver behaviour may have resulted in failure to capture important relationships between self-reported driver behaviour and predictor variables. Future research will need to examine whether the subscales of the DBQ provide information beyond that afforded by the total score.

An additional limitation related to the manner in which participants were recruited. Participants were recruited through convenience sampling from undergraduate Psychology courses as well as from a number of community organizations. As such, it is possible that the sample may not be representative of the general population. For example, those who chose to participate may have differed from those who chose not to participate in a number of fundamental ways (e.g., driving exposure, personality traits). Consequently, it is possible that selection bias may have affected our results. There is evidence to support the contention that volunteers differ from non-volunteers. Specifically, volunteers tend to score higher on measures of Extraversion, Conscientiousness, Agreeableness, and Openness-to-Experience (Lönnqvist et al., 2007). It has been proposed that high Extraversion is associated with volunteering due to the extensive social interaction often required of participants. As high Conscientiousness is related to task or goal oriented behaviour, highly conscientious individuals might be more responsive to reward or incentive (e.g., course credit, monetary compensation). Volunteers are performing an agreeable action in consenting to a request for research participation, possibly explaining higher rates of Agreeableness among volunteers. Individuals high on the trait of Openness-to-Experience can be described as interested in novelty and stimulation; these needs can be addressed by participating in research studies (Lönnqvist et al., 2007). Lastly, it is possible that individuals high in Sensation Seeking may be attracted to participate as an outlet for their interest in and desire for novel experiences. Given the above findings, there are limits on the generalizability of the results. Relatedly, it is possible that the self-report of unsafe driver actions by participants who were students may have been underestimated due to limited access, if any, to a vehicle while enrolled in university. For example, their estimation of the frequency in which

they engage in the behaviours listed on the DBQ may have been biased due to limited access to a vehicle while away from home, thereby influencing the generalizability of the findings.

Furthermore, the recruitment of participants from a moderately sized community in Northwestern Ontario (Thunder Bay, Ontario) may also have influenced the generalizability of the findings. For example, it is possible that participants may have less exposure to challenging driving situations (e.g., complex intersections) thus possibly reducing the variability of self-reported unsafe driver behaviours. We should also note that the issue of exposure is skirted in these analyses. Some individuals drive more miles than others and therefore have greater opportunity to engage in unsafe driver actions. As such, exposure should be explored in greater detail in future research.

To remain consistent with the literature in this field, we relied solely on the DBQ as it is one of the most frequently used instruments for measuring aberrant driving behavior. Self-reports of driving behaviour, such as the DBQ, rely on participants' honesty and ability to give reasonably accurate and reliable responses (Lajunen & Summala, 2003). Ironically, the DBQ requires participants to report how often they failed to notice important information (e.g., pedestrians, cyclists) or to remember instances from their trips (e.g., forget where you left your car). In other words, participants are asked to recall information they did not notice or simply forgot (Lajunen & Summala, 2003). Survey results suggest that the forgetting rate of near-crashes is approximately 80% after a delay up to two weeks (Lajunen & Summala, 2003), thus casting doubt on participants' ability to recall relatively less risky behaviour (e.g., forgetting what gear you are in). Additionally, self-reports of driving behaviour have been plagued by "self-bias" among drivers of all ages (Freund et al., 2005; Holland, 1993; McCormick, Walkey, & Green, 1996). The illusory superiority phenomenon suggests that when people estimate their

position on a number of attributes, they ascribe higher levels of such attributes to themselves than to the average other or most others (Hoorens, 1993). It has long been asserted that, for the most part, drivers tend to believe they are better than average (Freund et al., 2005; Svenson, 1981). Earlier studies instructed subjects to rate how safely they drove in comparison to the average driver. In general, the results of these studies revealed that approximately 70% to 80% of drivers reported themselves to be in the safer half of the distribution (Svenson, 1981). Taken together, these results suggest that more research is needed to investigate the effects of forgetting and self-bias on the DBQ.

As noted previously, each of the Big Five higher-order traits comprises six lower-order traits. These lower-order traits enable identification of meaningful individual differences within each higher-order trait and may be overlooked if only the higher-order traits are examined (Costa & McCrae, 1992). Elander and colleagues (1993) argue that more reliable correlations between driver behaviour and personality dimensions could be obtained using subscales rather than overall scores. As such, it is possible that more meaningful predictions about the role of personality in the prediction of unsafe driver behaviour could have been observed had we used a more comprehensive measure (e.g., NEO PI-R; Costa & McCrae, 1992) of the five higher-order traits of personality as well as the six lower-order traits that define each higher-order domain. There is also evidence to suggest that there may be some multiplicative effect of personality traits in the prediction of unsafe driving (Dahlen et al, 2006), suggesting that future research should include interactions among personality traits. On a related note, while we included both the linear and quadratic components of age, we chose not to include the non-linear component of personality due to the possibility of overfitting the models. There is data to suggest that the association of age with personality traits may be nonlinear, approaching a flat line in middle age

(McCrae et al., 1999). Future research should consider the possibility that personality relates nonlinearly to age and unsafe driver behaviour.

While our prediction of UFOV test performance offered many interesting findings (particularly among older participants), further research would assist in ensuring that our findings can be generalized to different populations of drivers. In addition, Ball and colleagues (1988) have proposed that age-related visual field shrinkage can be reversed, at least partially with a small amount of practice. While the authors do not quantify how much practice is necessary, some of our participants had repeated exposure to the UFOV test within the year prior to their participation in the current study. As such, this introduces the possibility that previous exposure to the test resulted in improved performance. Future research should investigate whether the protective effects of Neuroticism, Agreeableness, and Openness-to-Experience are diluted among older participants with practice. It is also probable that personality did not exert an effect among young participants given the limited variability in UFOV test performance, whereas among older drivers, where greater variability exists, the effect of personality was most pronounced. Finally, Eysenck (1967) proposed a curvilinear relationship between personality and performance on measures of processing speed, offering further support for inclusion of both the linear and quadratic components of personality.

The use of virtual environments to measure risky driving behavior is rare in research aimed at predicting unsafe driving based on individual differences. For the present study, the driving simulator offered many advantages over testing participants on-road. Simulation enabled us to test all participants under the same conditions, regardless of weather. Given the extended period of time over which participants were tested (12 months), the simulator enabled us to ensure that adverse weather conditions did not influence driving behaviour. In addition, the

driving simulator offered a cost-effective alternative to real world naturalistic driving (or having an examiner in car) and enabled us to measure driver behaviour precisely in a controlled, safe environment (for the driver and evaluator; Bédard et al., 2010).

As this study is the first observational investigation of the role of personality in the prediction of unsafe driving behaviour among both young and older adults, it presents a number of findings worthy of further investigation. Given the protective effect of Conscientiousness among middle-aged participants, future work should ensure that middle-aged drivers are sampled in order to more accurately capture the effect of personality across the lifespan. Despite the difficulties inherent with longitudinal research designs (e.g., cost, high rate of attrition), they are recommended for future research as they allow for repeated observation of the same variables over longer periods of time, thus allowing researchers to make conclusions about trends across the life span.

One variable that was not studied, but that has been connected to unsafe driver behaviour is the effect of passengers. There is much research to suggest that drivers are adversely affected by the presence of passengers (Bédard & Myers, 2004). Future research is needed to test these hypotheses. For example, the crash rate of 16-19 year old males and females was doubled in the presence of passengers; this effect was not observed among drivers aged 20 to 59 (Doherty, Andrey, & MacGregor, 1998). In general, the presence of passengers exerts an overall protective effect among older drivers (Bédard & Myers, 2004). Further work is needed to explore whether personality moderates the relationship between passenger presence and unsafe driver behavior.

Overall, the current study suggests that personality appears to play some role, albeit a modest one, in the prediction of observed driving performance among older adults. Unlike existing research in this field, our results do not provide support for the role of personality in the

prediction of self-reported unsafe driver behaviour, thus raising considerable doubt about the continued use of self-report inventories as measures of driver behaviour. Furthermore, our results suggest that personality may not have equal effects on all groups of drivers, suggesting that prevention programs designed to reduce crash risk may need to be tailored depending on age. In addition, to the best of our knowledge, to date, there is no research examining the effect of personality on UFOV performance. Our results suggest that UFOV performance is most strongly predicted by age. Although high Neuroticism, Agreeableness, and Openness-to-Experience demonstrated protective effects on UFOV performance among older participants, further research is needed to determine whether personality moderates the relationships between UFOV and driving performance.

References

Al-Balbissi, A. H. (2003). Role of gender in road accidents. *Traffic Injury Prevention*, *4*(1), 64-73. doi:10.1080/15389580309857

Arnett, J. (1990). Drunk driving, sensation seeking, and egocentrism among adolescents. *Personality and Individual Differences, 11*(6), 541-546. doi:10.1016/0191-8869(90)90035-P

Arthur, W., & Doverspike, D. (2001). Predicting motor vehicle crash involvement from a personality measure and a driving knowledge test. *Journal of Prevention & Intervention in the Community, 22*(1), 35-42. doi:10.1080/10852350109511209

Arthur, W., & Graziano, W. G. (1996). The five-factor model, conscientiousness, and driving accident involvement. *Journal of Personality, 64*(3), 593-618. doi:10.1111/j.1467-6494.1996.tb00523

Babyak, M. (2004). What you see may not be what you get: A brief, nontechnical introduction to overfitting in regression-type models. *Psychosomatic Medicine, 66,* 411-421. doi:10.1097/01.psy.0000127692.23278.a9

Ball, K., Beard, B. L., Roenker, D. L., Miller, R. L., & Griggs, D. S. (1988). Age and visual search: expanding the useful field of view. *Journal of the Optical Society of America, 5*(12), 2210-2219. doi:10.1364/JOSAA.5.002210

Ball, K., & Owsley, C. (1993). The Useful Field of View test: A new technique for evaluating age related declines in visual function. *Journal of the American Optometric Association, 64(*1), 71-79.

Ball, K. K., Owsley, C., Sloane, M. E., Roenker, D. L., & Bruni, J. R. (1993). Visual attention problems as a predictor of vehicle crashes in older drivers. *Investigative Ophthalmology and Visual Science, 34,* 3110 –3123.

Beck, K. H., Wang, M. Q., & Mitchell, M. M. (2006). Concerns, dispositions and behaviors of aggressive drivers: What do self-identified aggressive drivers believe about traffic safety? *Journal of Safety Research, 37*, 159-165. doi:10.1016/j.jsr.2006.01.002

Bédard, M., Guyatt, G. H., Stones, M., & Hirdes, J. P. (2002). The independent contribution of driver, crash, and vehicle characteristics to driver fatalities. *Accident Analysis and Prevention, 34,* 717-727. doi:10.1016/S0001-4575(01)00072-0

Bédard, M., & Myers, A. (2004). The influence of passengers on older drivers involved in fatal crashes. *Experimental Aging Research ,30*, 205-215. doi: 10.1080=03610730490275111

Bédard, M., Parkkari, M., Weaver, B., Riendeau, J., & Dahlquist, M. (2010). Assessment of driving performance using a simulator protocol: Validity and reproducibility. *American Journal of Occupational Therapy, 64*(2), 336-340.

Bédard, M., Stones, M., Guyatt, G. H., & Hirdes, J. P. (2001). Traffic-related fatalities among older drivers and passengers: Past and future trends. *The Gerontologist, 41*(6), 751-756.

Bédard, M., Weaver, B., Dãrzin, P., & Porter, M. (2008). Predicting Driving Performance in Older Adults: We Are Not There Yet! *Traffic Injury Prevention, 9*(4), 336-341. 10.1080/15389580802117184

Bergen, J. R., & Julesz, B. (1983). Parallel versus serial processing in rapid pattern discrimination. *Nature, 303,* 696–698. doi:10.1038/303696a0

Bieliauskas, L. A. (2005). Neuropsychological assessment of geriatric driving competence. *Brain Injury*, *19*(3), 221-226. doi:10.1080/02699050400017213

Blows, S., Ameratunga, S., Ivers, R. Q., Lo, K. S., & Norton, R. (2005). Risky driving habits and motor vehicle driver injury. *Accident Analysis and Prevention, 37*, 619-624. doi:10.1016/j.aap.2005.03.003

Boyce, T., & Geller, E. S. (2002). An instrumented vehicle assessment of problem behavior and driving style: Do younger males really take more risks? *Accident Analysis and Prevention, 34*, 51-64. doi:10.1016/S0001-4575(00)00102-0

Canadian Council of Motor Transport Administrators. (2006). *2005 annual report on road safety vision 2010: Targets and action plan.* Ottawa, ON: Transport Canada.

Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology, 56*, 453-584. doi:10.1146/annurev.psych.55.090902.141913

Clarke, S., & Robertson, I. T. (2005). A meta-analytic review of the big five personality factors and accident involvement in occupational and non-occupational settings. *Journal of Occupational and Organizational Psychology, 78,* 355-376. doi:10.1348/096317905X26183

Cook, R. D., & Weisberg, S. (1982). *Residuals and influence in regression*. New York: Chapman & Hall.

Costa, P. T., & McCrae, R. R. (1985). *The NEO Personality Inventory manual.* Odessa, FL: Psychological Assessment Resources.

Costa, P. T., & McCrae, R. R. (1988). Personality in adulthood: A six-year longitudinal study of spouse reports and self-ratings on the NEO Personality Inventory. *Journal of Personality and Social Psychology, 54*(5), 853-863. doi:10.1037/0022-3514.54.5.85

Costa, P. T., & McCrae, R. R. (1992). *Revised NEO Personality Inventory (NEO PI-R) and NEO Five-factor Inventory (NEO-FFI): Professional Manual.* Odessa, FL: Psychological Assessment Resources.

Costa, P. T., & McCrae, R. R. (2006). Age changes in personality and their origins: Comment on Roberts, Walton, and Viechtbauer (2006). (2006). *Psychological Bulletin, 132*(1), 26-28. doi:10.1037/0033-2909.132.1.26

Dahlen, E. R., Martin, R. C., Ragan, K., & Kuhlman, M. M. (2005). Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving. *Accident Analysis and Prevention, 37*, 341-348. doi:10.1016/j.aap.2004.10.006

Dahlen, E. R., & White, R. P. (2006). The big five factors, sensation seeking, and driving anger in the prediction of unsafe driving. *Personality and Individual Differences, 41*, 903-915. doi:10.1016/j.paid.2006.03.016

de Winter, J. C. F., & Dodou, D. (2010). The Driver Behaviour Questionnaire as a predictor of accidents: A meta-analysis. *Journal of Safety Research, 41*, 463-470. doi:10.1016/j.jsr.2010.10.007

Dickerson, A. E., Molnar, L. J., Eby, J. W., Adler, G., Bédard, M., Berg-Weger, M., … Trujillo, L. (2007). Transportation and aging: A research agenda for advancing safe mobility. *The Gerontologist, 47*(5), 578-590. doi:10.1093/geront/47.5.578

Dobbs, B. (2008). Aging baby boomers – A blessing or challenge for driver licensing authorities. *Traffic Injury Prevention, 9*, 379-386. doi:10.1080/15389580802045823

Doherty, S. T., Andrey, J. C., & MacGregor, C. (1998). The situational risks of young drivers: The influence of passengers, time of day and day of week on accident rates. *Accident Analysis and Prevention, 30*, 45–52. doi:10.1016/S0001-4575(97)00060-2

Durbin, J., & Watson, G. S. (1951). Testing for serial correlation in least squares regression. II. *Biometrika, 38*(1/2), 159-177. doi:10.2307/2332325

Edman, G., Schalling, D., & Levander, S. E. (1983). Impulsivity and speed and errors in a reaction time task: A contribution to the construct validity of the concept of impulsivity. *Acta Psychologica, 53,* 1-8. doi:10.1016/0001-6918(83)90012-4

Edwards, J. D., Ross, L. A., Wadley, V. G., Clay, O. J., Crowe, M., Roenker, D. L., & Ball, K. K. (2006). The useful field of view test: Normative data for older adults. *Archives of Clinical Neuropsychology, 21,* 275-286. doi:10.1016/j.acn.2006.03.001

Edwards, J. D., Vance, D. E., Wadley, V. G., Cissell, G. M., Roenker, D. L., & Ball, K. K. (2005). Reliability and validity of useful field of view test scores as administered by personal computer. *Journal of Clinical and Experimental Neuropsychology, 27,* 529–543. doi:10.1080/13803390490515432

Elander, J., West, R., & French, D. (1993). Behavioral correlates of individual differences in road-traffic crash risk: An examination of methods and findings. *Psychological Bulletin, 113*(2), 279-294. doi:10.1037/0033-2909.113.2.279

Eysenck, H. J. (1962). *The structure of human personality*. London, UK: Methuen.

Eysenck, H. J. (1967). *The biological basis of personality.* Springfield, IL: Charles C. Thomas.

Fine, B. J. (1963). Introversion-Extraversion and motor vehicle driver behavior. *Perceptual and Motor Skills, 12,* 95-100. doi:10.2466/pms.1963.16.1.95

Freund, B., Colgrove, L. A., Burke, B. L., & McLeod, R. (2005). Self-rated driving performance among elderly drivers referred for driving evaluation. *Accident Analysis and Prevention, 37*, 613-618. doi:10.1016/j.aap.2005.03.002

Freund, B., Gravenstein, S., Ferris, R., & Shaheen, E. (2002). Evaluating driving

competence of cognitively impaired and healthy older adults: A pilot study comparing on-road and driving simulation performance. *Journal of the American Geriatrics Society*, *50*(7), 1309–1310. doi:10.1046/j.1532-5415.2002.50325.x

Furnham, A., & Saipe, J. (1993). Personality correlates of convicted drivers. *Personality and Individual Differences, 14*(2), 329-336. doi:10.1016/0191-8869(93)90131-L

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research, 26,* 499-510.

Hansen, C. P. (1989). A causal model of the relationship among accidents, biodata, personality, and cognitive factors. *Journal of Applied Psychology, 74*(1), 81-90. doi:10.1037/0021-9010.74.1.81

Health Canada & Transport Canada. (2005). *Road safety in Canada – An overview.* http://www.tc.gc.ca/roadsafety/stats/overview/2004/menu.htm.

Holland, C. A. (1993). Self-bias in older drivers' judgments of accident likelihood. *Accident Analysis and Prevention, 25*(4), 431-441. doi:10.1016/0001-4575(93)90072-5

Hoorens, V. (1993). Self-enhancement and superiority biases in social comparison. *European Review of Social Psychology, 4*(1), 113-139. doi: 10.1080/14792779343000040

Jonah, B. A. (1997). Sensation seeking and risky driving: A review and synthesis of the literature. *Accident Analysis and Prevention, 29*(5), 651-665. doi:10.1016/S0001-4575(97)00017-1

Jonah, B. A., Thiessen, R., & Au-Yueng, E. (2001). Sensation seeking, risky driving and behavioral adaptation. *Accident Analysis and Prevention, 33*, 679-684. doi:10.1016/S0001-4575(00)00085-3

Kua, A., Korner-Bitensky, N., Desrosiers, J., Man-Son Hing, M., & Marshall, S. (2007). Older driver retraining: A systematic review of evidence of effectiveness. *Journal of Safety Research, 38*, 81-90. doi:10.1016/j.jsr.2007.01.002

Lajunen, T. (2001). Personality and accident liability: Are extraversion, neuroticism, and psychoticism related to traffic and occupational fatalities? *Personality and Individual Differences, 31*, 1365-1373. doi:10.1016/S0191-8869(00)00230-0

Lajunen, T., Corry, A., Summala, H., & Hartley, L. (1997). Impression management and self-deception in traffic behaviour inventories. *Personality and Individual Differences, 22*(3), 341-353. doi:10.1016/S0191-8869(96)00221-8

Lajunen, T., & Summala, H. (2003). Can we trust self-reports of driving? Effects of impression management on driver behaviour questionnaire responses. *Transportation Research Part F: Traffic Psychology and Behaviour, 6*(2), 97-107. doi:10.1016/S1369-8478(03)00008-1

Larsen, R. J., & Buss, D. M. (2008). *Personality psychology: Domains of knowledge about human nature.* New York, NY: McGraw-Hill.

Lee, H. C., Cameron, D., & Lee, A. H. (2003). Assessing the driving performance of older adult drivers: On-road versus simulated driving. *Accident Analysis and Prevention, 35*, 797-803. doi:10.1016/S0001-4575(02)00083-0

Lester, J. (1991). *Individual differences in accident liability: Review of the literature.* (Contractors' Report No. 306). Crowthorne, UK: Transport and Road Research Laboratory.

Lewin, I. (1982). Driver training: A perceptual-motor skill approach. *Ergonomics, 25*(10), 917-924. doi:10.1080/00140138208925051

Lönnqvist, J-E., Paunonen, S., Verkasalo, M., Leikas, S., Tuulio-Henriksson, A., & Lönnqvist, J. (2007). Personality characteristics of research volunteers. *European Journal of Personality, 21*, 1017-1030. doi: 10.1002/per.655

Lyman, S., Ferguson, S. A., Braver, E.R., & Williams, A.F. (2002). Older driver involvements in police reported crashes and fatal crashes: trends and projections. *Injury Prevention, 8*(2), 116-120. doi:10.1136/ip.8.2.116

Machin, A. M., & Sankey, K. S. (2008). Relationships between young drivers' personality characteristics, risk perceptions, and driving behaviour. *Accident Analysis and Prevention, 40*, 541-547. doi:10.1016/j.aap.2007.08.010

Matthews, G., Dorn, L., & Glendon, I. (1991). Personality correlates of driver stress. *Personality and Individual Differences, 12*(6), 535-549. doi:10.1016/0191-8869(91)90248-A

McCormick, I. A., Walkey, F. H., & Green, D. E. (1996). Comparative perceptions of driver ability – A confirmation and expansion. *Accident Analysis and Prevention, 18,* 205-208. doi:10.1016/0001-4575(86)90004-7

McCrae, R.R., & Costa, P.T. (1994). The stability of personality: Observation and evaluations. *Current Directions in Psychological Science, 3,* 173-175. doi:10.1111/1467-8721.ep10770693

McCrae, R.R., & Costa, P.T. (1995). Trait explanations in personality psychology. *European Journal of Personality, 9*, 231-252. doi:10.1002/per.2410090402

McCrae, R.R., & Costa, P.T. (2003). *Personality in adulthood: A five factor theory perspective, 2nd Edition.* New York, NY: The Guilford Press.

McCrae, R. R., Costa, P. T., Pedroso de Lima, M., Simoes, A., Ostendorf, F., Angleitner, A., … Piedmont, R. L. (1999). Age differences in personality across the adult lifespan: Parallels

in five cultures. *Developmental Psychology, 35*(2), 466-477. doi:10.1037//0012-1649.35.2.466

McGwin, G. J., & Brown, D. B. (1999). Characteristics of traffic crashes among young, middle-aged, and older drivers. *Accident Analysis and Prevention, 31,* 181-198.

McGwin, G., Owsley, C., & Ball, K. (1998). Identifying crash involvement among older drivers: Agreement between self-report and state records. *Accident Analysis and Prevention, 30*(6), 781-791. doi:10.1016/S0001-4575(98)00031-1

Naggara, O., Raymond, J., Guilbert, F., Roy, D., Weill, A., & Altman, D. G. (2011). Analysis by categorizing or dichotomizing continuous variables variables is inadvisable: An example from the natural history of unruptured aneurysms. *American Journal of Neuroradiology, 32*, 437-440. doi:10.3174/ajnr.A2425

Oltedal, S., & Rundmo, T. (2006). The effects of personality and gender on risky driving behaviour and accident involvement. *Safety Science, 44,*621-628. doi:10.1016/j.ssci.2005.12.003

Olsen, R. E., & Dewar, P. L. (2007). *Human factors in traffic safety, Second edition.* Tucson, AZ: Lawyers & Judges Publishing Company, Inc.

Owsley, C., McGwin, G., & McNeal, S. F. (2003). Impact of impulsiveness, venturesomeness, and empathy on driving by older adults. *Journal of Safety Research, 34*, 353-359. doi:10.1016/j.jsr.2003.09.013

Ponds, R. W., Brouwer, W. H., & van Wolffelaar, P. C. (1988). Age differences in divided attention in a simulated driving task. *Journal of Gerontology, 43*, 151–156.

Reason, J., Manstead, A., Stradling, S., Baxter, J., & Campbell, K. (1990). Errors and violations on the roads: A real distinction? *Ergonomics, 31*, 1315-1332. doi:10.1080/00140139008925335

Renner, W., & Anderle, F-G. (2000). Venturesomeness and extraversion as correlates of juvenile drivers' traffic violations. *Accident Analysis and Prevention, 32,* 673-678. doi:10.1016/S0191-8869(00)00230-0

Rizzo, M., McGehee, D. V., Dawson, J. D., & Anderson, S. N. (2001). Simulated car crashes at intersections in drivers with Alzheimer disease. *Alzheimer Disease and Associated Disorders*, *15*, 10 – 20. doi:10.1097/00002093-200101000-00002

Roberts, B. W., Robins, R. W., Trzesniewski, K., & Caspi, A. (2003). Personality trait development in adulthood. In J. Mortimer & M. Shanahan (Eds.), *Handbook of the Life Course* (pp. 579-598). New York: Kluwer Academy.

Schwebel, D. C., Ball, K. K., Severson, J., Barton, B. K., Rizzo, M., & Viamonte, S. M. (2007). Individual difference factors in risky driving among older drivers. *Journal of Safety Research, 38*, 501-509. doi:10.1016/j.jsr.2007.04.005

Schwebel, D. C., Severson, J., Ball, K. K., & Rizzo, M. (2006). Individual difference factors in risky driving: The roles of anger/hostility, conscientiousness, and sensation-seeking. *Accident Analysis and Prevention, 38*, 801-810. doi:10.1016/j.aap.2006.02.004

Simon, F., & Corbett, C. (1996). Road traffic offending, stress, age, and accident history among male and female drivers. *Ergonomics, 39,* 757-780. doi:10.1080/00140139608964497

Smith, D. I., & Kirkham, R. W. (1981). Relationship between some personality characteristics and driving record. *British Journal of Social Psychology, 20,* 229-231. doi:10.1111/j.2044-8309.1981.tb00491.x

Socan, G., & Bucik, V. (1998). Relationship between speed of information-processing and two major personality dimensions - Extraversion and neuroticism. *Personality and Individual Differences, 25*(1), 35-48.

Stanford, M. S., Greve, K. W., Boudreaux, J. K., Mathias, C. W., & Brumbelow, J. L. (1996). Impulsiveness and risk-taking behavior: Comparison of high-school and college students using the Barratt impulsiveness Scale. *Personality and Individual Differences, 21,* 1073-1075. doi:10.1016/S0191-8869(96)00151-1

Stanney, K., Salvendy, G., Deisinger, J., DiZio, P., Ellis, S., Ellison, J., …Witmer, B. (1998). Aftereffects and sense of presence in virtual environments: Formulation of a research and development agenda. *International Journal of Human-Computer Interaction, 10,* 135-187. doi:10.1207/s15327590ijhc1002_3

Stelmack, R. M., Houlihan, M., & McGarry-Roberts, P. A. (1993). Personality, reaction time, and event-related potentials. *Journal of Personality and Social Psychology, 65*(2), 399-409. doi:10.1037//0022-3514.65.2.399

Steyerberg, E. W. (2009). *Clinical prediction models: A practical approach to development, validation, and updating.* New York, NY: Springer Science+Business Medica, LLC.

Sümer, N., Lajunen, T., & Ozkan, T. (2005). Big five personality traits as the distal predictors of road accident involvement. In G. Underwood (Eds.), *Traffic & Transport Psychology: Theory and Application* (pp. 215-230). Oxford, UK: Elsevier Ltd.

Svenson, O. (1981). Are we all less risky and more skillful than our fellow drivers? *Acta Psychologica, 47*, 143-148. doi:10.1016/0001-6918(81)90005-6

Tabachnick, B. G., & Fidell, L. S. (2001). *Using Multivariate Statistics, 4th Edition*. Needham Heights, MA: Allyn & Bacon.

Tellegen, A. (1991). Personality traits: Issues of definition, evidence, and assessment. In W.M. Grove and D. Cicchetti (Eds.), *Thinking clearly about psychology: Personality and psychopathology, Vol. 2* (pp. 10-35). Minneapolis, MN: University of Minnesota.

Tillmann, W.A., & Hobbs, G. E. (1949). The accident-prone automobile driver. *American Journal of Psychiatry, 106,* 321-331.

Transport Canada (2007). *Canadian Motor Vehicle Traffic Collision Statistics: 2003*. http://www.tc.gc.ca/eng/roadsafety/tp-tp3322-2003-page2-632.htm

Trimpop, R., & Kirkcaldy, B. (1997). Personality predictors of driving accidents. *Personality and Individual Differences, 23*(1), 147-152. doi:10.1016/S0191-8869(97)00017-2

Weaver, B., Bédard, M., McAuliffe, J., & Parkkari, M. (2009). Using the Attention Network Test to predict driving test scores. *Accident Analysis and Prevention, 41*, 76-83. doi:10.1016/j.aap.2008.09.006

West, R., Elander, J., & French, D. (1993). Mild social deviance, Type-A behaviour pattern and decision-making style as predictors of self-reported driving style and traffic accident risk. *British Journal of Psychology, 84*(2), 207-219. doi:10.1111/j.2044-8295.1993.tb02474.x

Whitfield, R. A., & Fife, D. (1987). Changing patterns in motor vehicle crash mortality: 1940-1980. *Accident Analysis and Prevention, 19,* 261-269. doi:10.1016/0001-4575(87)90061-3

Wolfe (1989). Correlates of adapative and maladaptive musical performance. *Medical Problems of Performing Artists, 4*(1), 49-56.

Zebec, M. S., Kopacevic, D., & Mlacic, B. (2011). Relationship between the big-five personality dimensions and speed of information processing among adolescents. *Journal for General Social Issues, 20*(2), 435-455.

Zuckerman, M. (1994). *Behavioral expressions and biosocial bases of sensation seeking*. New York, NY: Cambridge University Press.

Zuckerman, M., Eysenck, S. B. G., & Eysenck, H. J. (1978). Sensation seeking in England and America: Cross-cultural, age and sex comparisons. *Journal of Consulting and Clinical Psychology, 46,* 139-149. doi:10.1037//0022-006X.46.1.139

Zuckerman, M., & Neeb, M. (1980). Demographic influences in sensation seeking and expressions of sensation seeking in religion, smoking, and driving habits. *Personality & Individual Differences, 1,* 197-206. doi:10.1016/0191-8869(80)90051-3

Appendix A

Demographic Questionnaire

Demographic Questionnaire

1. Name _____

2. Date of birth (dd/mm/yyyy) _____/_____/_____

3. Sex

[ ] Male [ ] Female

4. Mailing address (including postal code)

_____

_____

_____

5. Phone number: ( ) _____

6. Email address (if applicable)

_____

7. How old were you when you started driving? _____

Appendix B

Driving History/Habits Questionnaire

Driving History/Habits Questionnaire

1. Date (dd/mm/yyyy) _____/_____/_____

2. Approximately how many **kilometres (miles)** do you drive per week?

[ ] 0-20 km (0-12 m) [ ] 51-100 km (32-62 m)
[ ] 21-50 km (13-31 m) [ ] over 100 km (> 62 m)

3. How long ago was your last car accident involving a person, car, or fixed object?

[ ] Less than 1 year [ ] 4-5 years
[ ] 1-2 years [ ] 5-10 years
[ ] 2-3 years [ ] More than 10 years
[ ] 3-4 years [ ] Never had an accident

4. When driving, how many accidents (involving a person, car, or fixed object) have you been involved in? (*Do not include cases where you were a passenger*) _____

For how many of these was reporting to the police deemed unnecessary? _____

5. For what purposes do you drive in a **typical week**? *(Check all that apply to you)*

	How many times per week?
[ ] Groceries	_____
[ ] Other shopping (e.g., drug store, clothes shopping)	_____
[ ] Health-related appointments (e.g., doctor, dentist)	_____
[ ] Social events (e.g., recreation centres, friends)	_____
[ ] Worship (e.g., church, synagogue, etc.)	_____
[ ] Hobby-related (e.g., attend classes)	_____
[ ] Work, school, or volunteer activities	_____
[ ] Family events	_____
[ ] Other, please specify _____	_____

6. Which driving situation(s) do you find stressful, uncomfortable, or avoid when possible? *(Check all that apply to you)*

[ ] Turning left at intersections [ ] Navigating parking lots

[ ] Driving at night
[ ] Backing up
[ ] Parallel parking
[ ] Driving in unfamiliar areas
[ ] Driving with passengers in the car
[ ] Driving alone
[ ] Changing lanes
[ ] Maintaining the speed limit
[ ] Driving in bad weather
[ ] Driving in heavy traffic
[ ] Other _____
[ ] None of the above

7. Some people restrict their driving to certain situations. Do you restrict your driving to: *(Check all that apply to you)*

[ ] Daytime
[ ] When accompanied by a passenger
[ ] Outside of rush hour
[ ] Local routes
[ ] Fair weather
[ ] Other _____
[ ] None of the above

8. With regard to the speed limit on **local streets** (posted speed limit of 50 km/hr), do you typically drive:

[ ] 35 km/hr or less
[ ] 36-45 km/hr
[ ] 46-55 km/hr
[ ] 56-65 km/hr
[ ] 66 km/hr or more

9. With regard to the speed limit on **major highways** (posted speed limit of 90 km/hr), do you typically drive:

[ ] 85 km/hr or less
[ ] 86-95 km/hr
[ ] 96-105 km/hr
[ ] 106-115 km/hr
[ ] 116 km/hr or more

Appendix C

Driving Behaviour Questionnaire

No.	Driving Behaviour Questionnaire Please indicate, on average, how frequently you engage in the following behaviours using the scale below: **0 = never 1 = hardly ever 2 = occasionally 3 = quite often** **4 = frequently 5 = very frequently**						
1	Check your speedometer and discover that you are unknowingly traveling faster than the legal limit.	0	1	2	3	4	5
2	Lock yourself out of your car with the keys still inside.	0	1	2	3	4	5
3	Become impatient with a slow driver in the outer lane and overtake on the inside.	0	1	2	3	4	5
4	Drive as fast along country roads at night with headlights on low as on high beam.	0	1	2	3	4	5
5	Attempt to drive away without first having switched on the ignition,	0	1	2	3	4	5
6	Drive especially close or ‘flash’ the car in front as a signal to drive faster or get out of your way.	0	1	2	3	4	5
7	Forget where you left your car in a multi-level car park.	0	1	2	3	4	5
8	Get distracted or preoccupied, realize belatedly that the vehicle ahead has slowed, and have to slam on the brakes to avoid a collision.	0	1	2	3	4	5
9	Intend to switch on the windshield wipers, but switch on the lights instead, or vice versa.	0	1	2	3	4	5
10	Turn left on to a main road into the path of an oncoming vehicle that you hadn’t seen or who’s speed you had misjudged.	0	1	2	3	4	5
11	Misjudge the gap between parked cars and nearly (or actually) hit the adjacent vehicle.	0	1	2	3	4	5
12	“Wake up” to realize that you have no clear recollection of the road along which you have just traveled.	0	1	2	3	4	5
13	Miss your exit on a motorway and have to make a lengthy detour.	0	1	2	3	4	5
14	Forget which gear you are currently in and have to check with your hand.	0	1	2	3	4	5
15	Stuck behind a slow moving vehicle on a two-lane highway, you are driven by frustration to try to over-take in risky circumstances.	0	1	2	3	4	5
16	Intending to drive to destination ‘A’, you “wake up” to find yourself on route to ‘B’, where the latter is more the usual journey.	0	1	2	3	4	5

17	Take a chance and cross on lights that have turned red.	0	1	2	3	4	5
18	Angered by another driver's behaviour, you give chase with the intention of giving him/her a piece of your mind.	0	1	2	3	4	5
19	Try to overtake without first checking in your mirror, and then get honked at by the car behind you which has already begun its overtaking maneuver.	0	1	2	3	4	5
20	Deliberately disregard the speed limits late at night or very early in the morning.	0	1	2	3	4	5
21	Forget that your licence/plates have expired and discover that you are driving illegally.	0	1	2	3	4	5
22	Lost in thought, you forget that your lights are on high beam until 'flashed' by another vehicle.	0	1	2	3	4	5
23	On turning right, nearly hit a cyclist who has come up on your inside.	0	1	2	3	4	5
24	In a line of vehicles turning right on to a main road, pay such close attention to the traffic approaching from the left that you nearly hit the car in front.	0	1	2	3	4	5
25	Drive back from a party, restaurant, or pub, even though you realize that you may be over the legal blood-alcohol limit.	0	1	2	3	4	5
26	Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can.	0	1	2	3	4	5
27	Lost in thought or distracted, you fail to notice someone waiting at a crosswalk or a pedestrian crosswalk light that has just turned red.	0	1	2	3	4	5
28	Park in a no parking area and risk a fine.	0	1	2	3	4	5
29	Misjudge the speed of an oncoming vehicle when overtaking.	0	1	2	3	4	5
30	Hit something when backing up that you had not previously seen.	0	1	2	3	4	5
31	Fail to notice someone stepping out from behind a bus or parked vehicle until it is nearly too late.	0	1	2	3	4	5
32	Plan your route badly, so that you meet traffic congestion you could have avoided.	0	1	2	3	4	5
33	Overtake a single line of stationary or slow-moving vehicles, only to discover that they were lining up to get through a one-lane gap or roadwork lights.	0	1	2	3	4	5
34	Overtake a slow-moving vehicle on the inside lane or hard shoulder of a motorway.	0	1	2	3	4	5

35	Cut the corner on a left-hand turn and have to swerve violently to avoid an oncoming vehicle.	0	1	2	3	4	5
36	Get into the wrong lane to make a left or right hand turn at an intersection.	0	1	2	3	4	5
37	Fail to read the signs correctly and exit from a highway on the wrong road.	0	1	2	3	4	5
38	Fail to give right of way when a bus is signaling its intention to pull out.	0	1	2	3	4	5
39	Ignore yield signs and narrowly avoid colliding with traffic that has the right of way.	0	1	2	3	4	5
40	Fail to check your mirror before pulling out, changing lanes, turning etc.	0	1	2	3	4	5
41	Attempt to overtake a vehicle that you hadn't noticed was signaling its intention to turn left.	0	1	2	3	4	5
42	Deliberately drive the wrong way down a deserted one-way street	0	1	2	3	4	5
43	Disregard red lights when driving late at night along empty roads.	0	1	2	3	4	5
44	Drive with only 'half-an-eye' on the road while looking at a roadmap, dialing/text messaging on a cell phone, changing a cassette/CD or radio channel.	0	1	2	3	4	5
45	Fail to notice pedestrians crossing when turning into a side-street from a main road.	0	1	2	3	4	5
46	Get involved in unofficial 'races' with other drivers.	0	1	2	3	4	5
47	'Race' oncoming vehicles for a one-car gap on a narrow or obstructed road.	0	1	2	3	4	5
48	Brake too quickly on a slippery road and/or steer the wrong way in a skid.	0	1	2	3	4	5
49	Misjudge your crossing interval when turning left and narrowly miss colliding with an oncoming vehicle.	0	1	2	3	4	5

Appendix D

Psychology 1100 Students - Participant Cover Letter

Cover Letter

The Role Of Personality In Predicting Unsafe Driver Behaviour In Young and Older Adults

Dear Potential Participant:

Thank you for taking part in this research study investigating the role of personality in predicting driver behaviour.

During this study you will be asked to complete a series of questionnaires, two computerized tasks (one to assess processing speed and one to measure attention), and a 30-minute simulated drive. This study will take approximately 1.5 – 2 hours to complete.

This research project is being conducted under the supervision of Dr. Michel Bédard and Dr. Michael Stones and has been approved by the Lakehead University Senate Research Ethics Board. Only Dr. Bédard, Dr. Stones, and I will have access to the information you provide. Your performance will be coded by an assigned subject number insuring anonymity and confidentiality. The information will be securely stored in the Lakehead University Driving Laboratory (BB1026) at Lakehead University for five years. Upon completion of the study, it is the intent of the researchers to publish or make public presentations based on the research. Please note that your identity will remain anonymous.

Participation in this research study is completely voluntary and you may decline to answer any question or refuse to participate in any part of this study. If for any reason you wish to withdraw from the study you may do so at any time without penalty. There is no danger of physical or psychological harm (other than that normally encountered when working on a personal computer for 60 minutes) associated with participation in this study. You will receive 2 Psychology 1100 bonus points for your participation.

A report of findings will be available to those interested upon request. If you require additional information please do not hesitate to contact one of the researchers.

Thank you,

Julie Riendeau, M.A.
PhD student, Clinical Psychology
Department of Psychology
Lakehead University
Phone: (807) 766-7256
Email: jariende@lakeheadu.ca

Michel Bédard, PhD
Canada Research Chair in Aging and Health
Director, Interdisciplinary Program for
Research on Safe Driving
Lakehead University
Phone (807) 343-8630
Email: mbedard@lakeheadu.ca

Michael Stones, PhD
Professor
Department of Psychology
Phone: (807) 343-8994
Email: michael.stones@lakeheadu.ca

Office of Research
Lakehead University
Phone: (807) 766-7289

Appendix E

All Other Participants - Participant Cover Letter

Cover Letter

The Role Of Personality In Predicting Unsafe Driver Behaviour In Young and Older Adults

Dear Potential Participant:

Thank you for taking part in this research study investigating the role of personality in predicting driver behaviour.

During this study you will be asked to complete a series of questionnaires, two computerized tasks (one to assess processing speed and one to measure attention), and a 30-minute simulated drive. This study will take approximately 1.5 – 2 hours to complete.

This research project is being conducted under the supervision of Dr. Michel Bédard and Dr. Michael Stones and has been approved by the Lakehead University Senate Research Ethics Board. Only Dr. Bédard, Dr. Stones, and I will have access to the information you provide. Your performance will be coded by an assigned subject number insuring anonymity and confidentiality. The information will be securely stored in the Lakehead University Driving Laboratory (BB1026) for five years. Upon completion of the study, it is the intent of the researchers to publish or make public presentations based on the research. Please note that your identity will remain anonymous.

Participation in this research study is completely voluntary and you may decline to answer any question or refuse to participate in any part of this study. If for any reason you wish to withdraw from the study you may do so at any time without penalty. There is no danger of physical or psychological harm (other than that normally encountered when working on a personal computer for 60 minutes) associated with participation in this study. There are no direct benefits associated with participation in this study.

A report of findings will be available to those interested upon request. If you require additional information please do not hesitate to contact one of the researchers.

Thank you,

Julie Riendeau, M.A.
PhD student, Clinical Psychology
Department of Psychology
Lakehead University
Phone: (807) 766-7256
Email: jariende@lakeheadu.ca

Michel Bédard, PhD
Canada Research Chair in Aging and Health
Director, Interdisciplinary Program for Research on Safe Driving
Lakehead University
Phone: (807) 343-8630
Email: mbedard@lakeheadu.ca

Michael Stones, PhD
Professor
Department of Psychology
Phone: (807) 343-8994
Email: michael.stones@lakeheadu.ca

Office of Research
Lakehead University
Phone: (807) 766- 7289

Appendix F

Participant Consent Form

CONSENT FORM

The Role Of Personality In Predicting Unsafe Driver Behaviour In Young and Older Adults

My signature on this form indicates that I agree to participate in this study investigating the role of personality in predicting driver behaviour. This study is being conducted by Julie Riendeau in the Department of Psychology for her PhD dissertation under the supervision of Dr. Michel Bédard and Dr. Michael Stones. I understand that my participation in this study is conditional on the following:

1. I have read and understand the cover letter for this study.
2. I fully understand what I will be required to do as a participant in this study.
3. Participation in this research study is completely voluntary and I may decline to answer any question, refuse to participate in any part of this study, or withdraw at any time without reprisal.
4. There are no major physical or psychological risks associated with participation in this study. The physical risk will be the same as that of working with a personal computer for 60 minutes.
5. My data will be confidential and stored in the Lakehead University Driving Simulator Laboratory for a period of five years.
6. Should the researchers publish or make public presentations based on this research my identity will remain anonymous.
7. I will receive a summary of the project, upon request, following the completion of the project.

I agree to participate in the study entitled *"The Role Of Personality In Predicting Unsafe Driver Behaviour In Young and Older Adults"*.

_____

Signature of Participant Date

I agree to be contacted regarding future studies being conducted by researchers in the Lakehead University Driving Simulator Laboratory.

_____

Signature of Participant Date

Email Address: _____

Phone Number: ( ) _____